BYTE®

the small systems journal

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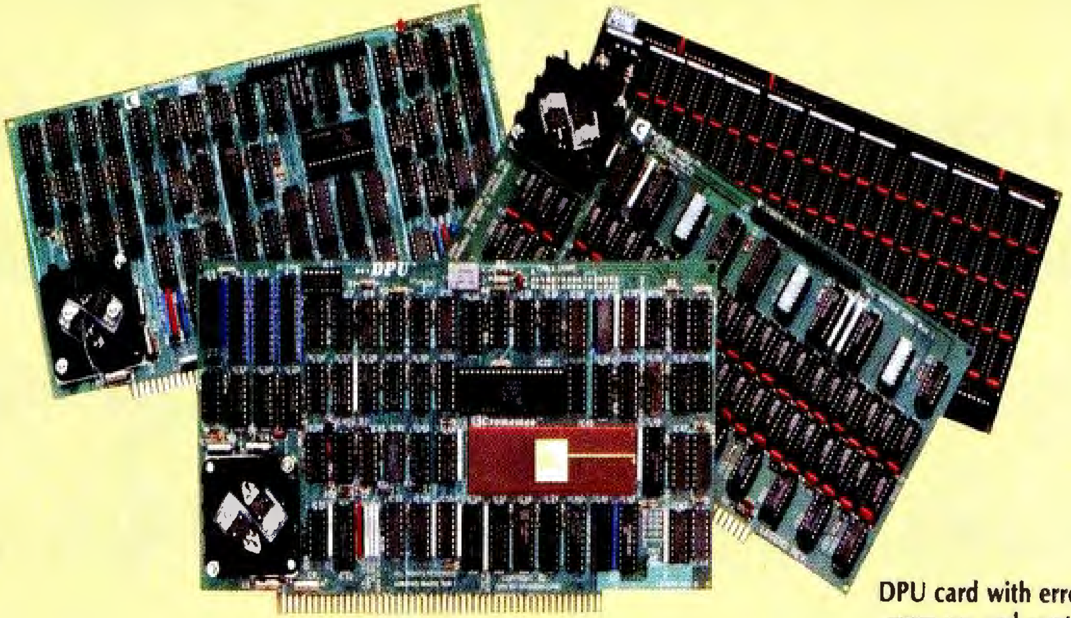

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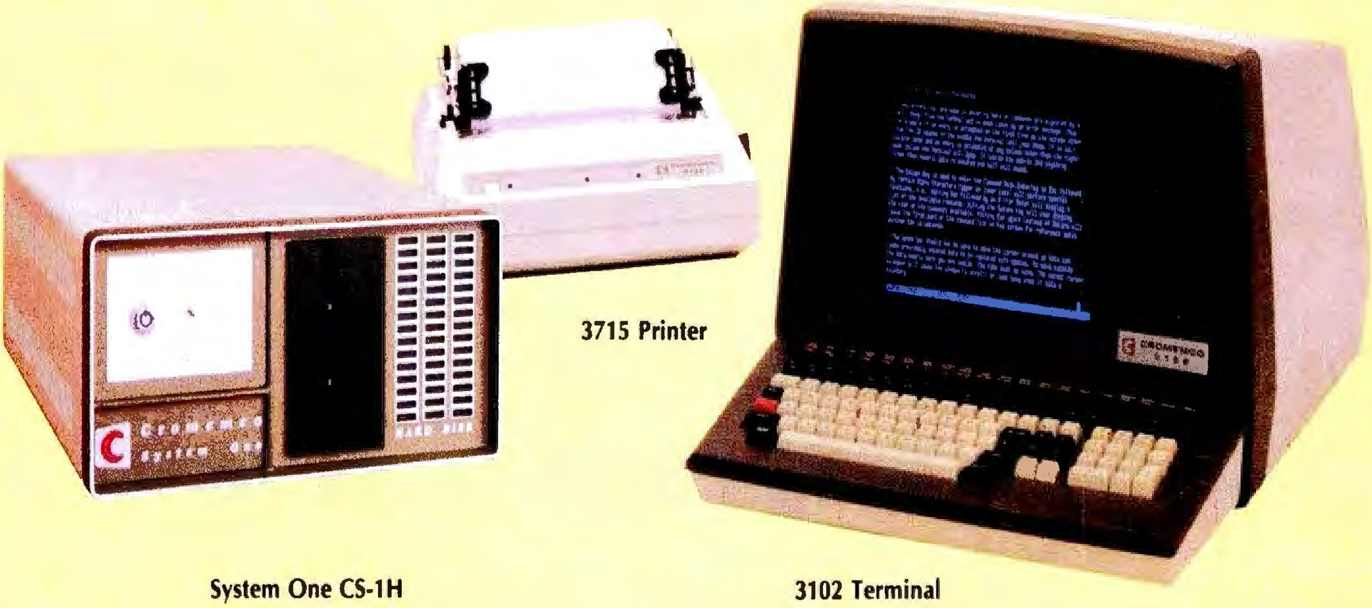

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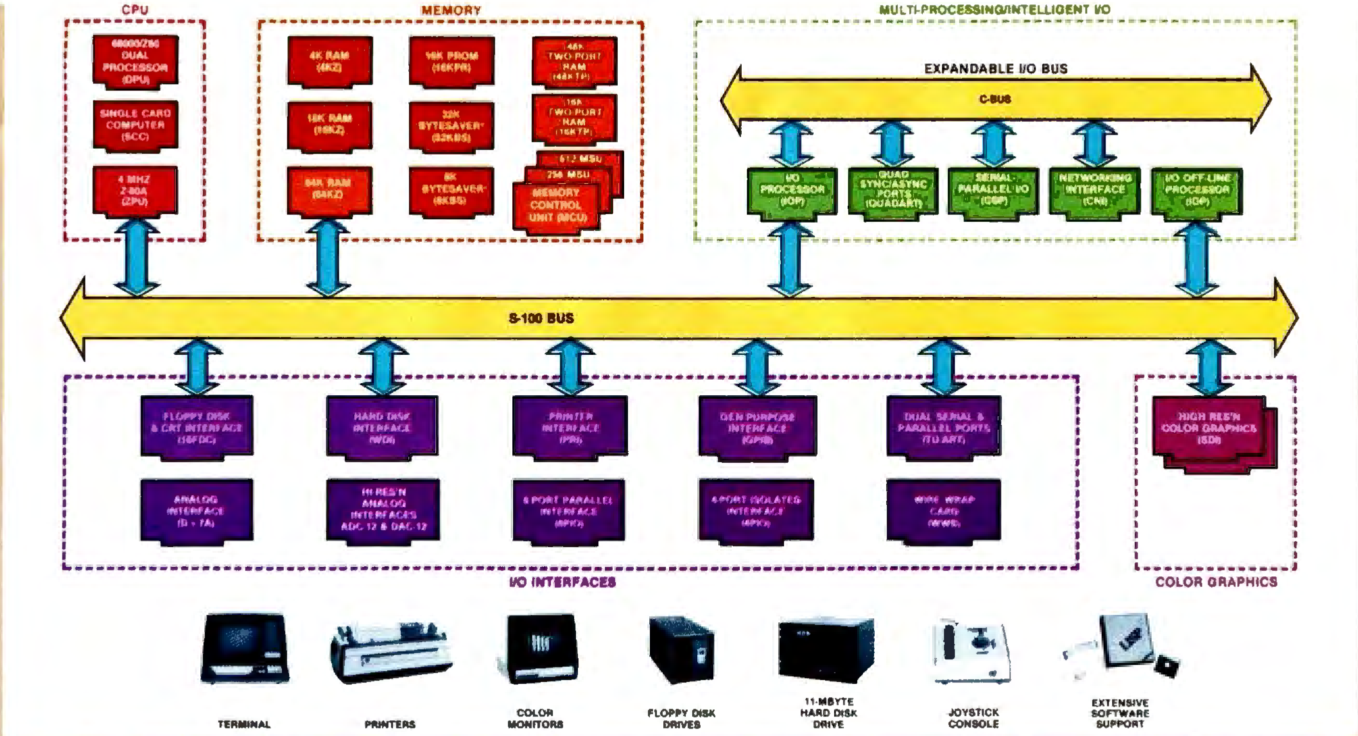

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In The Queue

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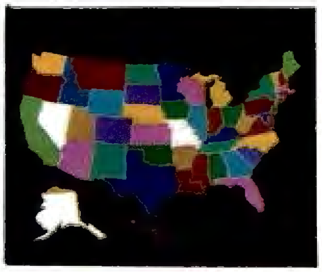

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In This Issue

The availability of small, powerful, and inexpensive computers has brought the power of the computer out of its traditional domain—science, mathematics, engineering, and business-data processing—and into the hands of historians, anthropologists, artists, musicians, political scientists, and others involved in the humanities, arts, and social sciences. Philip Schrodt (of "The Generic Word Processor" fame) presents a program to predict wars in his article "Microcomputers in the Study of Politics." Kevin McKean shows how computers can spin tall yarns in "Computers, Fiction, and Poetry,"and Wayne Holder helps you spin them yourself in "Software Tools for Writers." Ned and Lou Heite present their views on what is needed to advance the use of computers in the humanities in "Breaking the Jargon Barrier: Designing Programs for Humanists." We also have a computer simulation of neighborhood segregation, a program for measuring people's attitudes, and more.

Roger Taylor and Phil Lemmons conclude their two-part article "Upward Migration" with an in-depth comparison of CP/M-86 and MS-DOS, and their findings may surprise you. Jerry Pournelle gives his impressions of the West Coast Computer Faire in "Computers for Humanity," Steve Ciarcia shows you how to create sound effects with your computer, and William Barden Jr. illustrates how to use the RS-232C port on TRS-80 Models I and III. A generous sprinkling of product reviews and regular features round out our July issue.

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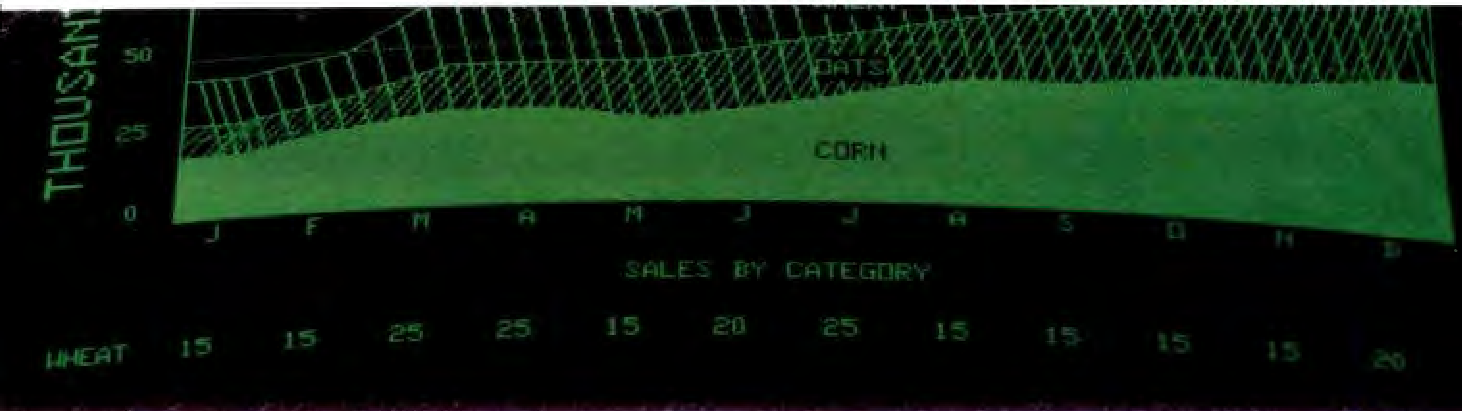
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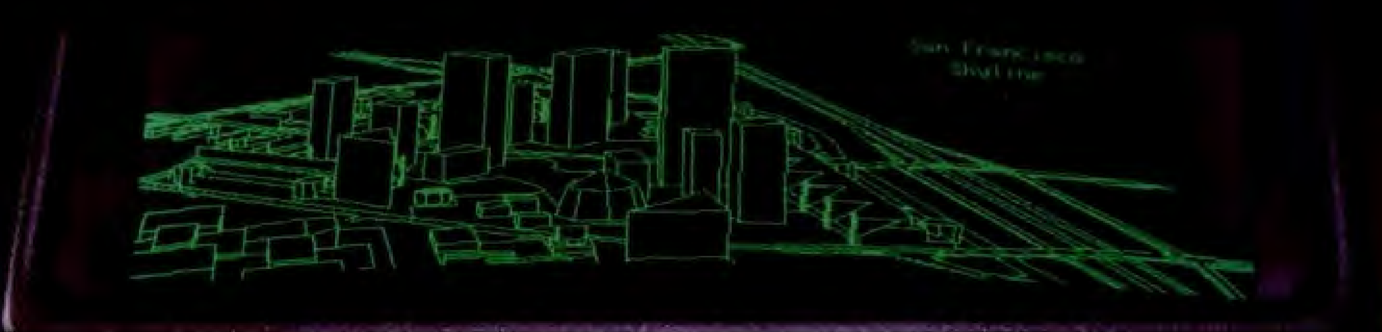

Editorial

The Briefcase Computer Market Heats Up

by Chris Morgan, Editor in Chief

Last April I predicted that "within two years the market will be flooded with portable computers having built-in screens of every size and shape." My prediction is coming true sooner than I expected. Several machines on the market now feature flat-screen displays; the most heralded is the Compass computer from Grid Systems in Mountain View, California. The Compass has many fascinating features. At $8150, though, it's in the premium class. But some competitively priced machines have sprung up as well. This month I'll examine some of the new briefcase computers.

Diverse in price, size, and quality, these new briefcase computers have at least one thing in common: they use a flat screen rather than a cathode-ray tube to display characters. Several technologies exist for building flat-screen displays, but the two that currently dominate the field are liquid-crystal displays (LCDs) and electroluminescent displays. (The Osborne 1 computer, though it qualifies as a portable computer because of its size, uses a conventional 5-inch CRT.)

Liquid-crystal displays can be found in the IXO Telecomputing System (featured on the April 1982 BYTE cover); the Epson HX-20 (April 1982 BYTE, page 104); the Toshiba T100 (May 1982 BYTE, page 109); the Panasonic Link—formerly known as the HHC (January 1981 BYTE, page 34); the Sharp-manufactured Radio Shack Pocket Computer (January 1981 BYTE, page 45); and several other models. The Grid Compass is currently the sole example of an electroluminescent-display computer. (The display is manufactured by Sharp in Japan.)

Photo 1: *Compass computer from Grid Systems.*

Photo 2: *Teleram T-3000.*

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Photo 3: *The T-3000's liquid-crystal display is the best around. The characters stand out clearly against a light, nonglare background.*

Although electroluminescent displays offer a superior image, they consume a lot of power—so much that they cannot be battery operated as can LCDs. So the otherwise portable Compass computer has to be plugged into an AC receptacle. The Compass, however, offers compensations, such as a sophisticated custom operating system and a simplified set of "modeless" commands that let you, say, jump out of a word-processing program, do some calculations, and jump back in with a minimum of fuss. At present, the Compass is available to corporate customers only; the first delivery is scheduled for September. It will be available in quantity to consumers some time in 1983.

A Good Portable Computer for Writers?

I do a lot of writing in remote places, and I've searched for a battery-operated computer that will let me use Wordstar, Magic Wand, or a similar word-processing program to write articles, edit them, and relay them back to the office via phone. None of the computers listed above, including the Compass, completely fits my needs. They don't accept commonly available software, or they are not truly portable. The Sony Typecorder doesn't make it, either. The Typecorder is a portable, dedicated word processor with a one-line LCD display. Unfortunately, its editing function controls are awkward to use, and only half a line of text can be displayed at once. The Typecorder falls just short of being a really useful product. A multiline display would help immeasurably. And that brings me to another new electronic aid for writers: Teleram's new T-3000.

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The T-3000, which will probably sell for less than $3000, has all the right features. It's small in size and

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weight (13 by 9¾ by 3½ inches, under 10 pounds); battery powered with rechargeable batteries; it has an 80-column by 4-line liquid-crystal display that tilts for better visibility; it has built-in bubble memory with up to 256K bytes (the bubble memory emulates drive A in the CP/M environment, thus letting the user run CP/M programs); 64K bytes of RAM; 4K bytes of ROM; a low-power version of the Z80 processor; standard keyboard with 16 function keys and a numeric keypad; and an RS-232C interface. An office module is also available from Teleram that lets you add a video monitor, up to four 5¼-inch floppy-disk drives, printers, additional bubble memory, and other peripherals.

Teleram, with headquarters in White Plains, New York, has been manufacturing portable computer terminals for reporters and writers for several years. On a recent trip to the Teleram offices I auditioned a prototype of the T-3000. Its most striking feature is the liquid-crystal display. It's the best-quality LCD I've seen. Characters stand out in sharp relief against a light, matte-finish background. Readability is good even at 45 degrees off axis. But the screen flips up during use, so angles shouldn't be a problem.

The keyboard layout is simple and logical, making it comfortable to use. And with an overlay, the 16 function keys could be used with word processors and the like.

As of this writing, Teleram plans to offer a variety of software with the machine, including a word processor (Wordstar or equivalent), a spread-sheet program, and a BASIC package (to be determined). The LCD acts as a "window" onto a standard 80-character by 24-line screen. Separate window and cursor controls let you move around on the page.

The T-3000 uses lead-acid batteries (the same technology as car batteries) rather than the more common nickel-cadmium batteries. Lead-acid batteries cost much less, but cannot be allowed to discharge too far lest they lose their recharging efficiency. To prevent this, the T-3000 gives you two separate warnings when the batteries get low. If you still fail to turn the machine off, the computer then saves the current file and turns itself off. The batteries should last for a minimum of five hours between charges, even longer when using a word processor because word processing does not unduly exercise the power-consuming bubble memories.

So it *is* possible to create a relatively inexpensive computer with real word-processing capability. Teleram has done an excellent job with the T-3000. I'll be using it over the coming months, and I expect to write an update later this year. By then there should be many more briefcase computers on the market from both Japanese and American manufacturers. I like the trend. ■

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How New Is Skip Sequential?

I share Jack Purdum's enthusiasm for what he calls the Skip Sequential file processing method (see "Skip Sequential: A New File Structure for Microcomputers," March 1982 BYTE, page 466). Certainly a number of BASIC programmers will realize enhanced file processing with this very simple and elegant technique. However, I want to call to the attention of both Mr. Purdum and your readers the fact that the term "skip sequential" is an existing one that has been described in computer-science and data-processing literature.

Although the technique described by Mr. Purdum is most probably new (at least as applied to microcomputers), the term "skip sequential" is most certainly not. "Skip sequential" processing is in fact one of the methods of processing an ISAM (indexed-sequential access method) file and is used in PL/I and COBOL. A discussion of this technique, explicitly referred to as "skip sequential processing," appears on page 145 in a recent book, *File and Data Base Techniques* by James Bradley (CBS Educational and Professional Publishing, 1982).

Given the above, I highly recommend that Mr. Purdum consider a new nomenclature for his technique. His use of an existing term for the technique he has described is inappropriate and will only cause confusion within the computing community and will probably result in his technique's being lost in obscurity. The new name should also better reflect the true nature of the technique, which I would classify as direct access of variable-length records. In any case, I'd be interested to see the results of his trademark search should he decide to stick with the term "skip sequential."

Michael David Stebel
UPA Technology Inc.
60 Oak Drive
Syosset, NY 11791

I had to laugh at Jack Purdum's article "Skip Sequential: A New File Structure for Microcomputers." Mr. Purdum states that his " 'new' [Mr. Purdum's quotes] file structure . . . is based on such a simple idea that many computerists will wonder why they didn't think of it." Indeed. And many more will wonder why Mr. Purdum thinks he invented an idea that has been around for over 20 years.

I have to admire the guy's brass, though. After explaining his technique (which, to give him credit, is useful and needed to be publicized), he graciously grants us permission to use it personally, but requests that we contact him before making commercial use of it. I wonder if his company, Ecosoft, has notified the legal departments at IBM, AT&T, DEC, Digital Research, the Massachusetts Institute of Technology, and the U.S. Department of Defense, to name only the more well-known organizations who have had the temerity to pirate this "invention."

In essence, Mr. Purdum has described a useful method for getting around a limitation in BASIC (i. e., the lack of an "OPEN FOR APPEND" statement) by keeping an internal copy of the end-of-file pointer. At the end of the article, he extends this idea to the more general one of keeping an index to a fully random file. Apparently he is unaware of the following:

First, the lack of an "OPEN FOR APPEND" is highly unusual, found only in BASIC and a few other special-purpose languages. "OPEN FOR APPEND" is considered essential by most operating-system designers.

Second, *all* operating systems keep an internal end-of-file pointer for every file; this is inherent in providing a filing system. Most modern operating systems make this pointer available by way of a system call for use in random seeks.

Third, the idea of keeping an index of pointers to records or bytes in a file, whether kept in that or another file, is also very old. Since my library goes back only 10 years, I cannot give a reference to even an early, let alone the original, description.

And finally, regardless of the originality of the idea, there is currently no legal basis in the United States for claiming any kind of ownership of a software construct, algorithm, or coding technique. Most of us decry this situation, but it is a fact. Programs can be protected by copyright (maybe) and trade secret (almost certainly, although you had better know what you are doing), but algorithms are considered to be "mathematics" (sure), and mathematics, being a naturally occurring phenomenon or "law of the universe" (hah!), cannot be patented or otherwise protected.

Oh, yes. In case you haven't guessed, I am going to make use of Mr. Purdum's technique without asking permission; or rather, I will continue to make use of it, because I have been using it for so long that I can't remember who taught it to me. I would recommend that all other BYTE readers do likewise. If they feel ambitious, they might also write their congressmen to complain about the lack of legal protection for software, so that they will have some protection when they come up with an *original* idea.

Geoffrey H. Kuenning
Design Interface
216 25th St.
Manhattan Beach, CA 90266

Jack Purdum Replies

Mr. Kuenning's letter seems to raise two issues: (1) the "newness" of Skip Sequential (SS) files and (2) the right to use them. Concerning the first issue, I am aware that similar file structures are available on other, usually larger, systems either as part of a language or through system calls. Indeed, this was the reason for placing the word "new" in quotes (see the third paragraph of the article). However, as Mr. Kuenning points out, this structure is not available in any dialect of BASIC with which I am familiar. In that respect, it is a new file structure for the BASIC programmer.

Concerning the second issue, at the time the article was written (in the fall of 1980), our accounting package was the mainstay of our product line. We were concerned that SS files would be used by someone in direct competition with us. We thought that if a product was in direct competition with the accounting package, a nominal fee might be charged. By the time this letter is printed, however, we will have sold the package to another firm. We have, therefore, dropped the idea of licensing altogether.

I have had a surprising number of letters from individuals that hope to be using SS files in the near future. I am pleased that Mr. Kuenning plans to be among them.

The Base 2 Printer

I enjoyed Walter Jeffries's article "Base 2 Printer" (March 1982 BYTE, page 206).

I, as well as many other people in a club to which I belong, own one or more Base 2 printers.

Owners should be aware of two possible problems. The first can lead to repeated failures of the type experienced by Mr. Jeffries. The cause is bad bypass capacitors; Base 2 must have been unlucky enough to get a bad batch. There are two checks that can be made. First, measure the +5 volts DC with respect to ground on pin 18 of the Centronics connector (J3). If it reads low (less than +5 volts) you can suspect a bad bypass capacitor. Next check each bypass capacitor's temperature. Most owners have been able to find the bad capacitor(s) by touching each one to detect a temperature rise. One person even found one capacitor discolored.

The second problem is much less likely to happen, but you still may want to protect your investment. It occurs when one of the print-head transistors does not turn off due to failure or other reasons. It ruins the print head at a repair cost of between $35 and $45. The solution is to fuse each print wire solenoid. The easiest place to do this is where the print-head cable mates to the chassis cable. A socket can be rigged at this point to accept a 14- or 16-pin header. To the header solder seven 3-amp fuses. Any miniature 3-amp fuse will do. You may also want to protect the stepper motors similarly.

If anyone has any related information they would like to share, I can be reached at the address below.

John A. McKinney
2430 Bethel Drive
Anaheim, CA 92806

In 1979 I was evaluating various printers for use with my Z80 S-100 system. At the time, no one printer was able to satisfy all my needs. Then at the '79 WESCON show in Los Angeles I came upon John Amos, then president of a small Fullerton firm named Base 2.

The product on display at WESCON was a model 800 MST printer. After reviewing the printer specifications and a demonstration, I knew that I simply had to have one of those printers. Hence, I became one of the first people to place an order for this product. The first deliveries were expected to take place in the spring of 1980. Five months of waiting weren't that bad, since they were accepting no money until deliveries could be made.

I received my printer, S/N 474, in February 1980. After only one hour of use, the printer malfunctioned. When I returned the unit to the factory it was discovered that some of the internal fuses used to protect the print head had opened. The fuses used at that time were considerably underrated for that particular use because of power surges that occurred whenever the unit was turned on and off. Since there was little space for a larger set of fuses, a design change was made by replacing the fuses with straight pieces of wire.

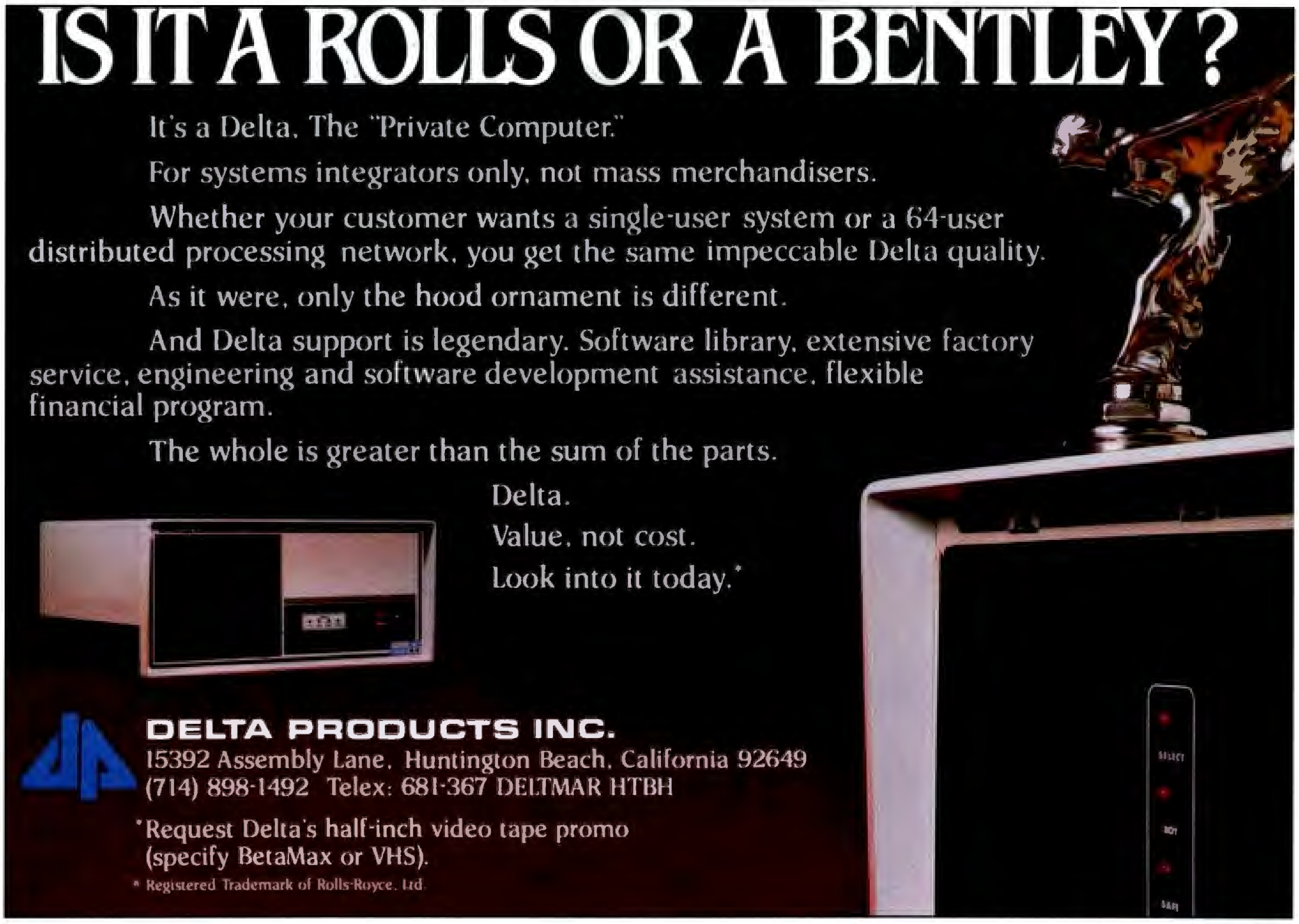
Three weeks later, I was again back at the factory. This time the problem was caused by a component failure on the power-supply board. Between March and June, I made four return trips to the Base 2 factory to have various modules replaced due to component failure.

I continued to encounter problems, on and off, for the next year and a half. I had been making return trips to Base 2 on an almost regular basis. They had been very courteous and understanding of the problems I experienced; but I did not wish to be dependent upon them for continuous support. I then decided to seek a complete refund of my purchase price plus an additional $100 incurred for printer number four.

My first attempts at obtaining a $749 refund were met with outright hostility. I was unable to contact president John Amos or any other of the personnel whom I had dealt with previously. I even sent a letter, which was never acknowledged, requesting my $749. I then filed for a court action against Base 2, seeking a $749 refund plus court costs.

The court date was set for November 25, 1981. But on October 29, I received a notification of nonservice from the Orange County Marshal. Apparently, sometime during the month of November, Base 2 went out of business. What happened after that is somewhat sketchy. I was informed that contact with Base 2 could be made through Advanced Computer Products (ACP). I was further informed that only written requests for information would be acknowledged. I wrote a letter to this company but didn't receive any response. It was my feeling that perhaps the advice about contacting ACP was given to prevent people like myself from directly reaching the corporate officers of Base 2.

Circle 395 on inquiry card. →



Circle 132 on inquiry card.

What has happened since? Well, immediately afterwards I bought an Epson MX-80 F/T. It has performed flawlessly and looks a lot better too. The Base 2 printer sits on a shelf gathering dust. One of these days I hope to repair it when I have the time. My co-workers at Rockwell occasionally rib me and ask if I've found John Amos yet or if my Epson still works.

Base 2 really had a good idea for what a printer should be. Too bad it didn't work.

Victor Ung
1980 Magnolia Drive
Monterey Park, CA 91754

I read with great interest Walter Jeffries's very well done review of the Base 2 printer. Unfortunately, Base 2 is no longer in business. I discovered this fact when I had trouble with my printer.

I realized that I was not the only one that might need service, so I located the management of Base 2 and made arrangements with them to provide service on the Base 2 printers. We were fortunate enough to locate some of Base 2's former technical staff who trained our engineers in every aspect of the printer, including sources for all parts, ribbons, tractor assemblies, cases, boxes, and so forth.

We understand that there are several thousand Base 2 printers in the field and eventually some of them will need service. We at Computer Peripheral Repair are prepared to provide prompt service and/or spare parts at a reasonable cost.

I appreciate the near disaster the author had with the shorted rectifier. To prevent this in the future, try lifting the rectifiers off the printed-circuit board about an eighth of an inch to allow the air to circulate around them and keep them cool. We have found that keeping the rectifiers cool will prevent them from shorting out and blowing fuses. If the fuse does not react quickly enough you will certainly burn out your print head. The print heads are expensive, but we have found that we can usually repair them at a fraction of the cost of a new one.

Thomas B. Torrence
Customer Service
Computer Peripheral Repair
1483 East Warner Ave.
Santa Ana, CA 92705

Infernal Documentation

There are three rings in hell reserved for the writers of computer documentation.

Ring One is for people who use names like "FILE.TXT" in examples. Angels, of course, use names like "FRODO.TXT" so that the novice is never confused between key words and arbitrarily chosen names.

Ring Two is reserved for people who document some 200 commands and 20 subcommands of a word processor without a single worked example or without showing how the commands interface to any other popular hardware or software. Angels provide a few *complete* (from logon to logoff) annotated examples showing the most commonly used command *sequences*. Archangels provide source listings.

Ring Three is for people who fail to proofread the documentation. Angels use word processors to avoid transcription errors. They print the documentation *without* proportional spacing so that it is abundantly clear if "PR #1" is or is not supposed to have a space between the "R" and the "#." They lovingly select a print element that makes a dramatic distinction

Circle 273 on inquiry card. →

between the letter "O" and the digit "0." They are very careful to distinguish between the ASCII (American Standard Code for Information Interchange) character for the digit zero and the binary number zero.

Roedy Green
1478 East 27th Ave.
Vancouver, B.C.
V5N 2W5 Canada

Update on VEDIT

The same week that I received the March 1982 BYTE containing my review "Text Editing With Compuview's VEDIT" (page 262), I received an update of VEDIT, version 1.34. Two improvements may be of interest to readers of my review: (1) you now *can* send text to your printer from within VEDIT (and a lot more easily than you can from Wordstar); (2) word-wrap and paragraph-reformatting have been added, which make VEDIT better suited for word processing. In my opinion, VEDIT's worst remaining drawback in word-processing applications is the awkward procedure for inserting control characters.

Compuview has added a lot in going from version 1.32 to 1.34. I wonder what version 2.00 will have.

Oh, and many thanks for Phil Lemmons's review "Five Spelling-Correction Programs for CP/M-Based Systems" (November 1981 BYTE, page 434). I bought The Word as a result, and it is everything Phil said it was.

Brad Thompson
Department of Chemistry
University of Toledo
Toledo, OH 43606

Service Above and Beyond the Call of Duty

Integral Data Systems (IDS) and the printers it manufactures were prominent in the March 1982 BYTE (see Curtis P. Feigel's "BYTE Printer Directory," page 278, and Ed Umlor's "Integral Data Systems' Prism Printer," page 44), and rightly so. One aspect of IDS worth emphasizing is the quality of its customer support. In my experience, IDS goes beyond providing knowledgeable and courteous telephone assistance, as the following anecdote illustrates.

In developing a complex graphics application, we couldn't figure out the source of mysterious extra graphics characters embedded in our printouts. Mr. Tom Churlis of IDS suggested that we check for self-generated characters from the interface card. Sure enough, the card automatically issues a carriage return after a certain number of characters is transmitted, and in the graphics mode the carriage return is recognized and printed only as a pattern of dots.

Although the company's hardware was not to blame and its manual was thorough, IDS has always been courteous and helpful. In fact, Mr. Churlis even called me back to see how my project was going. I have contacted IDS on several occasions and have always been gratified by a competent and polite response.

IDS is not the only company that staffs its phones with truly competent personnel. The people I've dealt with at Lazer Micro Systems Inc. are both knowledgeable and reliable; at Videx Inc., a competitor of Lazer Micro Systems, someone once copied and mailed information to me at no charge, even though I could have been sold a much more expensive solution.

If there is a hall of fame for outstanding customer support, these companies get my vote.

Peter G. Bartlett, Jr.
Bartco
529 West Belden Ave.
Chicago, IL 60614

Descenders for the MX-70

I was very excited to see Bruce Piggott's article "Lowercase Descenders for the Epson MX-70" in the March 1982 BYTE (page 248) on getting the MX-70 to print lowercase descenders. My enthusiasm quickly subsided, however, when I found that the program was for Apple users only. I have a TRS-80 connected to an MX-70, and I use Scripsit extensively.

Do you or any of your readers have any leads on any programs similar to Mr. Piggott's program that can be used with the TRS-80/MX-70 combination? I would certainly appreciate any help you can give me.

Kenneth Knaell
733 Sligo Ave., Apt. 316
Silver Spring, MD 20910

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Thank You, Mr. Heidner

After all the uproar about software piracy in the past few months, I just had to write you. I am selling an operating system called HEXDOS for the Ohio Scientific Inc. C1P computer, and I recently received a letter from Mr. Vern Heidner of Mound, Minnesota, which restored my faith in the basic honesty of the majority of computerists. It seems a friend had given him a copy of HEXDOS, which he liked and kept. He sent me a check in payment for it, though I would probably never have known he had it. He also sent a two-page letter describing some of his applications and some suggestions. Thank you, Mr. Heidner, and pirate prosecutors take note!

Steve Hendrix
415 South Pierce
Enid, OK 73701

Turn the Tables

The review of RSCOBOL in the March 1982 BYTE ("COBOL for the TRS-80 Models I and III" by Rowland Archer Jr., page 384) was very complete and well written. You have, however, switched the descriptions of table 1 and table 2. The files in table 1 are required during run time and for debugging and do not have to be online during program compilation. The files listed in table 2 must be online during compilation. Conversely, the files in table 2 do not have to be online during program execution, but they do have to be online during program compilation, since they represent the compiler and its overlays.

Mr. Archer also failed to mention what I consider the most outstanding quality of the compiler—it works as advertised. Ryan-McFarland Corporation has done an outstanding job of creating a piece of systems software that is not full of bugs, that is well documented, and that does what it says it does. I run RM COBOL (from which RSCOBOL was derived) on a CP/M system every day and I have yet to find an error in it. As a producer of high-quality software for manufacturing firms, I cannot afford the time to debug someone else's product. Of the three COBOL compilers I own, only one of them works reliably. The other two will remain unnamed.

I hope to see more reviews and samples of COBOL software in the pages of BYTE in the coming months. I have been using it for more than 16 years and I still find it to be the most useful of all languages for business-oriented applications. It may not be esoteric but it does the job and that's what counts.

Roger S. Erickson, President
Nordic Systems
23 Carriage Hill West
Williamsville, NY 14221

As a long-time proponent of COBOL and a recent convert to Radio Shack's TRS-80 Model III, I was pleased to find Rowland Archer Jr.'s software review of RSCOBOL. Unfortunately, Mr. Archer did a grave injustice to a magnificent software product.

The overall negative tone of the article obviously reflects Mr. Archer's lack of experience with COBOL and his narrow exposure to microcomputers.

BYTE's choice of article highlights was poor. How detracting is a non-full-screen editor compared to the powerful global Find and Change commands available in CEDIT? How many minicomputer, or for that matter, large-computer systems provide for compiler output listings to be routed to disk, printer, or screen? What are the true trade-offs to ISAM (indexed-sequential access method) files? What about the power of inter-program communications, program segmentation, run-time speed, source-code protection, and portability of application software?

Ryan-McFarland Corporation's RS-COBOL is a superior development system for the TRS-80. Although it is not a 100 percent implementation of the ANSI X3.23-1974 COBOL Standard, it is a major step in bringing quality mainframe software to the microcomputer. The $199 price is probably the best buy on the market today. By comparison, COBOL for the Apple II costs close to $1000 (five times as much) when you add the price of the software and the necessary add-on Z80-processor hardware (the Microsoft Softcard).

Our company, C.O.P.E., is presently marketing an accounts-receivable and billing system written entirely in RSCOBOL. A pharmacy management system will be completed shortly. Contrary to Mr. Archer's article, both systems utilize disk space very well. The use of computational fields (COMP-3) and intelligent choices of file accesses take full advantage of the two 5¼-inch disk drives the systems were designed for. I challenge any other language to maintain over 1500 customer records on one floppy disk with multiple access through ISAM organization, thus eliminating the need to sort.

Ronald Pokorny, President
C.O.P.E.
POB 227
Cooperstown, NY 13326

Learning from Pascal

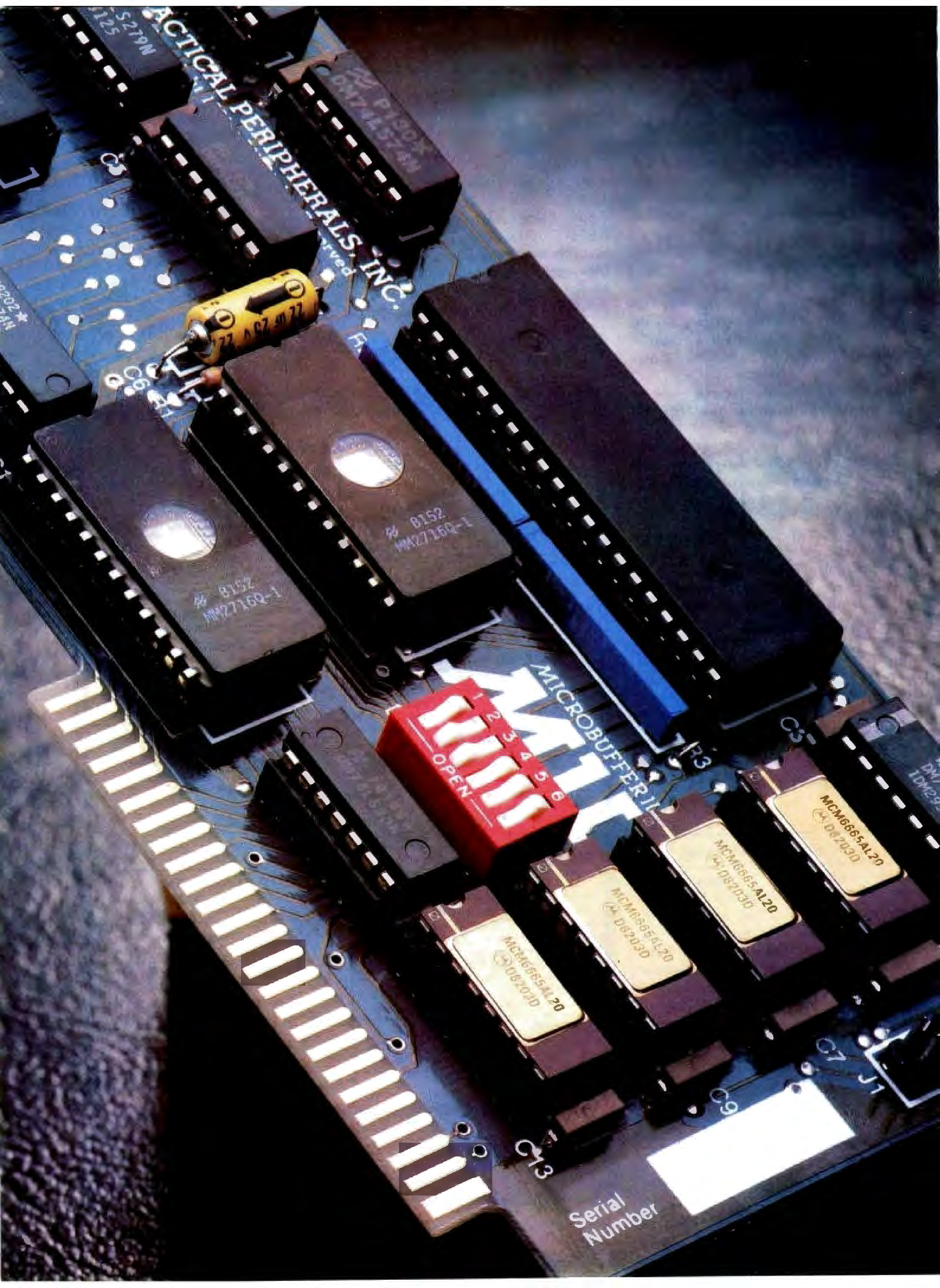
My contact with computers started with solving hyperbolic partial differential equations on the ENIAC computer in 1945. Since then I have been involved with many programming languages. Now retired, I have an Apple II with a Corvus hard disk. Being a novice with Pascal, I decided to put the timely Pascal programs in the February 1982 BYTE into my Apple as a learning exercise (see Edward Heyman's "FIT—A Federal Income Tax Program in UCSD Pascal," page 148, and Thomas E. Doyle's " Pascal NOW, Let Pascal Balance your NOW Account," page 290).

From Heyman's tax program I found that Pascal is somewhat wordy. The program to handle three of the 57 IRS tax forms took 60 pages of listings when I included the cross-reference listings. I expect it will be a useful program for the reasons he mentions.

From Doyle's NOW account checkbook balancer I learned several things. First I discovered that Pascal (at least Apple Pascal) has a data-entry flaw. READ and READLN for integers and real numbers produce fatal errors which cause the system to reboot and lose your checkbook file. There is an 'IORESULT' defined but the following sequence does not work:

```
REPEAT
    WRITELN('ITEMNUMBER');
    READLN ITEMNUMBER
  UNTIL IORESULT=0
```

After studying the way Heyman handled this problem I wrote two procedures, INTGR(I:INTEGER) and REALE (R:REAL), which read in a string, examine the characters to ensure that they are indeed digits, and then generate the desired integer or real. If an error was contained in the string it forgives and allows you to reenter the string. While I was making these changes to make data entry I also changed the program to (1) put balance amount in the record, (2) allow a choice



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Serial Number

between displaying the checks on the monitor or printer, and (3) permit modifying any quantity on any check.

Any reader interested in this modification of Mr. Doyle's program can send me an Apple 5¼-inch disk and a stamped self-addressed envelope and I will send him or her a copy.

R. F. Clippinger
57 Rockview St.
Jamaica Plain, MA 02130

More on Apple Pascal Units

Dr. Ross Tonkens's "A Guided Tour of Apple Pascal Units and Libraries" (February 1982 BYTE, page 225) has highlighted an elegant method of breaking down logically separate modules into physically separate "units." However, he did not mention the drawbacks and obscurities of units in UCSD Pascal.

UCSD Pascal units consist of an interface, an implementation, and an initialization part. Objects declared in the interface are global, just as if they had been declared in the host program. Objects declared in the implementation part are hidden from the host program; they are "private" to the unit. Private variables can be initialized by the initialization part; this happens at run time, *before* the host program is executed.

A good question is whether those peculiar "private" variables retain their initial value even if the unit containing them is *not* referenced. In Pascal, local variables and parameters are lost whenever the function or procedure containing them is exited. Thus one cannot expect a local variable to have the same value when the same procedure is called several times. In units, however, one can. Private variables are not removed from the stack, even if a unit is not active. This is a FORTRAN-like "feature," which clearly violates the spirit of Pascal and wastes space. The Apple Pascal compiler, however, is smart enough to detect variables which are declared in the implementation part but referenced nowhere. For such variables no space is allocated.

While private variables may be regarded as just obscure, the missing symmetry between the host program and its units can turn out to be a serious drawback to top-down program development. Units can be compiled without their host

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program, but the host program cannot be compiled without the units it uses. The reason for this is that all objects declared in the interface of a unit are *simultaneously* part of the global declaration part of the host program.

Let us imagine a unit containing functions and procedures which expect variables of type COLOR = (GREEN, YELLOW, RED) as input. Then the type COLOR has to be declared in the unit's interface part; otherwise the unit will not compile, due to an "UNDECLARED IDENTIFIER" error.

A host program which uses this unit must not declare the type COLOR; otherwise compilation will stop with the error message "IDENTIFIER DECLARED TWICE." This is true even if COLOR is used elsewhere in the host program.

The logic of the problem might now dictate the use of a second unit whose functions and procedures also deal with variables of type COLOR. In order to compile this second unit, we again have to declare the type COLOR in its interface part. But now we have got two units with the same type declaration, and therefore we get the "IDENTIFIER DECLARED TWICE" message when we try to compile the host program.

There are two ways around this problem: first, we could nest the second unit inside the first one—but this implies a hierarchical relationship that has nothing to do with the structure of the problem.

Second, we could declare two types: type COLOR1 = (GREEN, YELLOW, RED). This works because variables of type COLOR can be assigned to variables of type COLOR1 and vice versa: UCSD Pascal employs structure compatibility (as opposed to name compatibility).

The second trick is even worse than the first. Multiple declarations have to be used where the problem requires just one.

In my opinion this interface problem is a serious design flaw. A solution could have been a "symmetrical" construction: the interface part must appear both in the unit and the host program, allowing both the unit *and* the host program to be compiled separately. The price to be paid for this solution would have been the invocation of the linker every time a unit had to be used—no "prelinked" units would have been possible. But I consider this price to be small if compared with the present messy situation that seriously hampers the use of units in the development of large programs.

Finally, let me correct an error in Dr. Tonkens's article. He states that Pascal cannot express the concept of absolute addressing; i. e., there are no PEEKs, POKEs, or CALLs. On the other hand, he shows a unit that does the "dirty trick" of mapping absolute hardware addresses to integer variables through the use of variant records. Variant records, however, are in no way special to Apple/UCSD Pascal; they are part of the standard language as defined by Jensen and Wirth. Therefore this "dirty trick" works with *any* Pascal on *any* machine that embodies the Jensen and Wirth standard. No unit is necessary for this purpose.

Ulrich Schmidt
Am Höfling 4
5100 Aachen
West Germany

A minor error has been brought to my attention by an alert BYTE reader concerning a statement made by me on page 236 of my article in the February 1982 BYTE, "A Guided Tour of Apple Pascal Units and Libraries."

I stated that the interface section of a unit must always declare at least one procedure or function. This is not strictly true. In fact, it is true only if there is also an *implementation* section to the unit. According to the syntax diagrams on pages 201 and 202 of the *Apple Pascal Language Reference Manual*, an implementation section is optional. Thus, if there is no implementation section, there need be no procedure or function declarations in the interface section. This situation could arise if the unit were written solely to declare a set of global variables which many programs could share by using the same declaration-only unit.

I wish to express my thanks to Leslie Hogben, Assistant Professor of Mathematics at Iowa State University, for bringing this fine point to my attention.

Ross M. Tonkens, M.D.
Cedars-Sinai Medical Office Towers
8635 West Third St., Suite 1185W
Los Angeles, CA 90048

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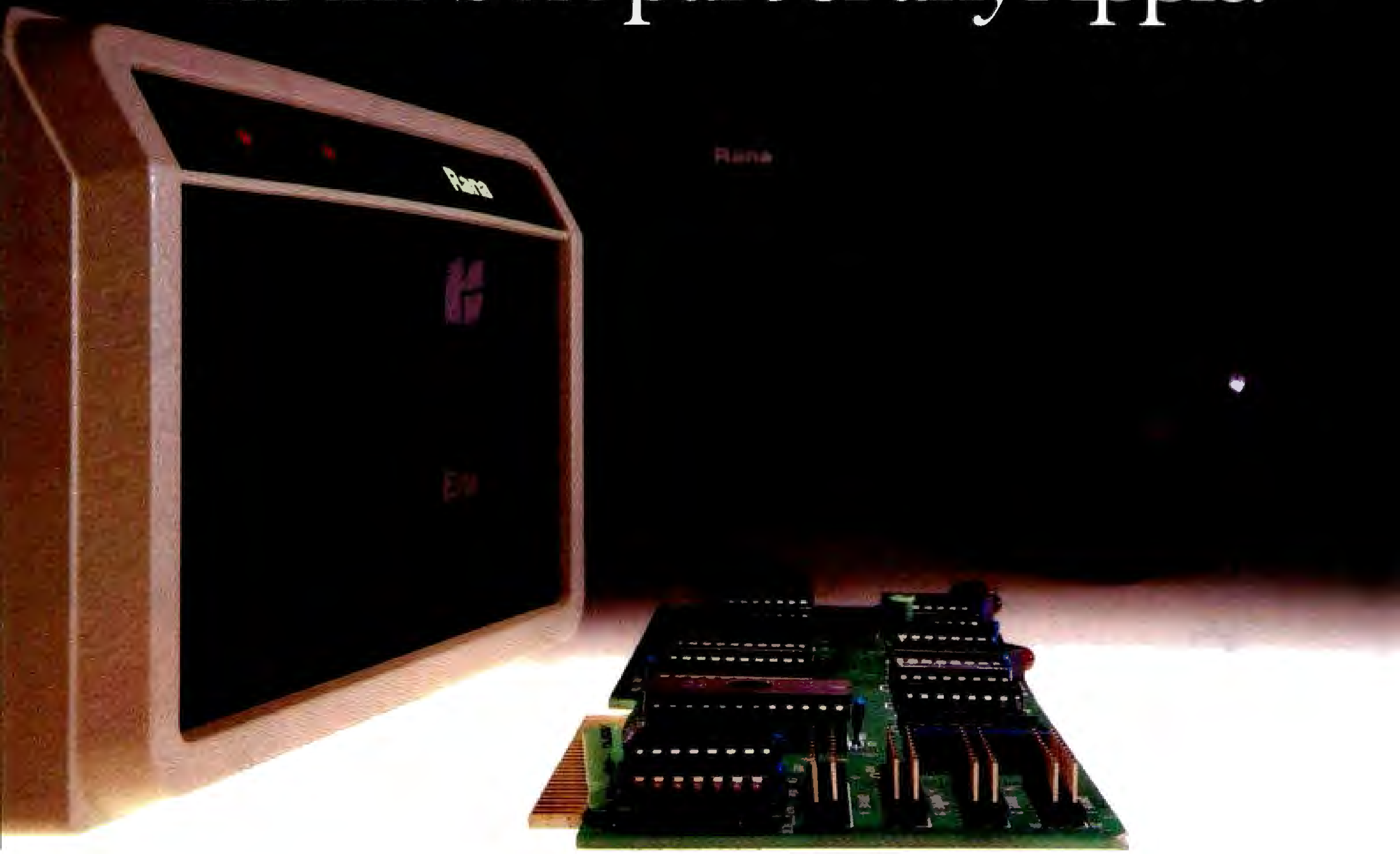

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Letters

Getting Rid of QWERTY

It is my understanding that the arrangement of keys on the traditional QWERTY keyboard is about the most inefficient layout that could be devised. This was the intent of the designer of the layout, whose early mechanical typewriter had considerable backlash so that an efficient typist using an efficient key layout would have typed too quickly, locking up the mechanical parts. Modern typewriters have overcome these mechanical limitations, but conservatism on the part of typists who have been trained on the QWERTY keyboard has resisted all attempts to introduce more efficient key layouts. This resistance to change is understandable but ill-advised, because retraining to a better layout takes very little time and its use allows the typist to work more efficiently with less fatigue.

Be that as it may, it seems to me that the designers of computers, and particularly microcomputers, are missing a great opportunity in not offering the option (or standard) of a more efficient key layout. The majority of people buying and using microcomputers have little or no professional typing experience and would welcome a more efficient and more easily mastered key layout.

The option of a different layout should be easy to offer—the main requirement would be a character-generator chip in the required configuration. In fact, the most tedious part of any conversion would be changing the keycaps on the keyboard to reflect the new layout.

Of course, it would be preferable if a change in layout could be to a new international standard layout. I believe that some work has been done on this, but perhaps agreement on a standard would (as usual) be the main stumbling block.

I am certain that if microcomputer manufacturers were to offer this option (or standard) it would be widely accepted by users and, in use, might overcome the resistance of established typists so that in time we might witness the demise (with no regrets) of the terrible QWERTY layout.

C. W. Green
POB 2972
Singapore 9049

Paging Malfunction

I wish to compliment Joseph Holmes on his excellent article about the Commodore 4022 and Epson MX-80 printers, "Commodore 4022 Printer" (March 1982 BYTE, page 26). Although I have owned a 4022 since last July, I was not familiar with the MX-80, but I suspected they were kissing cousins. The plotting routine for the MX-80 contained elsewhere in that issue could easily be adapted for use with the CBM/PET and 4022 combination.

However, Mr. Holmes's description of the 4022's paging function is not quite accurate. When paging is turned on initially, the printer does a linefeed, yielding one *less* than the set number of lines for the first page. Subsequent pages will have the correct number of lines. This can be quite annoying when printing out data in tabular form that requires more than one page. This will also happen if the set number of lines per page is changed.

Jack B. Cooper
46 Henry Ave.
Princeton, NJ 08540

No Discount—No Sale

Thank you for printing the letter from Mr. Dennis Pratt in the March 1982 BYTE (page 14). The information regarding the new sales rules and retail restrictions established by Apple Computer Inc. was most interesting.

In this day and time when everyone is making every possible effort to boost sales, it is interesting to find the management at Apple directing its sales outlets to stop all mail and phone discount sales. You can't blame a company for wanting to offer the best possible service; however, sales decisions of this type are not only foolish and very risky, but certainly show little consideration for those who have an Apple system and want to add to it by buying from those dealers that offer the best prices.

We were going to build a small-business computer system based on the Apple; however, with the nonavailability of discount components, I have today sold the Apple products that we had in the system. The computer, disk drives, monitor, printer, and other items were sold at a loss to us; nevertheless, I cannot see continuing with a system which is manufactured by a "no discount" company.

We will pick up and install our new brand of computer system tomorrow. I am sure there are others out there who make computers that perform just as well as the Apple. This decision by Apple comes at a time when there are other firms entering the small-business computer marketplace—firms that will discount their products in appreciation of our business. Maybe if other businesses follow actions like ours, we can offer Apple the challenge it's apparently looking for, and put that company in its proper position in today's marketplace.

This move by Apple is about as smart as adding a surcharge to the price of a new car. Lots of luck, Apple. You're going to need it.

William D. Mauldin
Broadcasting/Recording Productions
POB 547
Delray Beach, FL 33447

More Microcomputer Forms

I recently read Phil Lemmons's interesting article titled "Custom and Standardized Forms for the Microcomputer User" (March 1982 BYTE, page 198). I thought the article was well written and presented a true picture of what is happening in the microcomputer forms market.

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If Mr. Lemmons decides to write another article on microcomputer forms or supplies, we would appreciate being included.

Jack M. Resnick, General Manager
Direct Mail Marketing
UARCO
121 North Ninth St.
POB 948
De Kalb, IL 60115

Optical Reader Interface

I am attempting to interface an IBM 1230 Optical Reader to a TRS-80 Model II. I would appreciate hearing from anyone who has or intends to do the same.

Louis M. Ferrari
3919 Octave Drive
Jacksonville, FL 32211■

BYTE's Bugs

Switched Assignments

A few bugs were found lurking in David Staehlin's article "An 8080-Based Remote Appliance Controller" (January 1982 BYTE, page 239). In figure 1 on page 240, pin 4 and pin 6 of IC1 (IC1b) were switched. Pin 6 should be where pin 4 was located and vice versa. As it is shown, the circuit will fail to oscillate.■

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The Input/Output Primer

Part 6: Interrupts, Buffers, Grounds, and Signal Degradation

The conclusion of a six-part series covering fundamental issues in computer interfacing.

Steve Leibson
Cadnetics Corporation
5797 Central Ave.
Boulder, CO 80301

In our discussions about I/O hardware, we talked about the needs of a wide range of peripheral devices. Some devices are much slower than internal computer processes, some are about the same speed, and some are faster than the computer can comfortably handle through normal means.

We discussed the three hardware handshakes associated with these three classes of peripherals. Slow devices are best handled by interrupt. Only when the device is ready for another data transfer is the processor interrupted so that it can service the peripheral.

Medium-speed devices can interact with the processor directly since they will not degrade system performance. High-speed devices require special hardware for direct memory access (DMA) because the processor alone is not fast enough to service them.

This article concludes Steve Leibson's six-part series, The Input/Output Primer. *Covering the basics of how computers communicate with the world, the articles have described how some of the problems in this area have been solved. Steve's "An I/O Glossary," a valuable reference for the series, was published in the series' first installment (February 1982 BYTE, page 122). Figure numbers are continued from Part 4.*

The hardware to perform interrupt I/O and DMA is useless without software to support the capability. In the discussion of formatted I/O, we were referring only to the simpler handshake or programmed I/O. Most computers support this type of I/O even if it is only by using the PRINT statement.

Hewlett-Packard desktop computers support interrupt I/O in two ways: user interrupt-service routines and buffer transfers. DMA is supported only through buffer transfers. We will briefly discuss user interrupt-service routines and devote the rest of this discussion to buffers and buffer transfers.

High-level languages frequently have subroutine capability. In HPL (Hewlett-Packard's high-performance language for the 9825A/B), subroutines are invoked with the "gsb" statement and the main program is returned by using an "ret." BASIC uses the corresponding statements GOSUB and RETURN.

User interrupt-service routines are a variation of the subroutine. After interrupts are enabled, the subroutine is invoked because a peripheral interrupts. The subroutine is written in the high-level language of the computer and is terminated with an interrupt-return statement such as "iret" in HPL. The following HPL program fragment illustrates how user interrupt-service routines are written:

```
10:  1→I
11:  oni 6, "send"
12:  eir 6
•
•
•
87:  "send": wtb 6,A$[I,I]
88:  I+1→I;if I<=len(A$);eir 6
89:  iret
```

Line 10 sets a counter that points to individual characters in string A$. Should an interrupt occur, line 11 directs the program to line 87, labeled "send," and line 12 enables the interface hardware and software to accept interrupts. Line 87 sends a single character from string A$ each time the user interrupt-service routine is called. Line 88 increments the counter I to the next character and reenables interrupts if there are more characters to transmit. Line 89 forces a branch back to the main program.

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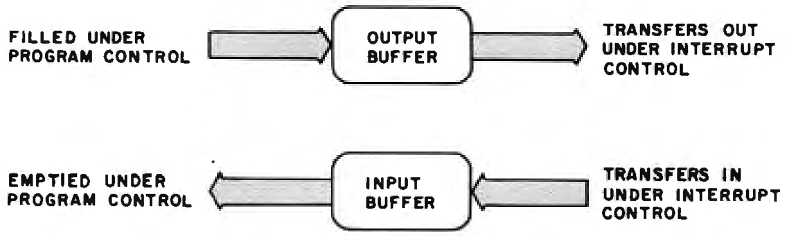


Figure 16: *A diagram showing the function of software buffers. These buffers store data for data-transfer routines that use interrupts. A program fills an output buffer and an interrupt-service routine empties it. An interrupt-service routine fills an input buffer and a program empties it. The program initiates both input and output transfers.*

Several things should be noted from this example. The "eir 6" enables the interface. The meaning of an interrupt is that the interface is not busy. The first interrupt will occur immediately after the computer executes line 12. Novices at interrupt routines always fall prey to this. If the interface has not been made busy by sending it a character before interrupts are enabled, interrupt is immediate.

Note that the program must use a counter to keep track of where the next character will come from in A$. Also, interrupts must be reenabled in the interrupt-service routine if the transfer is not finished. This is necessary because the "eir" is canceled when it is invoked. That prevents the interrupt-service routine from being interrupted.

Buffers

High-level-language program lines are slow compared to the native processor speed. User interrupt-service routines can support only low data rates. Buffer transfers are a much better choice for data transfers, leaving user routines to service special situations.

Buffers are blocks of computer memory allocated for I/O. Data passes through the buffer on the way into or out of the computer. Enabling of interrupts and character counters is taken care of automatically and new features are available. Data transfers can be terminated on a count, as in the above example, or by a character match for buffered input. Figure 16 shows how buffers are used for I/O.

The following sample program lines perform the same task as the first sample, but use buffered I/O:

```
10:  buf "OUT",100,1
11:  wrt "OUT",A$
12:  tfr "OUT",6
```

As you can see, this is much simpler. Line 10 creates a buffer of 100 characters, line 11 fills the buffer with the contents of string A$, and line 12 sends the data to the peripheral. The 1 at the end of line 10 specifies an interrupt buffer.

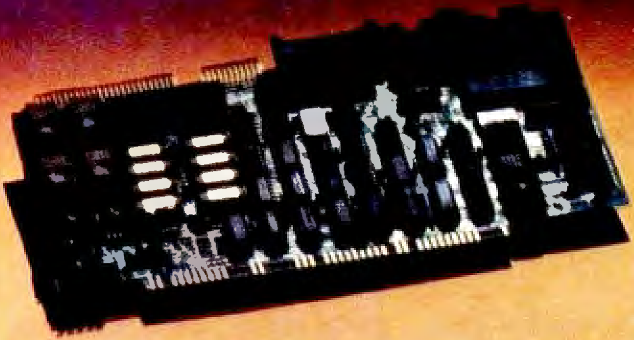
Why is this technique superior to simply writing out the data directly to the peripheral? Line 12 only initiates the data transfer. After that process is started, the program will continue with line 13. When the peripheral interrupts, it will automatically be given the next character. Meanwhile, the computer is executing the rest of the program.

Interrupt buffers are faster than user interrupt-service routines for one primary reason. The only safe place to interrupt a high-level-language program is at the end of a line. In the execution of a line of high-level-language code, temporary locations are set up, addresses are calculated, and a whirl of activity is taking place.

An interrupt routine must be able to return to where the program left off after the interrupt is serviced. If the user routine accesses variables being used by the main program, or worse yet, changes those variables, there could be disastrous results.

That is why high-level-language interrupts are restricted to the end of a line. Things are safe there.

Conversely, the routines used by the buffer-transfer interrupt-service



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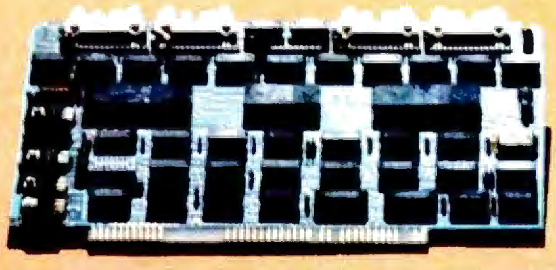

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routines are in machine code and are restricted. Their effect on the system is well known because all they are allowed to do is transfer data.

Buffer interrupts are allowed any time they are enabled. Thus, interrupt-buffer transfers can be much faster than user interrupt-service routines for data transfer. They are also easier to use.

The IBM Personal Computer has interrupt-input buffers that are used with the asynchronous communications adapter. In Personal Computer Advanced BASIC, the statement COM ON activates the buffer while ON COM specifies the line number of the program subroutine that will periodically empty the buffer. After executing each program line, the Advanced BASIC interpreter checks to see if any characters have been received. If so, a GOSUB is executed to the subroutine specified by the ON COM statement.

Once you understand interrupt-buffer transfers, DMA buffers are easy because they work the same way. A buffer is set up, filled, and transferred. The syntax is also the same. The only parameter that changes is the buffer type.

Only certain interfaces can support DMA transfers and only certain devices require DMA service. Since DMA requires special hardware, Hewlett-Packard desktop computers have only one DMA channel. Thus, only one DMA transfer can be active at one time.

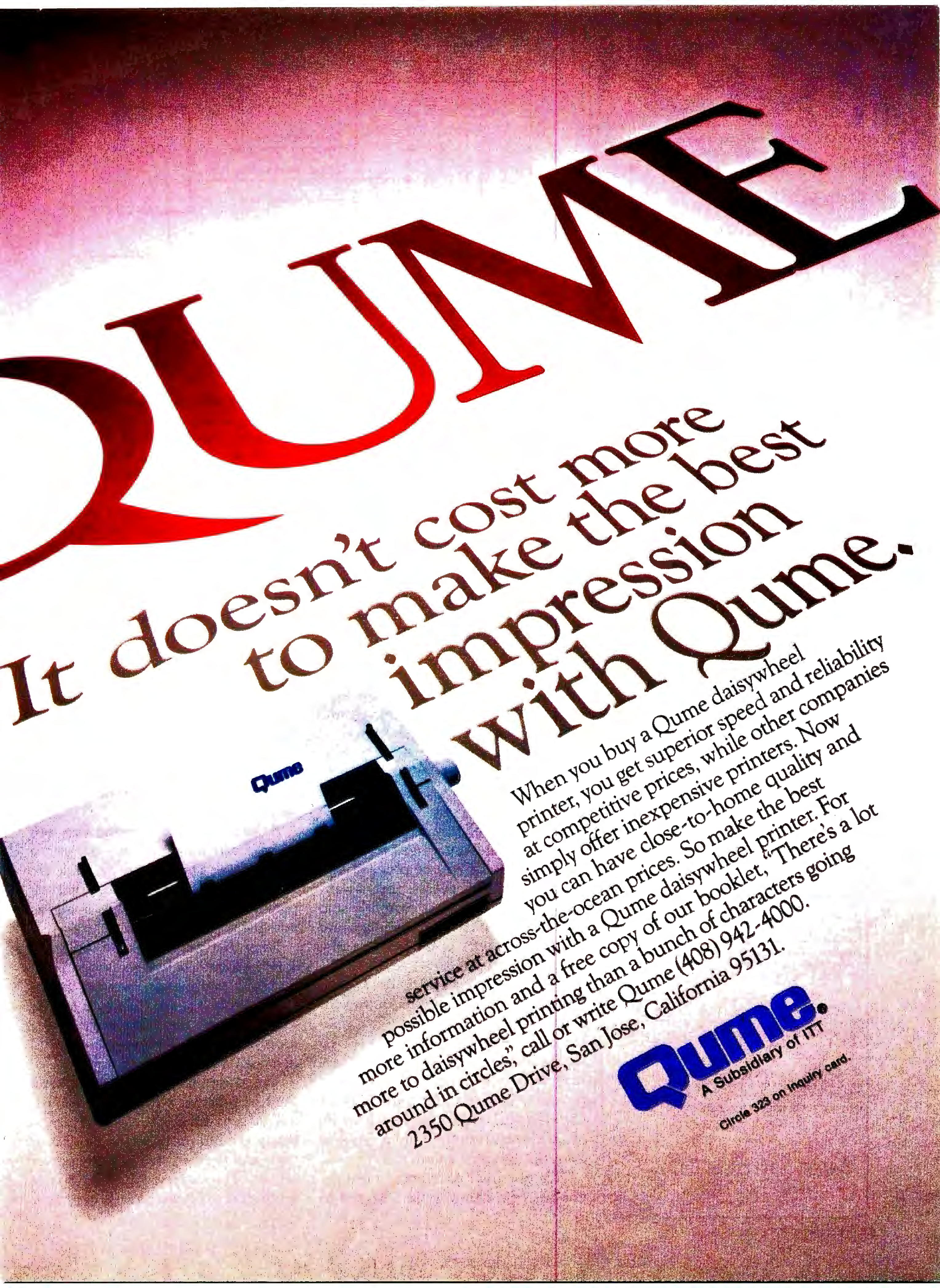
Buffered I/O is a real convenience. It is another way of taking I/O hardware, such as interrupt and DMA circuitry, and making the capability available in an easy-to-use form.

How High Is the Ground?

It is a paradox that of all the signal wires used in interfacing, the most complex is the one that seems simple. Ground wires are generally ignored in the design of computers and interfacing circuitry. No signals are intentionally impressed on them.

Often, the number of ground wires in an interface cable is determined by how many conductors are left over after signal wires have been allocated. Naturally, this type of interface design leads to problems. These problems can lead to signal degradation, loss of data, and even destruction of equipment.

Why do designers include ground wires in the first place? Electricity flows in loops. The laws of physics dictate that current must always return to its point of origin. When we send a logic signal to a peripheral device, we send it in the form of a current. This current must have a return path of low impedance so that the peripheral device will observe the full signal strength. Any impedance in the return path (or the signal path) will diminish the signal observed by the peripheral. It should be clear, then, that one reason to provide a ground is to supply a low-impedance signal-return path. This type of ground is called a *logic ground*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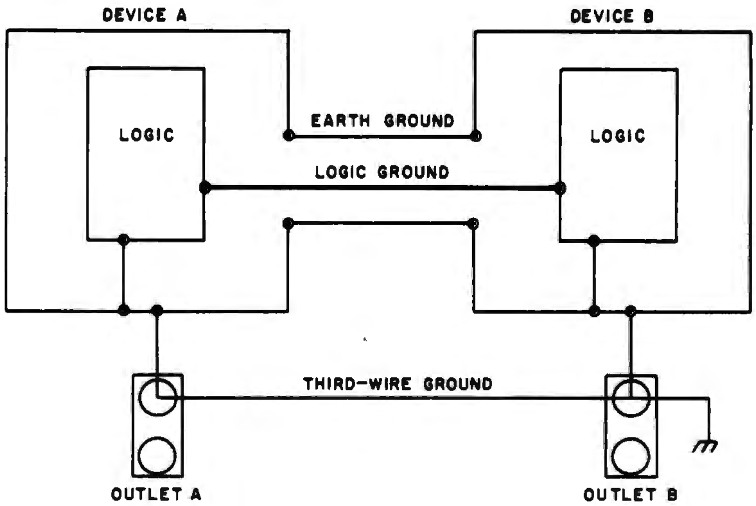

Figure 17: *A diagram of the grounding of a typical computer system. Three ground wires connect devices A and B. One wire is the signal ground, which serves as the return path for signal currents. The second wire is the earth ground in the interface cable between the two devices. It provides safety by equalizing the potential between the two devices. The third wire, usually invisible and forgotten, is the ground wire in power cords.*

This triple grounding can cause two kinds of problems. Ground-fault currents in other devices may flow through the third-wire ground, up the power cord, through the logic ground, and back down the other power cord. These currents usually exceed what the logic ground is designed for and a voltage develops between logic grounds of the two devices because of the small resistance in the wire. The voltage degrades signal margins by changing the voltage reference levels of the two devices.

The second problem is electromagnetic interference caused by a "noisy" logic ground, as represented in figure 18.

because it is associated with the logic signals. A second type of ground serves to ensure that the devices at either end are at or near the same potential.

One of the laws of interfacing states that there are never enough sockets on a wall power outlet to supply a complete computer system. At least one device will be plugged into another outlet several feet away. Most computer devices currently sold have three-pronged power plugs and use the third wire of the power outlet as an *earth ground.*

This earth ground is used as a safety ground to keep the voltage of exposed metal parts within safety limits. Unfortunately, due to haphazard wiring practices, there may be several volts of difference in potential between the third wire of one electrical outlet and the third wire of an electrical outlet only a few feet away in the same room.

This potential difference is usually not large enough to pose a hazard to humans, but it can kill a computer system. Signal levels for most interfacing systems today are 5 volts (V). A potential difference of only 2 or 3 V can destroy all trace of a signal. A potential difference of 20 or 30 V can destroy circuitry.

A safety or earth ground between devices can minimize this difference in potential. Once again, we seek the lowest possible impedance so that the potential difference is as small as possible.

Now that we have good logic and safety grounds between our computer and our peripherals, we can relax, right? Probably not. Chances are we have created the infamous *ground loop.* Figure 17 shows a system with just such a problem.

The computer and the peripheral are tied together with three grounds: a logic ground for the signal return, a safety ground for potential minimization, and the third wires in the power cords. The safety and third-wire grounds are connected together inten-

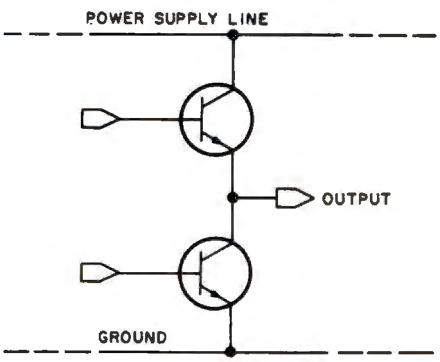

Figure 18: *A diagram showing the frequent cause of electromagnetic interference by a computer system. Most digital systems have noisy logic grounds. Earth grounds usually shield this noise, but if the earth and logic grounds are connected, the noise will transfer to the shield and radiate from it. The result is interference with radio and television reception.*

tionally. That loop cannot be avoided. The logic grounds in both devices are connected to a third-wire ground that is common in computer design. Loops are formed between logic and safety, logic and third-wire, and third-wire and safety grounds.

Two kinds of problems threaten this system. First, current may be flowing in the third-wire conductor due to a faulty or leaky device someplace else in the power system. This will cause a voltage difference at the two power outlets A and B. We installed the good safety ground to add a low-impedance path and minimize this difference.

The current sees the dual paths of third-wire and safety grounds, and the voltage difference will indeed be small. Unfortunately, the current will also see a third path to flow through, the logic ground. Typically, logic grounds are not designed to carry power-fault currents. They have higher impedance. Thus, a large current flowing through signal ground may prevent communications from taking place.

Since we added the grounds to allow the logic signals to be received reliably, we must also prevent ground loops from destroying that reliability. The best method is to plug all devices in a computer system into one electrical outlet. This assumes that there is enough current capacity on that circuit to supply the computer and all its peripherals with power. If there are not enough sockets on the outlet, use a power strip. The third-wire ground in a power strip is short and well defined, and will be of low impedance.

Electromagnetic Interference

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system is performing flawlessly, we can relax and listen to some music on the radio. Unfortunately, whenever the computer system is on, a lot of static appears on the radio. Worse, our neighbor down the hall notices the same effect. Welcome to the world of electromagnetic interference (EMI), the second problem in interfacing grounding.

Figure 18 is a picture of the output stage of a typical logic circuit. A transistor is connected to ground and the output signal line, and another transistor is connected between the power supply and the output signal line. If both transistors are turned on at the same time, a large current will flow and destroy the circuit. If only the top transistor is turned on, the output voltage will be close to that of the power supply. If only the lower transistor is turned on, the output voltage will be close to ground potential. The signal is switched by changing which transistor is on and which is off.

When this switching takes place, both transistors will be partially on for a brief period of time. One is partially on but going off; the other is partially off but turning on. At this instant, a large current is allowed to flow from the power supply to ground through both transistors. This current spike will make the ground jump a bit through the small but finite impedance of the ground line.

Literally thousands of these output circuits are in a computer, switching constantly. All are adding their share of noise to the logic ground. This noise is carried out to the interface cable and over to the peripheral on the logic ground wires we ingeniously ran between the devices in our computer system.

The voltage spikes in the ground are too small to affect the interface logic signals, but the interface cable acts as an antenna and transmits this noise for all to receive. The thousands of output circuits team up to form a low-voltage but high-current signal. The actual logic signals are much lower current and don't cause as much trouble.

Two solutions to this problem are available. The first involves the use of low-impedance ground planes in the computer and peripherals to minimize the ground noise. The second is to shield the interface cabling to prevent the noise from escaping. These techniques are both used in Hewlett-Packard's desktop computers.

Finally, interface designers are attacking the ground-loop and EMI problems using a new interfacing technology: fiber optics. Glass optical fibers carry modulated light signals between devices. No grounds are used, which means no loops. Also, no antennas pick up and transmit noise.

Fiber-optic interfacing now costs more than the conventional interfaces covered in this series. Some applications requiring long distance or good noise immunity are already using fiber optics. Many more applications will do so in the future.

Conclusions

This primer has been written to expose you to many of the elementary concepts in computer interfacing. The connection of computers to peripherals and other computers is a vast and complex subject.

Microcomputers do not yet have the types of interfacing problems that larger computers face. The software tends to be simpler and smaller, and the data rates are slower.

But microprocessor manufacturers are determined to change the situation. The newer 16-bit microprocessors are every bit as complex as minicomputers. Software for these processors will also be as large and complex as that for minicomputers. And the interfacing requirements for the computers based on these microprocessors are sure to be more complex than the requirements of 8-bit machines.

Although the Chinese did not invent the microprocessor or an electronic interface, they do have a curse appropriate for the engineers who must master the complexity of the 16-bit microprocessors: May you live in interesting times! I hope that this primer will help you get through the interesting times that lie ahead.■

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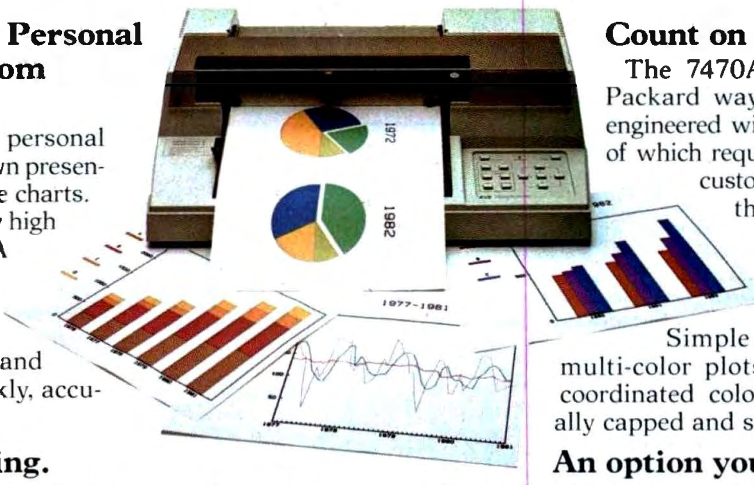

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Computers, Fiction, and Poetry

Stories and poems written by computers are hardly masterpieces, but they do shed some light on creativity.

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Writing poetry with a computer is like eating spaghetti with a fork a yard long. It can be done, but it's not easy. —computer poet Louis Milic

Pity the poor computer poet. While the computer has gained grudging acceptance as a tool for the artist or musician, it remains an odd duck in the hands of the creative writer—except, perhaps, as a word processor. True, computers are used for many other literary tasks: preparing concordances (indexed lists of all the words in a text), studying the quantitative aspects of style, and resolving questions of authorship. Yet computer poets and writers often are regarded by fellow literati with a mixture of fear, derision, and antagonism. Even computer scientists sometimes consider this work either wasted or doomed to failure. Part of the hostile reaction stems from the general quality of computer-generated verse and prose. It is frankly awful, as its human programmers readily admit.

Yet computer-assisted literature shows no signs of dying out. From the whodunit to medieval Chinese verse, from the fairy tale to the operatic libretto, virtually every literary form has been, or is being, attempted with computers. (Last October *Omni* magazine even published a piece of science fiction said to be written by computer.) Computer authors maintain they are not trying to produce great literature, but rather to understand the workings of the human mind. As researcher Natalie Dehn of Yale University puts it: "I'm trying to construct a model of what makes people creative. If my model is correct, then my program should be able to make up interesting stories." In this respect, delving into the workings of the mind, the slender works of computer literature speak volumes.

Prose Becomes Poetry

Computer poetry traces its origins to a discovery made accidentally by Louis Milic and other early workers in the field of computer-generated prose. Milic, now a 59-year-old English professor at Cleveland State University, had programmed a computer to generate simple sentences—"A shirt thought with a dog," "A house sat to a picture," and so forth—by randomly substituting words in a rigid framework. To his surprise, he found that this sort of nonsense made people think of poetry.

"The question was," Milic says, "why would a sentence generated by a computer be mistaken for poetry?" The answer, he reasoned, must be that many people are used to poems' not making sense.

A Comparison

Compare the following two poetic excerpts:

1

Because the pleasure-bird whistles
after the hot wires,
Shall the blind horse sing sweeter?

2

What does she put four whistles
beside heated rugs for?

The first is from the poem "Because the Pleasure Bird Whistles" by Dylan

About the Author

Kevin McKean is a staff writer for Discover *magazine.*

Thomas; the second was written by a computer. True, Thomas's lines are more melodic and haunting. But isolated from context, they make just as little sense as the computer's odd question.

Milic decided to test his theory that readers are accustomed to poems' not making sense. He took some of Dylan Thomas's poems and let a computer rearrange them. "My students couldn't always tell which poems had been doctored and which were genuine," Milic recalls. He then wrote a program called Erato, ambitiously named for the muse of lyric poetry, that used an elaborate algorithm to scramble and rescramble words from the first lines of 10 famous poems. Readers who know Gerard Manley Hopkins's poem beginning, "Margaret, are you grieving" will recognize it in one of Erato's more successful attempts:

Margaret, are you saddening
Above the windy jumbles of the tide.

Wave to me in the peace of the night.
Jealousy is not all: It is not refreshment nor water.

Return to me in the pause of the shade,
Darling, because my spirit can chime

Above the early flounces of the stream.
Margaret, are you saddening?

Milic explains: "What we accomplish by this is to learn something about poetry. It doesn't weaken our admiration for poets. On the contrary, it deepens it because we see how much easier they do what the programmer and machine are trying to do." Milic produced a computer-scrambled version of the poem "Return" by Alberta Turner that prompted Turner to write four new poems in response. "The random-generating power of a computer can produce combinations which the human brain normally would exclude as either meaningless or offensive to its sense of order," Milic says. Turner agreed, calling this randomizing "a valuable step in initiating or restimulating the poetic process."

Although Milic's experiments would give nightmares to an Oxford don, they are not without precedent. Jonathan Swift, in *Gulliver's Travels*, described a mechanical writing machine that allowed "the most ignorant person . . . [to] write books in philosophy, poetry, politics, law, mathematics, and theology without the least assistance from genius or study." More recently, the dadaists in the 1920s and the beatniks in the 1950s experimented with composing poems by randomly clipping words from newspapers and other printed sources. A computer, however, is far more efficient.

This efficiency points to one of the first problems with computer poetry—the sheer volume of poetry that can be produced very quickly. Richard Bailey, a University of Michigan professor who has studied this subject, says it reminds him of the sorcerer's apprentice who ordered his broom to fetch water and then was nearly drowned in the deluge. Bailey cites the case of one poet, Robert Gaskins, who wrote a program to create haiku and then sent the output directly to a video-display terminal. New haiku would appear at the bottom of the screen, scroll slowly to the top and disappear forever. Within months, Bailey says, Gaskins and his computer "became the most prolific poetic collaborators of all time." But there was never any sense of loss in seeing a haiku scroll up into infinity, Bailey says, because another one would be along in a moment.

"I'm trying to construct a model of what makes people creative."

The Seeds of Revolt

While programs like Erato and the haiku generator left the computer with little more to do than randomly select from among lists of words, other scientists were trying to give the machine more responsibility. One of these researchers was Sheldon Klein at the University of Wisconsin. In the early 1970s, Klein, a linguist and professor of computer science, collaborated with his students to devise a program to write 2100-word mystery stories in 19 seconds each. The group soon followed with a program to create Russian fairy tales.

More recently, Klein says, he and his students have invented a program to write operas. Like the earlier two programs, the opera-writer is divided into two parts. A simulator generates the plot in a special symbolic language devised by the group, then translators turn the symbolic plot into words, music, and moving pictures of the action. (The music is generated by an Apple; other functions take place on a Terak computer. The simulation language, whose name is written as five vertical slashes and pronounced "bar-bar," is based on UCSD Pascal.)

To facilitate display on a video terminal, the opera is based on Edwin Abbott's nineteenth-century fantasy *Flatland* about a two-dimensional world, and it is titled *Revolt in Flatland*. Klein and his colleagues showed a video-taped sample at the Fifth International Conference on Computers and the Humanities in Ann Arbor, Michigan, last year. But, says Klein, "I'm not keen on showing it because, to be perfectly frank, the music is superb but the action is quite dull." This is because the action simulator treats the cast's movements as if they were taking place on a realistic scale, rather than compressed onto a stage. "Most of what's happening in the current version is that little squares and triangles and polygons are moving slowly from one house to another. The action only happens occasionally, when they meet," Klein says. A refined version of *Revolt in Flatland* is being prepared which will automatically omit the boring scenes. In the meantime, says Klein, "Potentially, our opera could be five hours long, like a real opera, but at the end there would be nobody watching."

Klein's early programs allowed the computer to develop a plot but gave only limited consideration to the motivations of individual characters.

One of those who set out to solve that problem was Jim Meehan, now an artificial-intelligence researcher at the University of California at Irvine.

Tale-Spin's Fables

Meehan's 1976 program, called Tale-Spin, created stories that were modeled loosely after Aesop's fables. Characters with names like Joe Bear, George Ant, and Irving Bird lived in a simple universe with rivers, fields, caves, and trees. The human author set the plot in motion by giving one of the characters a motive such as hunger, thirst, sleepiness, or a desire for sex (primly referred to by Tale-Spin as "fooling around"), and the characters then wheeled and dealed with one another in symbolic form to resolve their goals. Meanwhile, a natural-language translator reported on their movements to the outside world. Here is a sample of the raw output:

Once upon a time George Ant lived near a patch of ground. There was a nest in an ash tree. Wilma Bird lived in the nest. There was some water in a river. Wilma knew that the water was in the river. George knew that the water was in the river. One day Wilma was very thirsty. Wilma wanted to get near some water. Wilma flew from her nest across a meadow through a valley to the river. Wilma drank the water. Wilma wasn't thirsty any more.

In this particular story, George Ant goes on to fall in the river and is rescued by Wilma Bird. The fall has been planted by the human programmer; the rescue came about because all characters are automatically motivated to rescue any other character they know is in danger of dying. Tale-Spin kept track of the social relationships between its characters, and it made a list of each character's goals, crossing out goals as they were accomplished. But it was prone to silly mistakes. For example, in one fable, a character named Henry Crow inadvertently dropped a piece of cheese and was soon mired in an endless loop of bargaining with himself to get the cheese back. The program didn't realize that its internal representations of "Henry Crow" and "himself" were the same character.

When Tale-Spin worked, it created stories of a natural simplicity reminiscent of folk tales (see the illustration below).

The problem with Tale-Spin, says Meehan, who is 32, was that its stories lacked purpose. "There was no overall goal as to what the story would be about. It might be filled with perfectly rational behavior, but it might not be particularly interesting, just as what you and I do in a day may be rational but may not constitute a story." For this reason, Meehan doubts that efforts to invent a "story grammar"—a set of rules for creating good fiction—will ever succeed, although many authors and scholars have tried to devise such rules. Says Meehan: "It doesn't take much literary education to find a half-dozen great stories that don't fit the model and another half-dozen terrible stories that do."

Author's Purpose

Building on Tale-Spin's approach, Yale's Natalie Dehn is creating a more ambitious program that considers what the author wants from a story. "The author has goals, things she

Once upon a time, there were two bears named Jack and Joe, and a bee named Sam. Jack was very friendly with Sam but very competitive with Joe, who was a dishonest bear.

One day, Jack was hungry. He knew that Sam Bee had some honey and that he might be able to persuade Sam to give him some. He walked from his cave, down the mountain trail, across the valley, over the bridge, to the oak tree where Sam Bee lived.

Jack asked Sam for some honey. Sam gave him some.

wants to accomplish," says Dehn, a 28-year-old researcher in artificial intelligence. "She starts off with an initial intent but may wind up with something quite different. I'm trying to model what the author is doing."

Dehn's program, appropriately called Author, starts with a general idea for a story but then refines and focuses the idea as it goes. It may even abandon the first idea in favor of a better one. But, thanks to a memory model developed by Roger Schank, the program is also capable of being "reminded" of earlier ideas and returning to them. In this respect, it is like a human author who is reminded of people, situations, and events from his or her own life, or from earlier versions of a work of fiction, and then incorporates them into a story. Dehn's interest in such problems dates to high school when, she says, "I began to think that the most interesting problems were in the humanities but that the best methods for problem-solving were those of science."

A program like Author has come a long way from the random-generated poetry writers of the 1960s and early 1970s because it "understands" what it is doing. Dehn calls the earlier programs, which only simulated intelligence, "hack programs"; the classic of these was the popular Eliza, or Doctor, program that mimicked a psychiatrist talking to a patient.

The story-generating methods being developed for Author will find practical use in another program, which Dehn is writing to help adults who are poor readers. This program, called Starship, will generate a story in which the user is a crew member on a space vessel engaged in an important mission. At crucial times in the plot the program will ask the reader what should be done next. "The moves he makes," says Dehn, "will tell how well he has understood the story so far." As a training tool, the Starship program will have elements in common with such games as Dungeons and Dragons, in which the user becomes the lead character in what amounts to an adventure novel, or with commercial software adventures that allow the user to walk through branches of fictional possibilities.

When Tale-spin worked, it created stories of a natural simplicity reminiscent of folk tales.

Where Will It Lead?

Today's computer-generated literature is limited in part by the difficulties of producing a natural language but even more so by the fundamental problem of giving a computer the capacity to find interesting things to say. As a result, computer literary products are still quite crude. Yet they point to exciting things ahead: poems that write or revise themselves, novels in which the reader is a character or author, and so forth. All of this may not satisfy critics today, but it heralds an interesting and lively future. As computer poet Milic says, "People who scoff at computer poetry are simply not thinking. It would be like complaining, as people did when Gutenberg came around, that the word of God was not meant to be printed by machine."■

Then Joe Bear walked over to the oak tree and saw Jack Bear holding the honey.

He thought that he might get the honey if Jack put it down, so he told him that he didn't think Jack could run very fast. Jack accepted this challenge and decided to run. He put down the honey and ran over the bridge and across the valley.

Illustration by Coni Porter

Joe picked up the honey and went home. (This story was created by Meehan's Tale-Spin program. He translated the story into more conventional English from the choppy sentences of the original.)

Scion Color System

Mark Dahmke
Consulting Editor

In the November 1980 BYTE (see 'The MicroAngelo Video Display," page 196) I reviewed the Scion Microangelo graphics display—an S-100 board that provides 512 by 480 dot resolution. The board contains a Z80 microprocessor and 32K bytes of memory, making it one of the most powerful graphics displays of its class. It has only one limitation—no color or gray levels. Each dot out of 245,760 dots is either on or off.

Now, Scion has announced the Microangelo Color System, which consists of a set of Microangelo boards connected together through a color mixer or palette board. With more than one board contributing to the display, each dot or pixel (picture element) can be described by enough bits to specify a color or other intensity for each pixel.

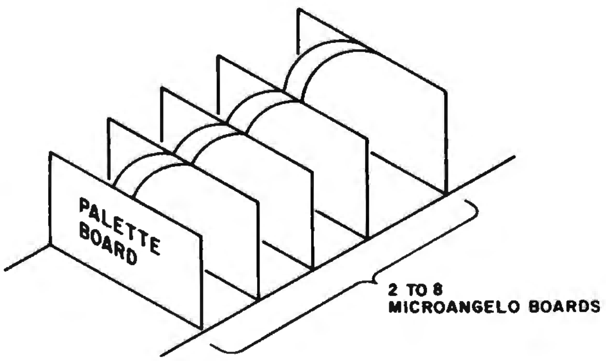


Figure 1: *Scion Color System hardware organization. From two to eight Microangelo S-100 boards may be connected via 20-pin ribbon cable to the palette board, which selects colors and generates RGB output for a color monitor.*

The color system offers unprecedented capabilities for its low price. Because each Microangelo has an on-board computer, you can send commands to each board and have them processed simultaneously. The palette board mixes the outputs of multiple (from two to eight) Microangelo boards by looking for the color value represented by parallel bits in the parallel Microangelo boards. In a two-board system, you could display 4 different colors; in an eight-board system, 256 different colors. Each color-palette entry is defined in red, green, and blue (RGB) components, each of which can range from 0 to 100 percent in 256 steps. This means that on a full system, you could choose 256 colors out of a palette of more than 16 million colors.

Figure 1 shows the hardware organization of the color system. The palette board must be present on all versions, but you can start with two Microangelo boards and work up to eight. A 20-conductor ribbon cable connects the boards to the palette board. Each Microangelo has its own Z80 running at 4 MHz and on-board firmware in PROMs (programmable read-only memories). The firmware can be either Screenware Pak I or Screenware Pak II, which offers the additional capabilities of region flooding, hardware and software test routines, split screen for separate alpha and graphics regions, firmware circle drawing, and macro definition allowing the on-board Z80 to draw frequently used shapes or objects. I will not spend much time describing the firmware features of the Microangelo; I suggest that you read my review in the November 1980 BYTE.

The Palette Board

Figures 2 and 3 show how the palette board converts bitplane information into colors. The software must set the appropriate bits in the Microangelo boards so that the bits make up the number of the color-palette entry. When the display is generated, the palette board converts the number into separate red, green, and blue values, which are in turn sent to the RGB color monitor. The process is really quite simple and powerful. Note that the color of an object on the screen can be changed after the fact by simply changing the color-palette entry for that combination of bits.

Software and Firmware

As mentioned earlier, the Screenware Pak I and II PROMs are on board the individual Microangelo bitplanes. The system is very fast because each board receives its commands and executes functions such as drawing a vector or circle. A software package called Colorpak that manages these high-level functions is included. Colorpak is written as a subroutine library, callable from FORTRAN-80. It greatly simplifies the development of an application program. If you want to draw a vector in color number 3, you would code the following:

```
CALL CURCLR(3)
CALL GRCUR(100,100)
CALL VECTOR(120,150,−1)
```

The first statement selects color 3 (which was previously defined in the program). The second line moves the graphics cursor to screen coordinates 100,100. The third statement draws a vector from the graphics cursor location to 120,150. The −1 parameter tells the Colorpak to draw the vector in the currently selected color.

It is also possible to group bitplanes into "transparencies." This is like having several windows or screens that overlap each other. For example, you could set up two transparencies with four bitplanes, allowing 16 colors per transparency. One transparency could have a grid on it, while the other could display a floor plan for a building. The two transparencies can be displayed separately or overlaid in several ways. First, you could display the floor plan on top of the grid, or for measurement purposes, you could put the grid on top. This can be changed dynamically by subroutine calls without redrawing the image.

You can also decrease the intensity of a transparency to any percentage of full intensity. Whenever there are multiple transparencies, the color palette is automatically configured to display the color that has precedence—the color from the transparency that overlays all others. You can mix colors that overlap, creating a new color. One possible use for this feature would be in circuit-board layout. The wiring diagram for a circuit could be displayed, with the cross-over points highlighted in a different color.

The hardware also allows winking bitplanes. When configured to wink, the display will alternate between two colors about every second. This feature also could be used to highlight information on the screen.

At a Glance

Name
Scion Color System

Type
512-by-480-resolution color graphics system that can display up to 256 colors out of a palette of more than 16 million colors

Manufacturer
Scion Corporation
12310 Pinecrest Rd.
Reston, VA 22091

Price
Color System with two Microangelo boards (4 colors), $2,495; with six boards (64 colors), $6,495; with eight boards (256 colors), $8,495; for Screenware Pak II, add $400, plus $40 for each extra board beyond the first. A fully configured eight-board system with Pak II would cost $9,175. RGB color monitors are available at $2,495.

Features
Up to 256 colors on one display with a full eight-board system; a light pen is optional. Each board has a Z80 running at 4 MHz (which can run at 6 MHz), 32K bytes of main memory, room for 8K bytes of EPROM memory (used for Screenware Pak I or II), and 512 by 480 dot display. Palette board has RGB generation circuits and high-speed look-up memory for palette selection.

Firmware
Full firmware to generate vector graphics and characters; high-level commands sent via parallel ports. Functions include: drawing vectors, plotting points, and generating characters (normal or double size; rotation is also available). Screenware Pak II can flood a region with a color.

Software
Several CP/M-compatible programs are available including COED, a color editor program that displays a palette on the screen and lets you build colors from either the RGB or HLS models. A FORTRAN-80-compatible subroutine library (Colorpak) is provided so that high-level commands can be executed without having to understand or program the hardware. Three sample programs are also on the distribution disk as well as the source listing (in FORTRAN) for the Colorpak subroutine library.

Computer Needed
Any S-100-compatible computer or any computer that has an S-100 bus adapter. Although the Color System uses a Z80 microprocessor, the host processor does not have to be Z80 or 8080 compatible. If you plan to use the COED and Colorpak software, you must be able to run it with CP/M and FORTRAN-80 (or a similar language). You will also need a wide-bandwidth (15 MHz or more) RGB color monitor. Monitors are also available from Scion.

Documentation
A 131-page Color System manual is provided along with a pocket reference card for the Colorpak subroutine library calls and the Microangelo hardware manual (80 pages). Documentation is adequate but not exceptional.

Audience
Anyone requiring high-resolution color graphics on an S-100 system

The Color Editor

Defining an organization of transparencies and colors can be difficult at best. It is very handy to be able to see the colors as you mix them on the palette. Scion has gen-

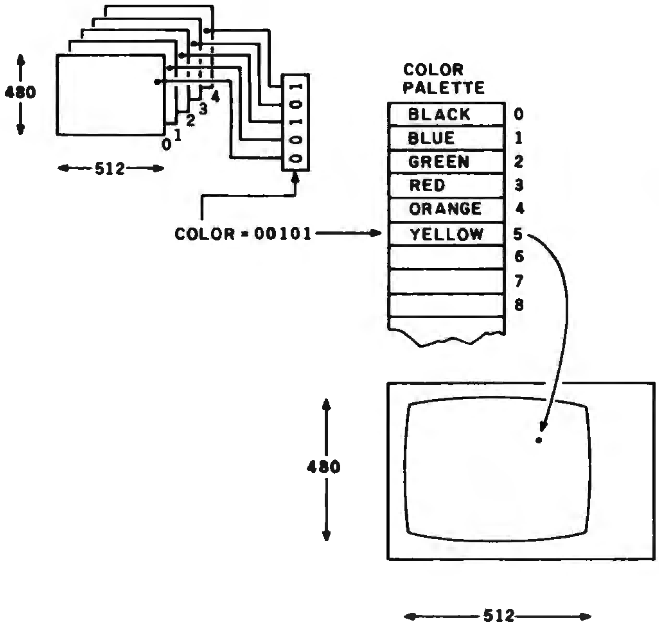


Figure 2: *The palette board uses information from each bitplane as a color number that points to a color palette entry. The user may load the color palette with any of 16 million colors by mixing red, green, and blue.*

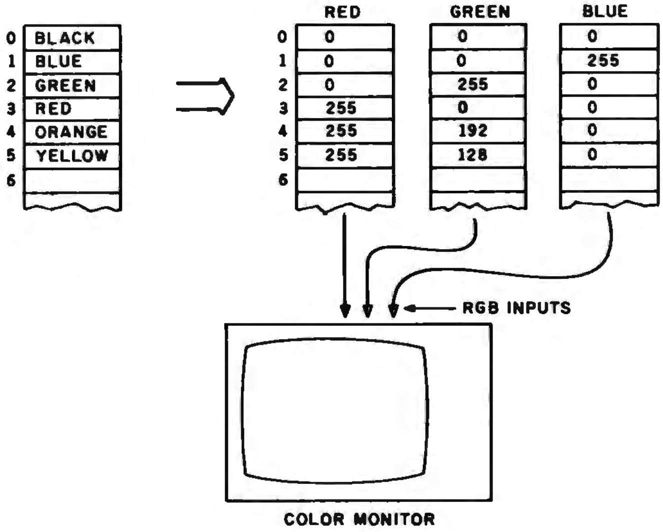


Figure 3: *The color palette actually consists of three separate values, one for each primary color. Red, green, and blue may each be specified, in a range of 0 to 100 percent, in 256 steps. The resulting color values are sent to the red, green, and blue guns on an RGB color monitor. This process is repeated for each of the 245,760 dots or pixels every 1/60 second.*

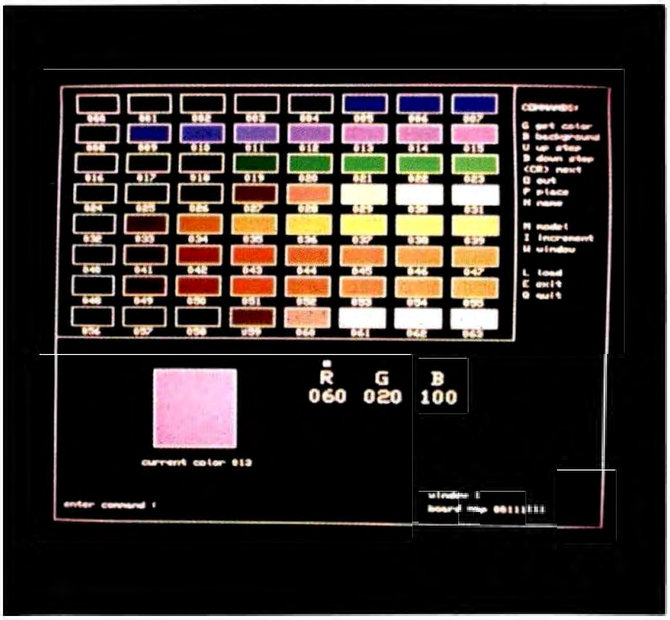


Photo 1: *A sample display of the Scion Color Editor. This utility program allows you to create color libraries for application programs. After setting up a group of colors, the library may be stored and later loaded into a user program. This particular display was used in my application program for demonstration purposes. It represents the spectral colors of the main sequence of stars. Each horizontal row is a spectral color: very blue, blue, green, white, yellow, orange, red, and a second white row. Photo by Mark Dahmke.*

erously provided a color editor that aids in the design of an application. The color editor is a large program that draws a set of one-inch-long boxes on the color display. A small command language allows the user to vary each of the RGB components of each palette entry to see the resulting colors. When a color has been selected, it can be stored in one of the 64 palette entries. Actually, there are up to 256 palette entries (if you have eight bitplanes), but only 64 are displayed at one time. Photo 1 shows the color editor with a typical palette of colors.

The editor normally uses the RGB method of building and mixing colors, but the HLS (hue, lightness, saturation) model can also be used. Figure 4 shows the topology of this model. At first it may look quite confusing but is really a useful model. Hue is measured in degrees, from 0 to 360. Blue is at 0, red is at 120, and green is at 240. Note that all of the primary additive colors are at 120-degree increments around the circle. Yellow appears at 180 degrees. Lightness is measured in percent, from 0 to 100. Zero percent is black, regardless of the hue and saturation values, and 100 percent will produce white. Saturation is also measured from 0 to 100 percent and is really a measure of the chroma or amount of color visible. It is graphically represented in figure 4 as the radius of the color circle.

Colorpak Functions

Working with Colorpak is like working with a combination of a Tektronix graphics terminal and the IBM 2250 graphics display. Most of the subroutine calls are obvious, e.g. "CALL VECTOR" and "CALL POINT," and the color system requires a fair amount of initialization. You must do one of two things: use the color editor to define a set of colors and one or more transparencies, or use Colorpak to define the same. With the color editor, the task is quite simple. To load a screen organization and color palette, you would code:

```
CALL GETSYS('FILENAME',0)
```

where "FILENAME" is the file defined by the color editor, and 0 indicates that it is on the current disk drive.

If you wish to do it the hard way, the following sequence might be used:

```
CALL CINIT(112,3,240,224,208,0,0,0,0,0,2)
CALL DEFTRN(1,3,0,0,0,0,0,0,0,0)
CALL PUTCLR(1,1, 0, 0,255,0,0,0)
CALL PUTCLR(1,2, 0,255, 0,0,0,0)
CALL PUTCLR(1,3,255, 0, 0,0,0,0)
CALL PUTCLR(1,4,255,192, 0,0,0,0)
CALL PUTCLR(1,5,255,128, 0,0,0,0)
CALL ERASE(1,1)
```

The first statement initializes the color system and defines it as having three bitplanes at decimal I/O (input/output) port addresses 240, 224, and 208. The last parameter is 2, which tells the Colorpak that you are using Screenware Pak II. The second line defines a transparency structure with one transparency of three bitplanes. The next five lines assign colors to the palette. This particular initializa-

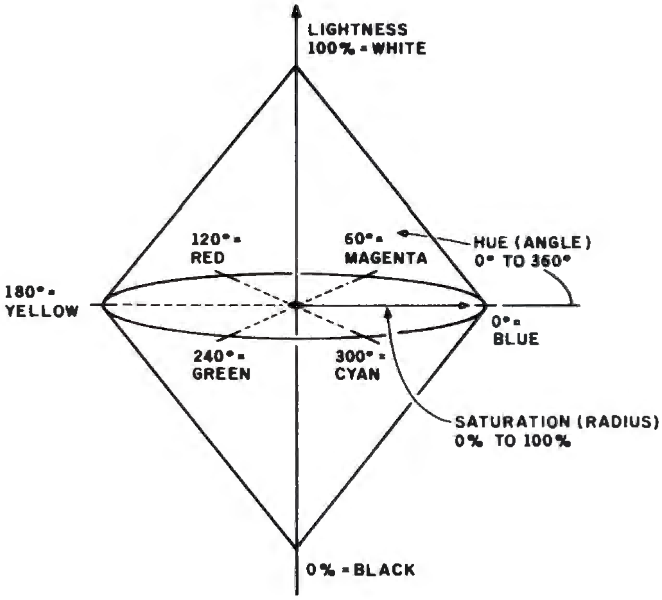


Figure 4: *The HLS color model. Either the RGB or HLS models may be used in the Scion Color Editor (COED) program. The HLS model is diagrammed as a pair of cones, with the vertical axis representing lightness. The top is 100 percent white; the bottom is black. Hue is represented as an angle where 0 degrees is pure blue, 120 is red, and 240 is green. Saturation is represented as the radius of the cone. A saturation of 0 percent will produce a gray scale of lightness from 0 to 100 percent.*

Photo 2: *A sample illustration on the Scion Color System. Photo courtesy of Scion Corporation.*

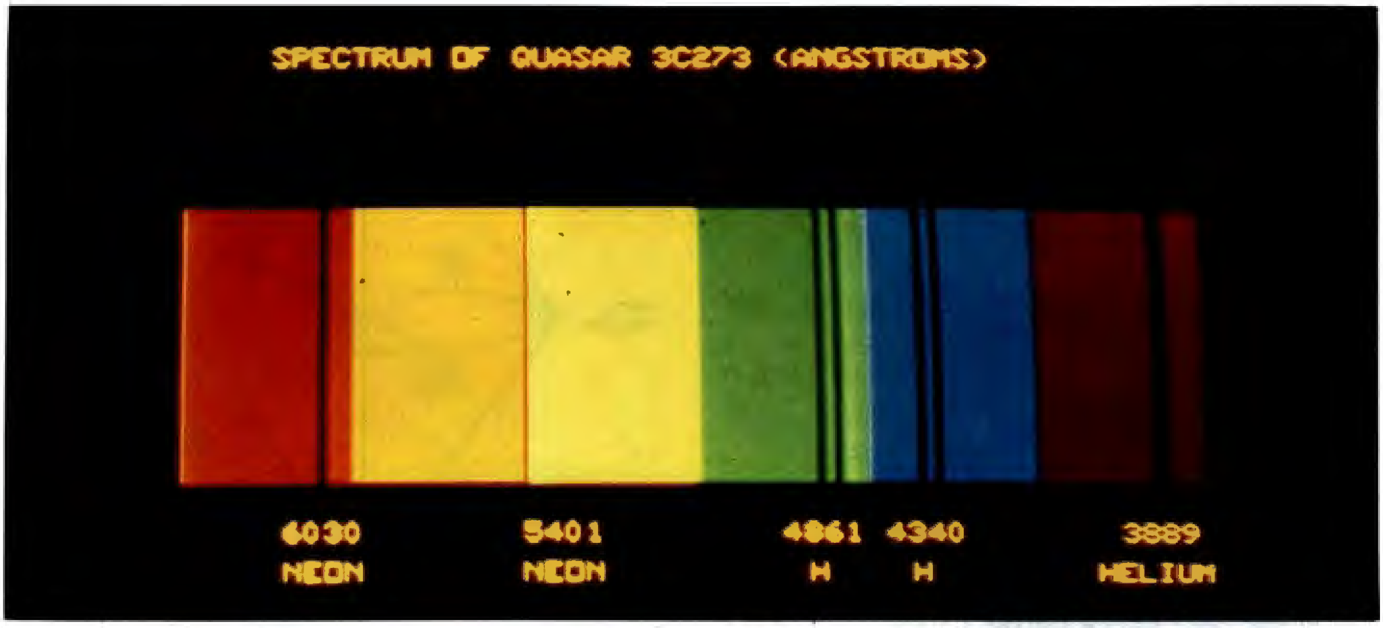


Photo 3: *A simulation of an absorption spectrum of a quasar on the Scion Color System. Photo courtesy of Scion Corporation.*

tion will make the system look like the examples in figures 2 and 3. The last call is made to erase transparency 1.

Colorpak has some useful subroutines such as FLOOD, which will fill a bounded region with the currently selected color. The fill algorithm is in firmware, so it runs very fast. FADE will fade out a transparency to a percentage of its full brightness, and FUSE will fuse colors in overlapping transparencies. MOVTRN allows you to change the display precedence of transparencies. As with the Microangelo video display, cross hairs and a lightpen interface are available.

A Real-Life Application

After trying out the samples included on the CP/M dis-

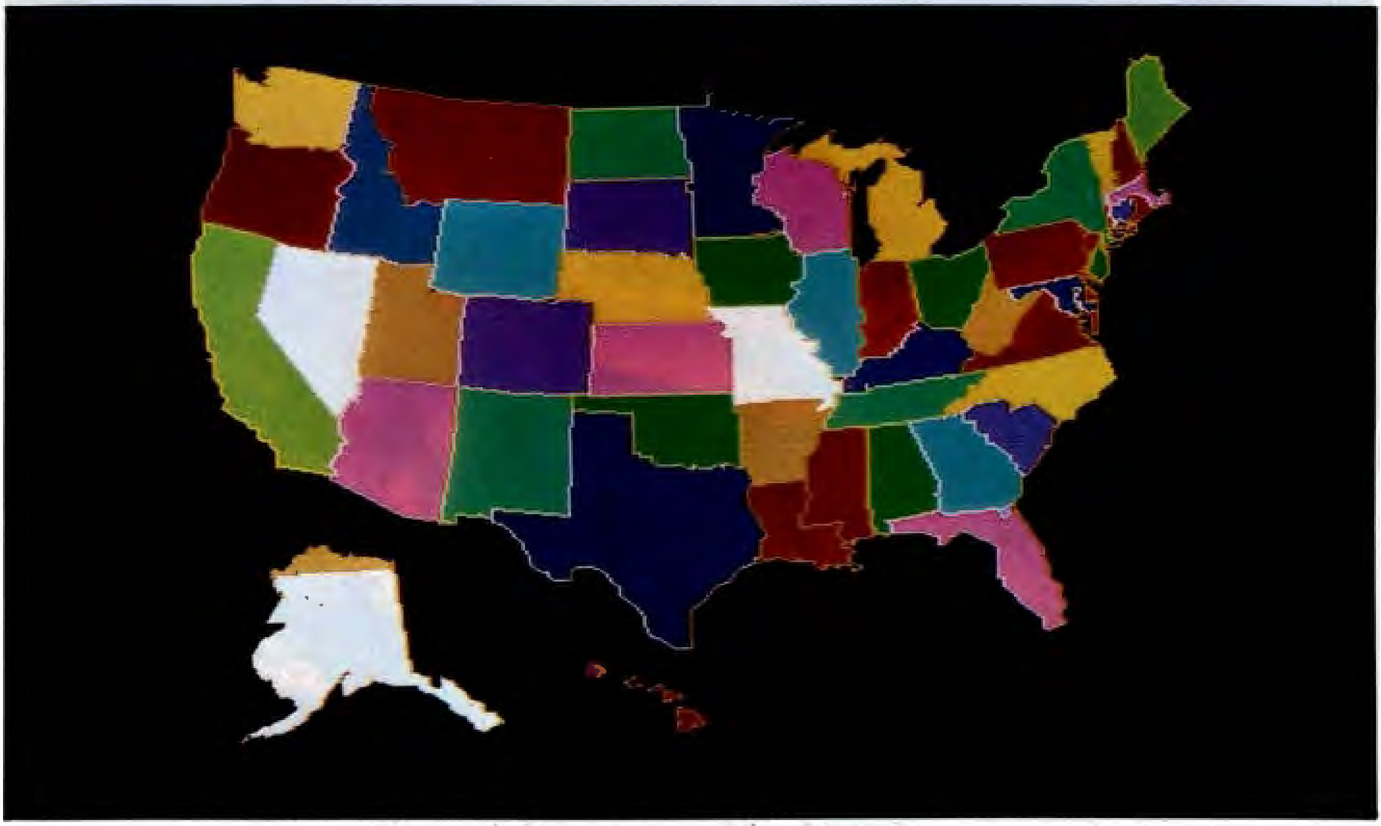


Photo 4: *A sample illustration on the Scion Color System. Photo courtesy of Scion Corporation.*

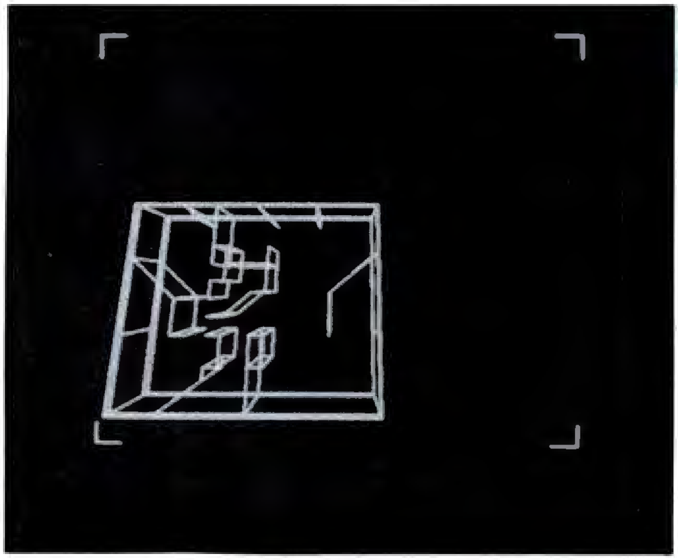


Photo 5: *A sample of Ken Livingston's three-dimensional architectural modeling program on the Scion display. Photo by Mark Dahmke.*

tribution disk, I pulled out my old favorite—the three-dimensional model of the galaxy (see "A Simulated View of the Galaxy" April 1979 BYTE, page 66). I decided to include stellar magnitudes (brightness) and spectral color for a better effect. I down-loaded the FORTRAN program from an IBM System/370 on which I had been running it and recompiled the program on my CP/M system. I added the initialization calls, using a color library I defined with the aid of the color editor. Photo 1 shows the resulting color palette, which has seven different colors, each with eight intensity levels. In astronomy, the colors of the stars are categorized as O, B, A, F, G, K, and M. These are very blue, blue, green, white, yellow, orange, and red, respectively. (A second white row appears at the bottom.) Other samples of color graphics are shown in photos 2, 3, 4, and 6.

Conclusions

I have had the Scion Color System for several months, and I really don't want to give it up. It is one of the most convenient graphics systems I have ever worked with. The best test I could give it was my star map program, which used almost all the features of the system. The fact that I down-loaded the FORTRAN program from an IBM computer and modified it to run on the Scion system in less than three hours also says a lot for the system. BYTE author Ken Livingston and I also down-loaded Ken's architectural three-dimensional modeling system. It took one evening to change the graphics interface and recompile it on my CP/M system, then a few more hours to fine tune it. After that we were able to generate wire models of buildings and project different views of them. Photo 5 shows a sample of Ken's program.■

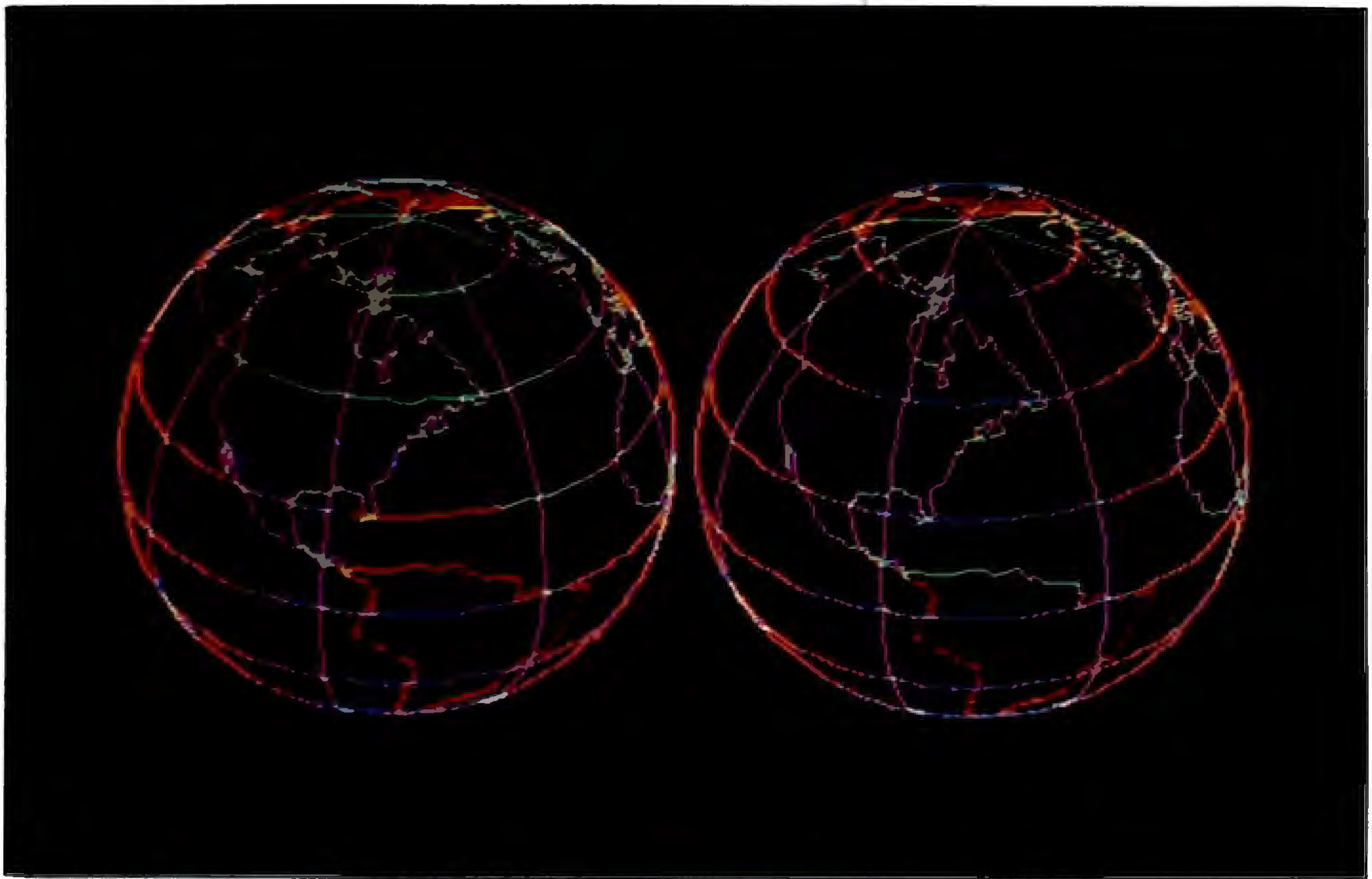


Photo 6: *A sample illustration on the Scion Color System. Photo courtesy of Scion Corporation.*

Add Programmable Sound Effects to Your Computer

Silicon replaces gunpowder for producing sound effects.

Steve Ciarcia
POB 582
Glastonbury, CT 06033

The explosions were still ringing in my ears as I peered through the smoky atmosphere. Suddenly behind me I heard someone open fire with a phaser. I whirled, expecting to be vaporized. Then I remembered where I was.

I had gone down to the local convenience store to get a quart of milk, and I had walked past a row of video arcade games.

The lifelike sound effects associated with arcade games represent the fruit of years of work in various technologies. In the past, sound men for radio serial dramas kept in their bags of tricks such objects as coconut shells, squeaky hinges, and watering cans. Producing sound effects involved physically producing the noise through mechanical means. This often required talent rivaling that of the actors.

Today the sand board and coconut shells are gone. Physically produced sound effects have given way to the electronic synthesizer and the computer. You can simply sprinkle a little pink noise through a programmable attenuator to make a horse gallop or trot on command.

Surprising sound effects can be obtained with relatively little hardware.

Computerized sound generation has not eliminated a profession, however. It has added a new dimension to entertainment. The sound effects used in movies such as *The Empire Strikes Back* could not have been produced 30 years ago.

Sound generation of that quality is of course beyond the typical Circuit Cellar project, but surprising results can be obtained with relatively little hardware. This month I'm working with the SN76489A sound-generator integrated circuit from Texas Instruments. (Another TI product, the SN76494N, is identical to the 76489A except that it runs at a lower clock frequency.) These two chips are shown in photo 2 on page 62.

In this article, I'll describe a sound-generating circuit that can be connected to virtually any computer. I'll also provide some sound-effects routines in BASIC for you to use with your own computer arcade games.

SN76489A: General Structure

Figure 1 is a block diagram of the SN76489A integrated circuit. The chip contains four signal sources: three independent generators of single-frequency tones and one generator of noise. In addition, each source has its own attenuator with a 28-dB (decibel) attenuation range. The output signals from the four attenuators

Photo 1: *You don't need a pistol to produce the sound effect of a gunshot. The Texas Instruments SN76489A integrated circuit can produce the same sound under program control.*

are summed together as a single amplified output.

The 76489A is sealed in a 16-pin DIP (dual-inline package) and is designed for connection to and operation with computer address and data buses, appearing to the computer as a write-only location in memory or I/O (input/output) address space. Commands are communicated to the sound-generator chip's internal registers via its own 8-bit data bus during the interval of activation of the Write Enable and Chip Enable lines by corresponding strobed signals. Typically, this is accomplished by tying the address decoder's output to the 76489A's Chip Enable pin and the computer's Read/Write line to the Write Enable pin.

The SN76489A is designed to run at a maximum clock frequency of 4 MHz (megahertz) and loads data rather slowly. The input data must remain stable during the 32 clock cycles (16 μs [microseconds]) that the 76489A requires to load an 8-bit data value. When the loading has been completed, the sound-generator chip brings its $\overline{\text{Ready}}$ line to an active-low state. This signal can be used to halt the computer processor for the required time if necessary. We'll find out more on the process of loading data later.

Sound Possibilities

Each of the three tone generators in the 76489A contains a presettable 10-bit programmable down counter used as a variable frequency divider. The output frequency of each generator is selected by loading the 10-bit count register through a command from the processor. The counter is decremented by a submultiple of the clock frequency; when the count register reaches zero, it toggles a flip-flop. The output signal from the flip-flop becomes the output of the tone generator, which is a square wave.

With a 2-MHz clock frequency, as is found in many typical computer systems, the 10-bit counters allow the 76489A to cover a range of five octaves: from two octaves below middle C to three octaves above it. This is wide enough for most applications. The output frequency of a given tone generator is defined by the following equation:

$$f = n \;/\; 32 \times I$$

where f is the tone generator's output frequency, n is the system's clock frequency (here assumed to be 2 MHz), and I is the decimal equivalent of the 10-bit counter register's contents.

The noise generator is a 15-bit exclusive-OR feedback shift register that produces pseudorandom noise, which is generally used for sound effects such as explosions and gunshots. The rate at which the register shifts determines whether the noise contains a majority of high-frequency or low-frequency components. The

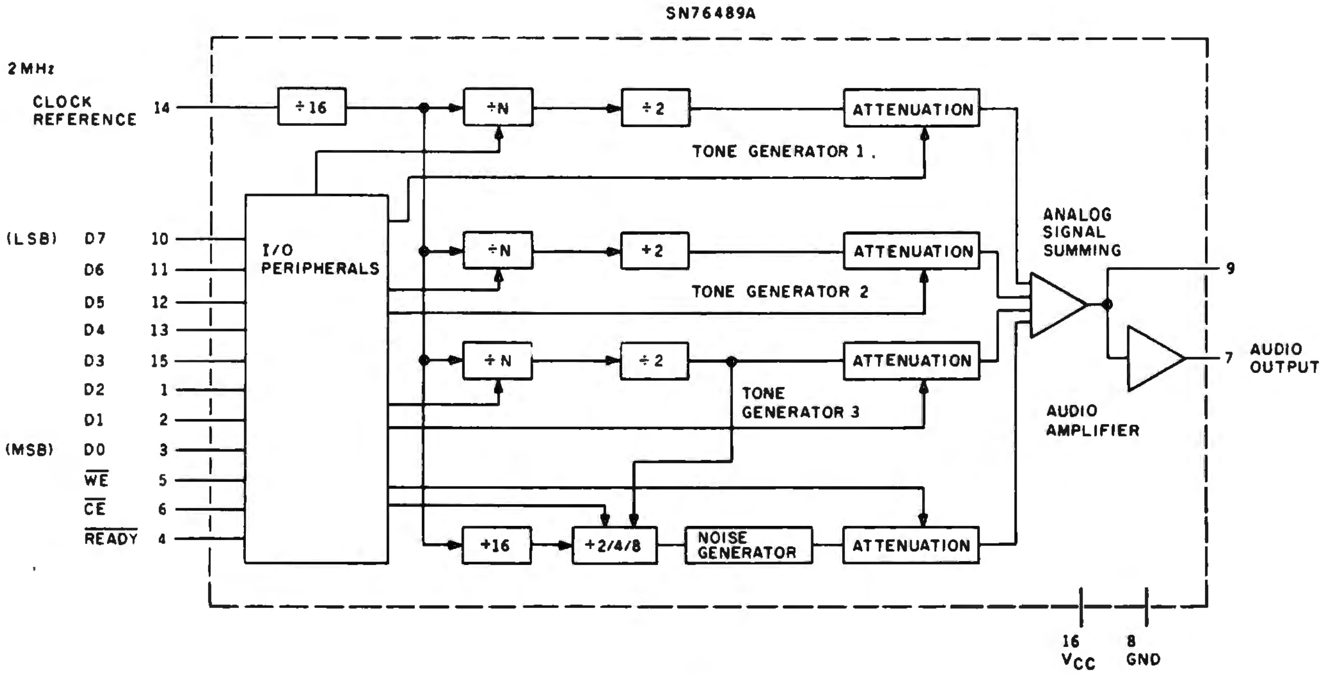


Figure 1: *Block diagram of the Texas Instruments SN76489A sound-generator integrated circuit, which runs at a maximum clock rate of 4 MHz. The similar SN76494N runs at a clock frequency of 500 kHz (kilohertz).*

shift rate can be controlled by the frequency set on tone generator 3 or independently through the noise-generator-control register.

The output attenuators, one for each of the four sources, are logarithmic and designed primarily for musical applications. The 4-bit attenuator range is from 0 dB (maximum amplitude) to −28 dB (minimum amplitude). The sixteenth step, which would be predicted to set the amplitude to −30 dB, turns the attenuator off. By very quickly turning the attenuators on and off or changing their control values, you can synthesize interesting envelope effects to simulate bells or a piano.

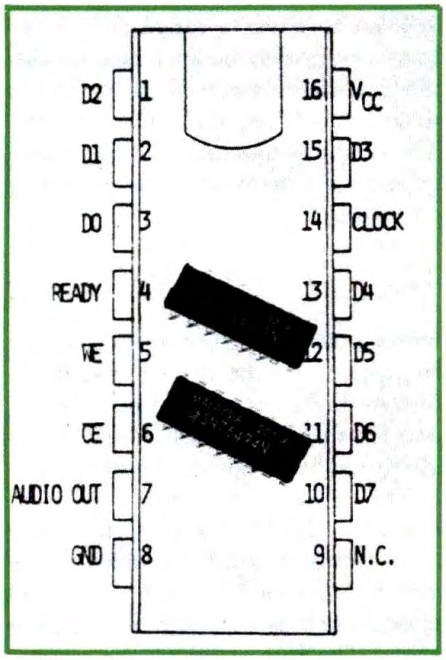


Photo 2: *The SN76489A and its sibling the SN76494N are nearly identical, but operate at different clock frequencies.*

The four attenuator outputs are added together through an analog summing circuit, and the combined output is then amplified to 10 mW (milliwatts) with a voltage swing of about 2 V (volts), but an external power amplifier is required to drive a speaker.

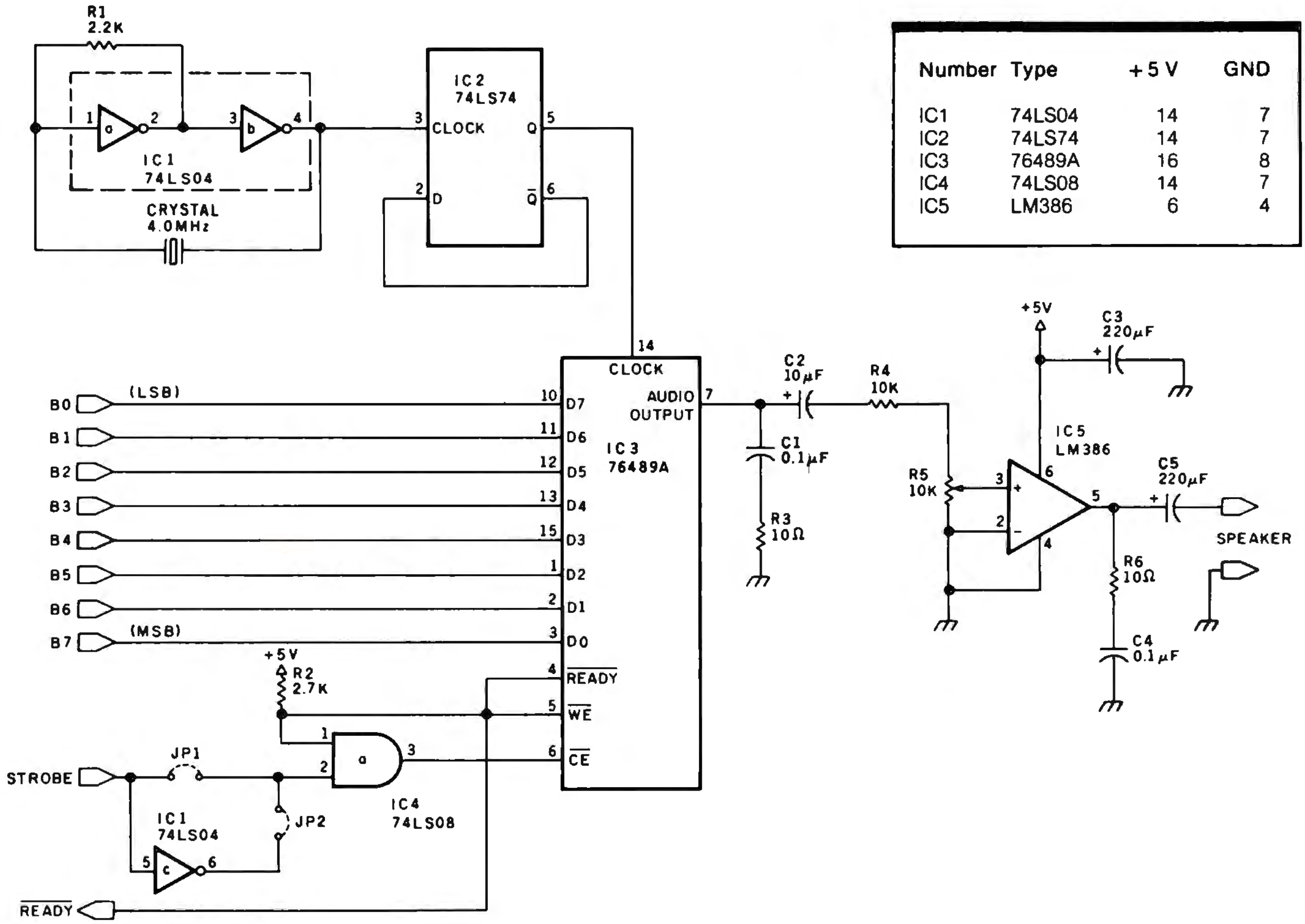
An Easily Built Interface

While the 76489A can be attached directly to a microprocessor's bus, given a suitable address-decoding and data-latching scheme, the details of such a connection depend on which processor is used, and the design requires attention to accommodating the register-loading delay. To avoid this, I designed a parallel interface that is neither processor- nor load-time-dependent.

The design, shown in the schematic diagram of figure 2, is a four-chip sound-generator circuit that incorporates the SN76489A. It can be attached to an 8-bit latched parallel output port that uses a data-ready strobe line (a Centronics-compatible printer port will work). A prototype of the circuit is shown in photo 3 on page 65.

In the figure, note that the data lines B0 through B7 are oriented to follow general interfacing conventions in the matter of bit hierarchy rather than the Texas Instruments format. In the TI hierarchy, bit 7 of every byte is the LSB (least significant bit), and conversely bit 0 is the MSB (most significant bit). This just happens to be the way TI does things. The TI system is used later in the descriptions of the SN76489A's internal registers.

I have chosen to run the sound generator at 2 MHz. IC1 and IC2 (inverter sections and a flip-flop) generate this frequency, dividing a 4-MHz crystal-oscillator output by 2. (If you have a 2-MHz or 4-MHz signal handy



Number	Type	+5 V	GND
IC1	74LS04	14	7
IC2	74LS74	14	7
IC3	76489A	16	8
IC4	74LS08	14	7
IC5	LM386	6	4

Figure 2: *Schematic diagram of a sound-generating circuit incorporating the SN76489A designed to be attached to a computer system through a parallel I/O port. A source for parts is given in the text box at the end of the article.*

in your computer, you could use it instead by connecting it to IC2 or IC3 [the SN76489A] as required, omitting the crystal.)

How It Works

The computer loads a byte of data into the SN76489A (IC3) by making it available on the data lines and then pulsing the Strobe input line. (The jumper connections JP1 and JP2 respectively select use of a negative-going strobe or a positive-going strobe signal.) This signal is passed through IC4 (an AND gate) to the Chip Enable (CE) line of IC3. When the CE line is strobed, the Ready line (IC3 pin 4) goes to a logic 0, triggering the Write Enable (WE) input (IC3 pin 5). With a 2-MHz clock the Ready line stays low for 32 μs while IC3 is being loaded. When it is finished, the Ready line goes high, and another byte can be loaded in a similar manner. Configured as in this circuit, the processor must wait at least 32 μs between byte transfers to the sound generator.

If you will be controlling the interface with a BASIC program, there is no possibility of sending data too fast. Most BASIC interpreters take at least 2 ms (milliseconds) to execute a statement. But some sound effects and music may not be easily generated by BASIC. In such cases, the interface must be driven with a machine-language program. To properly time the data transfer, the Ready line from the interface can be monitored through an input port (such as the Printer Busy input of your Centronics port) or connected directly to the Wait input of the processor.

Changes to registers will cause immediate changes in the audio output.

The output of the sound generator is amplified through a 1-W (watt) power amplifier (IC5) to drive a speaker.

Data Formats

Figure 3 on page 64 shows the three data formats used in programming the 76489A, which contains 8 registers (listed in table 1) that control the various noise and tone outputs. Noise or attenuation parameters are loaded as 1-byte values, while frequency updates require 2 bytes. (Figure 3 uses the TI bit hierarchy.)

The 76489A's input channel appears as a single address to any processor. To differentiate between the first and second byte of any data transfer, all first-byte or single-byte

R0	R1	R2	Control Register	
0	0	0	tone 1	frequency
0	0	1	tone 1	attenuation
0	1	0	tone 2	frequency
0	1	1	tone 2	attenuation
1	0	0	tone 3	frequency
1	0	1	tone 3	attenuation
1	1	0	noise control	
1	1	1	noise attenuation	

Table 1: *Register addresses for controlling various functions of the SN76489A. These 3-bit values determine which of the registers receives that remainder of the bits in the control byte as data.*

A0	A1	A2	A3	Attenuation Weight
0	0	0	0	0 dB
0	0	0	1	2 dB
0	0	1	0	4 dB
0	0	1	1	6 dB
0	1	0	0	8 dB
0	1	0	1	10 dB
0	1	1	0	12 dB
0	1	1	1	14 dB
1	0	0	0	16 dB
1	0	0	1	18 dB
1	0	1	0	20 dB
1	0	1	1	22 dB
1	1	0	0	24 dB
1	1	0	1	26 dB
1	1	1	0	28 dB
1	1	1	1	off

Table 2: *Attenuation parameters for each of the signal sources. The SN76489A must receive an attenuation-control byte, formatted as shown in figure 3, before any output can be heard.*

(3a) Update Frequency (2-byte transfer)

First byte: MSB … LSB

$$1\ \underbrace{r0\ \ r1\ \ r2}_{\text{register address (table 1)}}\ \underbrace{f6\ \ f7\ \ f8\ \ f9}_{\text{data}}$$

Second byte: MSB … LSB

$$0\ \ x\ \underbrace{f0\ \ f1\ \ f2\ \ f3\ \ f4\ \ f5}_{\text{data}}$$

(3b) Update Attenuator (single-byte transfer)

MSB … LSB

$$1\ \underbrace{r0\ \ r1\ \ r2}_{\text{register address (table 1)}}\ \underbrace{a0\ \ a1\ \ a2\ \ a3}_{\text{attenuation value (table 2)}}$$

(3c) Update Noise Source (single-byte transfer)

MSB … LSB

$$1\ \underbrace{r0\ \ r1\ \ r2}_{\text{register address (table 1)}}\ \ x\ \ \underbrace{FB}_{\text{noise type (table 3)}}\ \underbrace{NF0\ \ NF1}_{\text{noise clock (table 3)}}$$

Figure 3: *Formats required for programming the control registers in the 76489A. The first bit of the first control byte is always 1; the second byte, if used, has a first bit with a value of 0.*

transfers have the most significant bit equal to a logic 1. The second byte always has the MSB equal to logic 0.

Programming Tones

Setting a frequency of 440 Hz for tone generator 1 is done as follows. First find I

$$I = n/32 \times f$$
$$I = (2\ \text{MHz})/(32 \times 440)$$
$$I = 142.045$$

Since I must be an integer quantity, we set it to 142. The actual frequency will be 440.14 Hz.

Next, we convert I to a 10-bit binary value (using the TI bit hierarchy, where bit f0 is the MSB and f9 is the LSB):

MSB … LSB

f0	f1	f2	f3	f4	f5	f6	f7	f8	f9
0	0	1	0	0	0	1	1	1	0

(While I could have converted everything to follow the bit-hierarchy conventions of the rest of the world, anyone comparing this article to the specification sheets of the 76489A would become utterly confused. But the external interfacing connections to my circuit in figure 2 do follow the ordinary convention.)

The frequency data for tone generator 1 must be transferred to the 76489A as a 2-byte quantity. From figure 3a, we see that byte 1 must contain three register-designation bits, r0, r1, and r2, which denote that the value is to be applied as a frequency change for generator 1. We chose the value 000 from table 1 for these three bits.

We then see from figure 3 that 4 of the data bits go in the 4 low-order bits of byte 1 and that the remaining 6 bits go in the 6 low-order bits of byte 2. The MSB in byte 2 must be 0, and one of the bits in byte 2 is not used.

Therefore, to set tone generator 1 at 440 Hz, the first control byte becomes

MSB … LSB

1	r0	r1	r2	f6	f7	f8	f9
1	0	0	0	1	1	1	0

which is the same as hexadecimal 8E or decimal 142, and the second byte becomes

MSB … LSB

0	x	f0	f1	f2	f3	f4	f5
0	0	0	0	1	0	0	0

which is the same as hexadecimal 08 or decimal 8.

A simple way to load these values via BASIC is to execute the statements OUT *n*,142 and OUT *n*,8 where *n* equals the port address of the sound-generator interface. The argument of the first statement conveys the register address and the 4 low-order bits of the value to be loaded into the down counter. The second

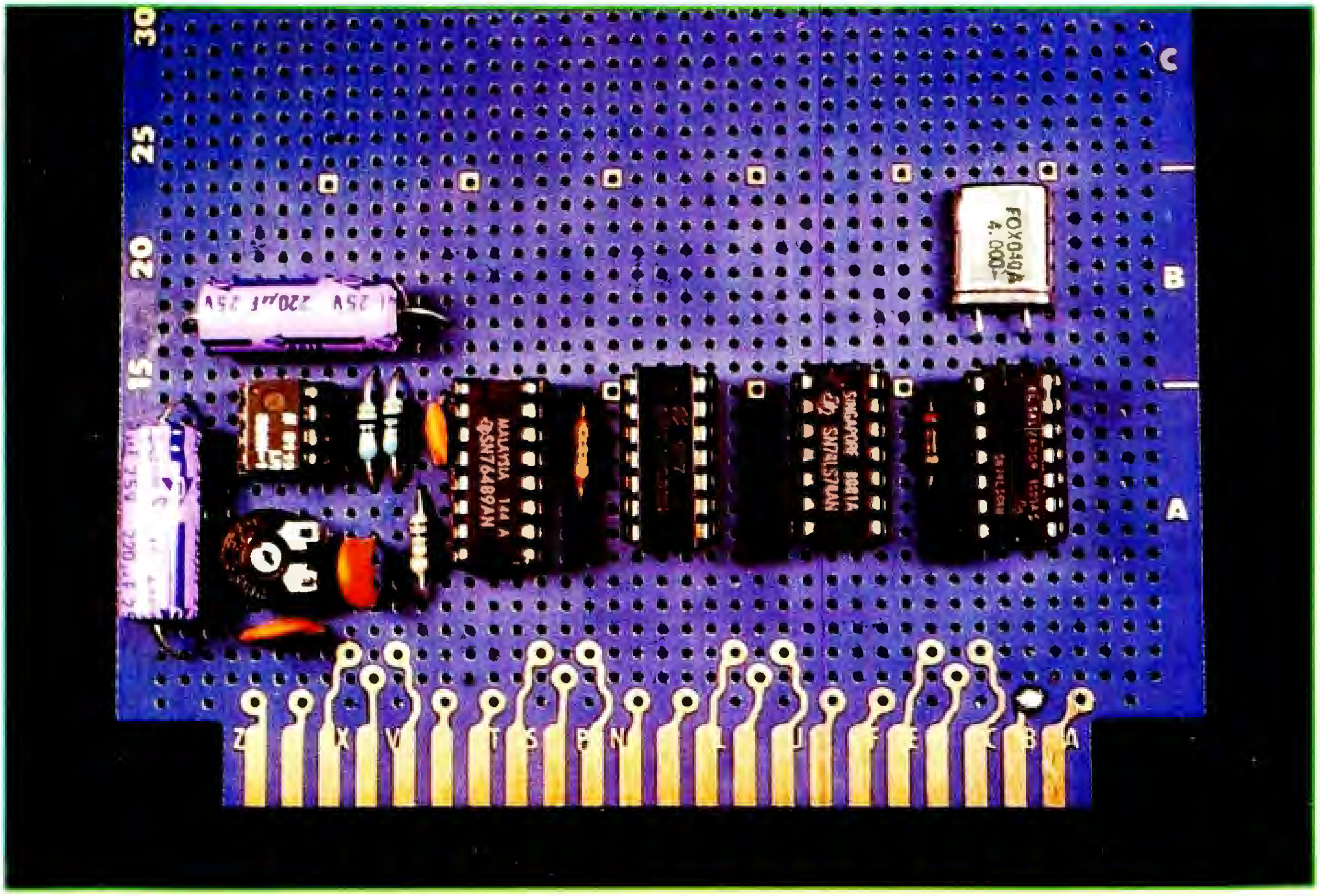


Photo 3: *Prototype of the parallel-port-driven sound-generation circuit shown in figure 2.*

argument contains the remaining 6 bits for the counter.

Once these values have been transmitted, tone generator 1 is loaded, but the attenuator has not been set to enable any output. Changing the attenuator setting requires only a single byte of data, set according to the attenuation parameters shown in table 2.

From table 1, we select the attenuation-register address of 001 for tone generator 1. A 0-dB attenuation setting (0000 from table 2) turns the volume on full. The resulting formatted control byte, according to figure 3b, is

MSB							LSB
1	r0	r1	r2	a0	a1	a2	a3
1	0	0	1	0	0	0	0

which is the same as hexadecimal 90 or decimal 144.

To turn on the 440-Hz tone at full volume, therefore, we have to execute the statement OUT *n*,144 after we have set the tone parameters. To reduce the output amplitude by 4 dB, an OUT *n*,146 statement would be executed.

Programming Noise

To change the output of the noise source, we change the noise-control and noise-attenuation registers. Both use single-byte commands, shown in figure 3c.

As shown in table 3 on page 66, the one of the bits is called the FB, or feedback, bit. This bit controls the feedback in the noise-generator shift register. If the FB bit is a logic 1, the result is white noise. If the FB bit is a logic 0, the feedback is disabled, and a lower-frequency repetitive (periodic) noise is produced.

Two bits, NF0 and NF1, control the clock frequency fed to the noise-generator shift register. Four options are available: three options select fixed rates (in the formulas, *n* is the 2-MHz clock frequency), or you can select the output of tone generator 3 as the shift-register clock. In the latter case, some interesting effects, such as sweep frequency noise, are produced when the frequency of tone generator 3 is varied.

Performance Hint

One last comment on loading registers. The SN76489A runs in real time. If you change a register, the results will be heard immediately after each byte is loaded. On a 2-byte frequency-change command, if the time delay between loading the first and second byte is extraordinarily long, it can result in some off-frequency notes being heard. When exercising the 76489A with a slow interpreted language such as BASIC, it is generally a good idea to shut off a tone generator's output before changing its frequency. After you have loaded the 2-byte value (or only a single byte if

FB	Configuration
0	periodic noise
1	white noise

NF0	NF1	Shift Rate
0	0	*n*/512
0	1	*n*/1024
1	0	*n*/2048
1	1	tone generator 3 output

where n = clock rate

Table 3: *Noise-control parameters for the noise source. White or periodically varying noise may be produced; the output of tone generator 3 may be used to control the noise generator.*

Note	*I* Value	Frequency
C	239	261.50 Hz
C#	225	277.77 Hz
D	213	293.43 Hz
D#	201	310.95 Hz
E	190	328.95 Hz
F	179	349.16 Hz
F#	169	369.82 Hz
G	159	393.08 Hz
G#	150	416.67 Hz
A	142	440.14 Hz
A#	134	466.42 Hz
B	127	492.13 Hz

Table 4: *A diatonic scale may be played by the tone generators using the values of I shown here as control parameters loaded into one of the down counters. The frequencies produced are quite close to standard.*

all 10 bits of the frequency specification don't have to be changed), the output can be turned on again. For single-byte register changes, the only concern is that the rate of change be consistent with the type of sound you are trying to produce.

Producing Tones in BASIC

Many variations are possible with such a versatile sound generator, and much of the experimenting can be accomplished without having to think in binary radix. A few simple lines of BASIC allow you to determine the value of *I* for a particular frequency and automatically format the 2-byte tone parameters.

Listing 1 is a program that facilitates testing of the interface and demonstrates some simple formatting techniques. You can hear the tone produced by any value of the down-counter register. The register value is entered as the value I. The second byte B becomes the result of the calculation:

$$B = INT(I/16)$$

and the first byte A is derived and formatted:

$$A = I-B*16+128$$

In BASIC the sequence is executed as OUT *n*,A and OUT *n*,B (where *n* is the port address). Again, to turn on the tones, it is necessary to execute a statement to set the attenuators to some state other than off, as was done before by the statement OUT *n*,144.

Should you care to experiment with a diatonic scale, a list of the appropriate values of I and the corresponding frequencies is shown in table 4.

Demonstration Programs

The program in listing 2 on page 68 uses these notes to play a few bars of "The Entertainer" by Scott Joplin. In this program, DATA statements are used to list each note (BASIC variable F) and its duration (D) as it is played on the tone 1 output. In addition, the program takes this same data and shifts it an octave and outputs it to tone generator 2 as well. The result is an interesting effect and a pleasing sound.

Listing 3 is a further example of using the tone generators. This program simulates a clock chime, striking 12 times. The sound is synthesized by mixing and linearly attenuating two tones that are close in frequency.

Finally, no article on sound effects would be complete without a program to produce phaser and explosion sounds. Listings 4 and 5 on page 70 fulfill this requirement. In both cases, the noise generator is the key ingredient.

To produce a phaser sound, the noise generator is set to white noise with its clock rate controlled by the output of tone generator 3. When the phaser sound is to be heard, the frequency of tone generator 3 is swept, and the attenuation is linearly ramped down.

Listing 1: *A BASIC program to test and demonstrate the SN76489A circuit, and to possibly inspire other ideas for programming it. The sound generator is assumed to be interfaced to the computer through a parallel I/O port.*

```
100 REM   ****   SN76489A TONE TEST   ****
110 N=17 :REM Sound Generator port address
120 OUT N,159:OUT N,191:OUT N,223:OUT N,255 :REM Clear Outputs
125 REM Tone output is clock/32*I -- Enter I to test tone output
130 PRINT"Divider Valve = ";:INPUT I
150 B=INT(I/16)
160 A=I-B*16+128
200 OUT N,A :OUT N,B :REM Set 2 byte tone value on 76489A
220 OUT N,144 :REM Turn on Tone 1 Output
230 FOR X=0 TO 1000 :NEXT X :REM Delay
240 GOTO 120
```

Listing 2: *A BASIC program that plays part of "The Entertainer" by Scott Joplin.*

```
100 REM   **** THE ENTERTAINER by Scott Joplin ****
110 REM         **** Played on the SN76489A ****
120 REM
130 N=17 :REM Tone Generator Address
140 GOSUB 370 :REM Clear Outputs
150 DATA 239,8,213,8,201,8,190,8,120,8,190,4,120,8,190,4,120,16
160 DATA 2,2,120,8,107,8,101,8,95,4,120,4,107,4,95,4,127,6,107,8
170 DATA 120,16,0,0
180 DIM F(50),D(50)
190 FOR I=1 TO 30
200 READ F(I),D(I)
210 IF F(I)=0 THEN 230
220 NEXT I
230 E=I :I=1
240 B=INT(F(I)/32)
250 A=F(I)/2-B*16+128
260 OUT N,A :OUT N,B :REM Set 1ST Octave Value
270 B=INT(F(I)/16) :A=F(I)-B*16+160
280 OUT N,A :OUT N,B :REM Set 2ND Octave value
290 OUT N,144 :REM Turn on Tone 1
300 OUT N,176 :REM Turn on Tone 2
310 FOR X=0 TO 20*D(I) :NEXT X :REM Hold Tone 1/4,1/2, or Whole
320 I=I+1 :REM Increment Note Counter
330 IF I=E THEN GOSUB 370 :END
340 GOTO 240
350 REM
360 REM
370 OUT N,159 :OUT N,191 :OUT N,223 :OUT N,255
380 RETURN
```

Listing 3: *Program that simulates the ringing of chimes.*

```
100 REM  **** CHIME SOUND ****
110 REM
120 N=17 :REM Tone Generator Address
130 GOSUB 1000 :REM Clear All Outputs
135 REM
140 REM Set Tone 1 to 679 Hz
150 OUT N,140 :OUT N,5
160 REM
170 REM Set Tone 2 at 694 Hz
180 OUT N,170 :OUT N,5
185 REM
190 FOR T=0 TO 11 :REM Strike Chime 12 Times
200 FOR A=145 TO 159 :REM Loop to Generate Attentuation Steps
210 OUT N,A :OUT N,(A+32)
220 FOR Q=0 TO 65 :NEXT Q :REM Delay While Sounding Chime
230 NEXT A
240 NEXT T
250 REM
1000 OUT N,159 :OUT N,191 :OUT N,223 :OUT N,255
1010 RETURN
```

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Listing 4: *Program that simulates the sound of a phaser firing.*

```
100 REM   **** PHASER SOUND ****
110 REM
120 N=17 :REM Sound Generator Address
130 GOSUB 1000
140 OUT N,231 :OUT N,240 :REM set noise and attentuation
150 FOR L=0 TO 15
160 FOR A=192 TO 207
170 OUT N,A :OUT N,L
180 NEXT A
190 OUT N,(240+L)
200 NEXT L
210 END
1000 OUT N,159 :OUT N,191 :OUT N,223 :OUT N,255
1010 RETURN
```

Listing 5: *Program that produces an explosion sound.*

```
100 REM   **** EXPLOSION ****
110 N=17
120 GOSUB 1000
130 OUT N,228 :REM Set high pitched white noise
140 FOR A=240 TO 255
150 OUT N,A :REM STEP ATTENTUATION
160 FOR D=0 TO 50 :NEXT D :REM delay
170 NEXT A
180 GOSUB 1000 :END
1000 OUT N,159 :OUT N,191 :OUT N,223 :OUT N,255
1010 RETURN
```

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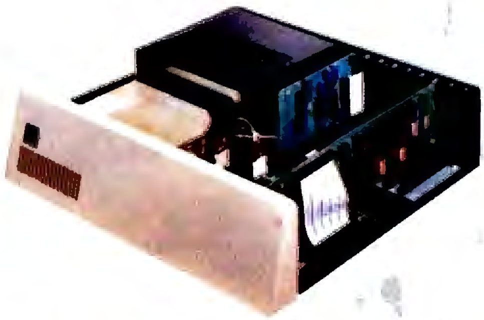

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Producing an explosion is easier. The procedure is simply to set the white noise to a high volume and linearly attenuate the output. Abruptly shutting off the output will make it sound more like a gunshot.

In Conclusion

The SN76489A has some truly remarkable features for a 16-pin integrated circuit. I have only scratched the surface of the sound effects that it can produce, and the programs I have included are merely a first attempt at producing sound effects. I even think that given proper incentive and a bank of SN76489As, I could give the Cleveland Symphony Orchestra a run for its money.

In reality, I probably won't use this interface for music as much as I might use it as a warning device or annunciator on one of my computer systems. The good old days of bells, whistles, and lights on computers aren't gone. And now these accessories are programmable.

Next Month:

A spritely attempt at building a simple, versatile color-video graphics and animation circuit. ■

A complete kit of parts, including a printed-circuit board, for the sound-generator circuit of figure 2 is available from:

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The kit sells for $40 postpaid in the United States. For foreign orders, please include $5 for shipping. For orders within Connecticut, please include 7½-percent sales tax.

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

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, 70 Main St., Peterborough, NH 03458.* Ciarcia's Circuit Cellar, Volume I, *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II, *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III, *contains the articles that were published from July 1980 through December 1981.*

Editor's Note: *Many readers have inquired about the experimental multicolor (red, green, and blue) light-emitting-diode component mentioned in the text box I wrote to accompany Steve's article "Use Infrared Communication for Remote Control," April 1982 BYTE, page 40. Sanyo Electric expects that a blue-only LED based on the same technology will be available in mid-1983, with a multicolor device possibly following. North American distribution will be handled by Sanyo Semiconductor Corporation, 7 Pearl Ct., Allendale, NJ 07401, (201) 825-8080. . . .* **R.S.S.**

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

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

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

Compare CompuView With IBM

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

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

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

V-COM Disassembler

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

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

8086 Software

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

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

Bootable CP/M-86 disks for popular S-100 computers . . . . Call

Breaking the Jargon Barrier

Designing Programs for Humanists

Archaeologists design programs for their colleagues using the language of the profession.

Ned Heite and Lou Heite
Heite Consulting
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Camden-Wyoming, DE 19934

The belief that knowledge and the students thereof are divisible into two bodies, one scientific, the other "humanistic," is indeed one of the constitutive ideas that frame contemporary intellectual life.

John Higham, *Writing American History: Essays on Modern Scholarship* (Indiana University Press, 1970), page 6.

Humanists seldom are trained to deal with quantified information or to express ideas in numerical form. Because computers are numerical devices and computer specialists belong to the scientific branch of society, a communication gulf often exists between computerists and humanists.

About the Authors

Ned and Lou Heite, both archaeologists and office information management consultants, are developing computer programs for other archaeologists, including an archaeological drafting and statistical package in Commodore's BASIC.

Some humanists, such as "cliometric" historians (those who apply statistics to Clio, the muse of history), do use statistical methods to interpret information. These brave humanists must fight their way through one set of technical jargon in order to master statistics; and if they use computers in their statistical work, they must face the even more formidable barrier of computer jargon.

Humanists who persevere and master the new methods and jargon find that they are now working in the *social sciences*, with the emphasis on *sciences*. Traditional humanists, put off by the incomprehensible jargon, sometimes seem to feel that their quantitative colleagues have left the humanities and become scientists. Traditional scientists, on the other hand, are unlikely to regard social scientists as scientists of any kind. This situation hardly encourages more humanists to start using computers.

Computers in Archaeology Today

At a recent national conference attended by more than 700 archaeologists, only seven—less than 1 percent—attended the session on microcomputer applications in archaeology. This poor turnout confirms the existence of the jargon barrier. Busy professionals have no time for re-education in a new discipline. Because many humanists believe that buying a microcomputer would involve learning computer science, they can hardly be expected to queue up at their campus computer stores. Microcomputer manufacturers reinforce the barrier when they pack five thick volumes of documentation with each system, each volume filled with mystifying computer jargon. The humanist has a subtle appreciation of language. When he or she flips through one of these manuals, terms like *initialize*, *diskette*, and even *user-friendly* are sure to catch the eye and grate on the sensibility.

In short, the jargon barrier current-

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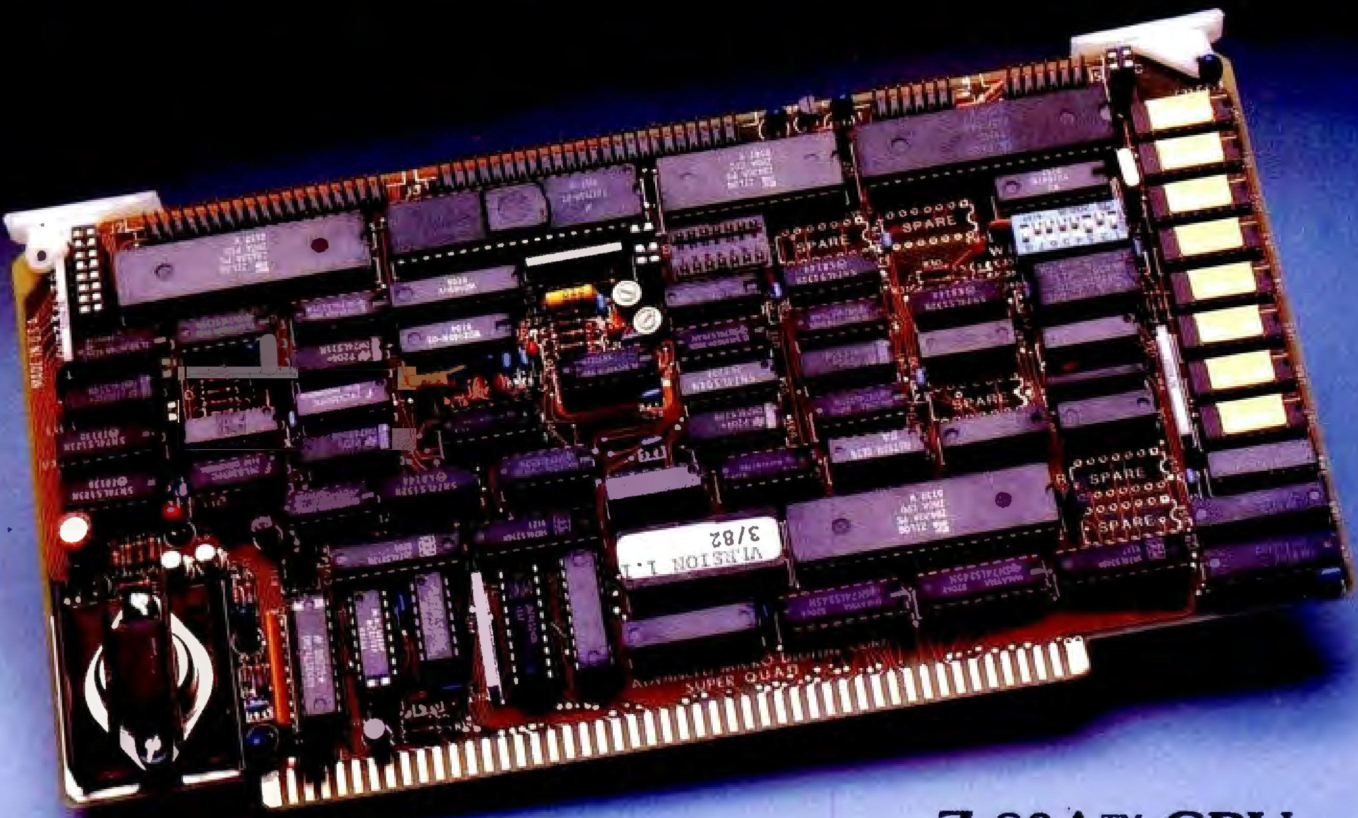

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for a doctorate in the humanities. Computerese, even rudimentary computerese, is considered to be a foreign language.

Microcomputers are not yet as friendly as SPSS. Jinsam, a microcomputer extended database system, does have available many of the essential functions of SPSS. However, procedures in Jinsam cannot be designed and executed in plain English. Therefore, even experienced SPSS users cannot simply sit down at a microcomputer and run stats on Jinsam using their SPSS experience. The foreword to the Jinsam manual clearly states the problem: "It is assumed that the Customer is familiar with the basic operation of the Commodore PET/CBM and the necessary peripheral devices." Then follow 72 pages of jargon-filled, obscure prose, plus two volumes on supplemental modules. By contrast, the same person needs absolutely no knowledge of the IBM 370 to use SPSS on it.

Suppose an archaeologist buys a computer, printer, disk drive, database manager, Visicalc, and word processor. Despite the big investment, 10 or more volumes of heavy reading, and getting used to a strange machine, he still will not be equipped to compute a mean ceramic date or a bore-diameter mean date. Without studying the 10 volumes in detail, he probably won't be able to keep an excavation register either. So why should he leave the friendly embrace of the university's computer department to blaze trails in microcomputing?

The program must actually reduce the users' work load and not complicate their lives.

What Archaeologists Do

The most basic archaeological activity is brute data handling. Every artifact and its associated find-spot is detailed in a document, commonly called an excavation register, that allows complete paper reconstruction of field observations for later analysis. To supplement the written register, archaeologists keep detailed drawings and maps of their sites, recorded in a three-dimensional grid system. Every drawing, every object discovered on the site, and every observed condition are carefully documented and keyed to numerical coordinates.

Archaeological sites often contain confusing patterns of post holes, pits, and foundations created at different times for different purposes. Traditionally, these patterns have been sorted intuitively, sometimes with controversial results. In one English example, over 2500 post holes occurred in an area of 8000 square

meters distributed apparently at random. For 20 years, the site plan sat undeciphered; then a mainframe computer reanalyzed the pattern and found circular house patterns where none had been visible to the unaided eye (see reference 1).

Once the site records are complete, archaeologists commonly interpret them through fairly simple statistical procedures. Descriptive statistics (frequencies and histograms) and measures of central tendency and dispersion (means, medians, and standard deviations) form the bulk of archaeological statistics. Few archaeologists have explored more sophisticated descriptive techniques such as measures of skewness or kurtosis (the peakedness or flatness of a graph representing a frequency distribution).

Chi-square is the most commonly used measure of association, and lately some investigators have begun to employ higher-level correlation measures such as dummy variable analysis, Student's t, and variations of the Pearson's correlation formula. A very few also have begun to use probability distributions such as the Poisson distribution for certain types of site-location prediction.

Beyond these standard procedures, archaeologists use statistical tools peculiar to the field, such as the mean ceramic date and the bore-diameter date formulas. While off-the-shelf programs can be adapted for standard statistical applications, they are nearly useless to the archaeologist in performing field-specific analyses.

Fairly standard recording systems are used throughout the profession, and reporting formats are almost ritualized. Since archaeological procedures already have been adapted to large computer systems, microcomputers are a natural next step.

Writing Software

About a year ago, we began to develop a program package for specific archaeological applications. To promote its acceptance, we set down certain strict ground rules that could apply equally to any programming project in the social sciences and humanities:

1. Procedures should follow as closely as possible the usages of archaeology, regardless of the traditions of computing.
2. The manual must be minimal. After simple instructions for loading the program, the users should be guided by screen prompts written in language familiar to them from their previous professional training.
3. Operating instructions and input procedures must follow archaeological practice. Wherever possible, people familiar with archaeology should be able to perform the operations without computer training.
4. The program must actually reduce the users' work load and not complicate their lives.
5. The system must be completely free of rough edges and must compensate for users' lack of knowledge in such areas as legal string entry and other arcane subjects that computerists take for granted.

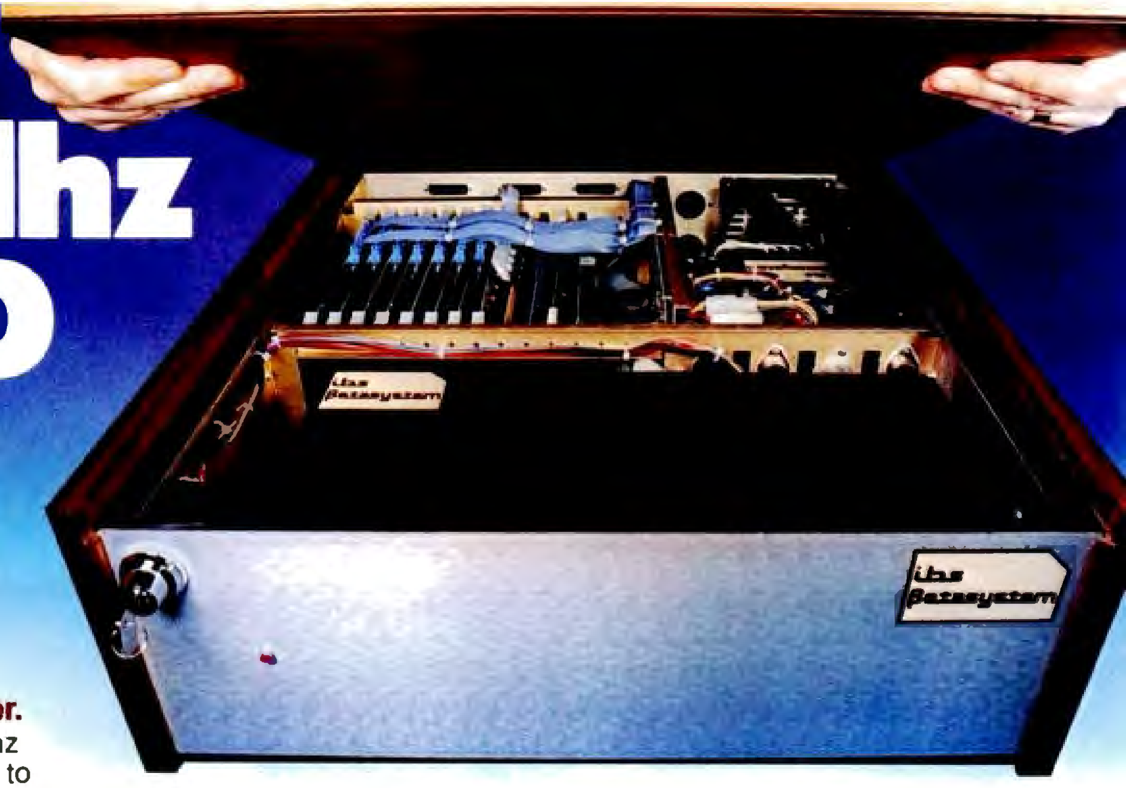
An *archaeological* program should result, even if it might be a clumsy *computer* program. With these principles in mind, we set out to create programs to meet some real needs in the profession.

The Pipes Program

About 30 years ago, J. C. Harrington observed that the bore diameters of white clay smoking pipes decreased through time. Most pipes made in 1600 had stem holes 9/64 inches in diameter, whereas pipes made in 1790 generally had holes 4/64 inches in diameter. Over the intervening years, the English smoking pipe industry gradually reduced the size of the wires used to bore the holes. Harrington discovered that a histogram of the bore diameters of pipestem fragments from any site could accurately reflect the date of the site's occupation (see reference 6).

Ten years later, Lewis Binford observed that the reduction in bore diameter over time was a fairly regular process, decreasing at a rate of about 1/64 inches every 38.26 years. If the reduction trend had continued

36Mhz Z-80



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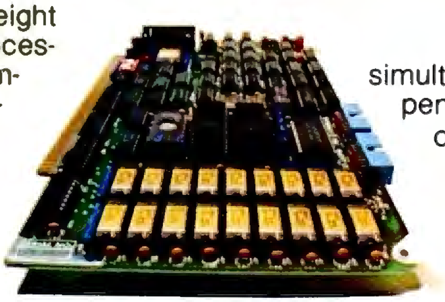

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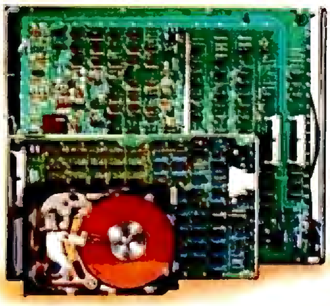

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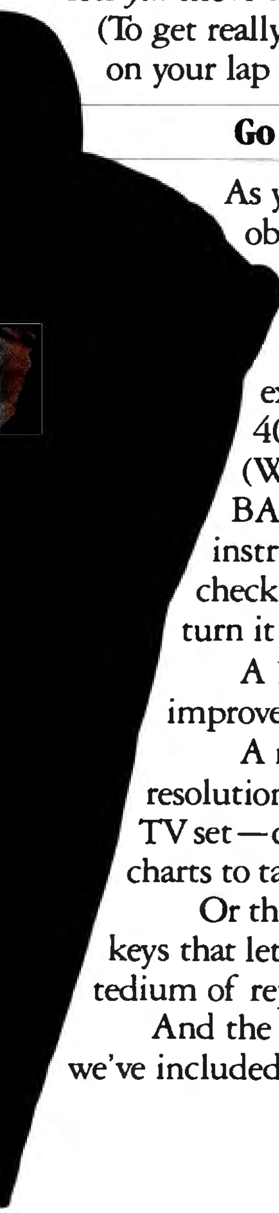

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And the list goes on. Which is why we've included a box (at right) that tells all.

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IBM PERSONAL COMPUTER SPECIFICATIONS

User Memory
16K-256K bytes*

Microprocessor
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Auxiliary Memory
2 optional internal diskette drives, 5¼", 160K bytes or 320K bytes per diskette

Keyboard
83 keys, 6 ft. cord attaches to system unit*
10 function keys*
10-key numeric pad
Tactile feedback*

Diagnostics
Power-on self testing*
Parity checking*

Display Screen
High-resolution*
80 characters x 25 lines
Upper and lower case
Green phosphor screen*

Operating Systems
DOS, UCSD p-System, CP/M-86†

Languages
BASIC, Pascal, FORTRAN, MACRO Assembler, COBOL

Printer
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80 characters/second
12 character styles, up to 132 characters/line*
9 x 9 character matrix*

Permanent Memory
(ROM) 40K bytes*

Color/Graphics
Text mode:
16 colors*
256 characters and symbols in ROM*
Graphics mode:
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Black & white resolution: 640h x 200v*
Simultaneous graphics & text capability*

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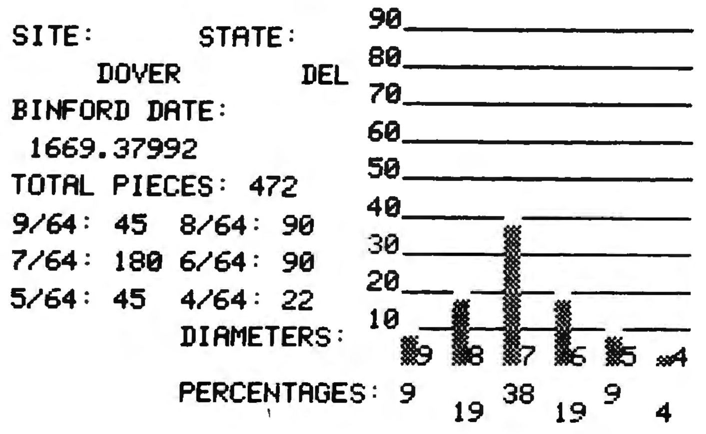

Figure 1: *The data that the Pipes program displays on the video screen after data entry. Based on data about the bore diameters (ranging from 9/64 inches to 4/64 inches) of clay smoking pipes found at the site, the program has calculated that the mean date of the site is the year 1669.*

beyond 4/64 inches, the hole would have disappeared altogether at 6 a.m., November 6, 1931 (Greenwich mean time), which didn't happen. About 1760, bore diameters stopped diminishing. Binford expressed this phenomenon as a straight linear function:

$$y = 1931.85 - 38.26x$$

where x is the mean bore diameter of the sample and y is the mean date. This seemingly exact date is just an approximation, but it provides a useful benchmark for a site's occupation.

To relieve the tedium of calculating mean dates and drawing histograms for each site and feature (which can involve hundreds of calculations in a large dig), we wrote the Pipes program. In this program, the computer asks the user to type the name of the site, the state or province, and the count for each diameter. The computer thereupon displays a histogram, counts, percentages, and the mean date on the screen. Figure 1 mimics the screen display produced at that stage of the program. The printer then copies the same data in two different formats. Figure 2 shows one of these formats.

The Pots Program

Flushed with success from this exercise, we tackled a more complicated project that eventually involved more than 25,000 bytes of code to execute a single formula: mean ceramic date analysis, which incorporates probably the largest specialized formula commonly used by American archaeologists. The formula has 410 constants.

About 10 years ago, Stanley South developed a statistical procedure to derive mean occupation dates for sites, based on the known manufacture dates of pottery types made in America, China, and Europe between 1600 and 1900 (see reference 4). He chose 82 different wares and charted their first manufacture date, last manufacture date, and median date. South multiplied the number of fragments of each type by its median date and added the products. When the total of the products was divided by the total number of sherds from the site, a mean occupation date for the site resulted.

William and Sarah Turnbaugh elaborated the formula with a technique for bracketing the site's probable occupation date with the means of the beginning and ending dates (see reference 5).

More recently, Steven Mrzowski of Brown University and Marley Brown of Colonial Williamsburg have observed that the standard deviation of the South mean date can delineate with startling accuracy the dates when a property changed occupants (see reference 2). As the formula becomes more sophisticated, its

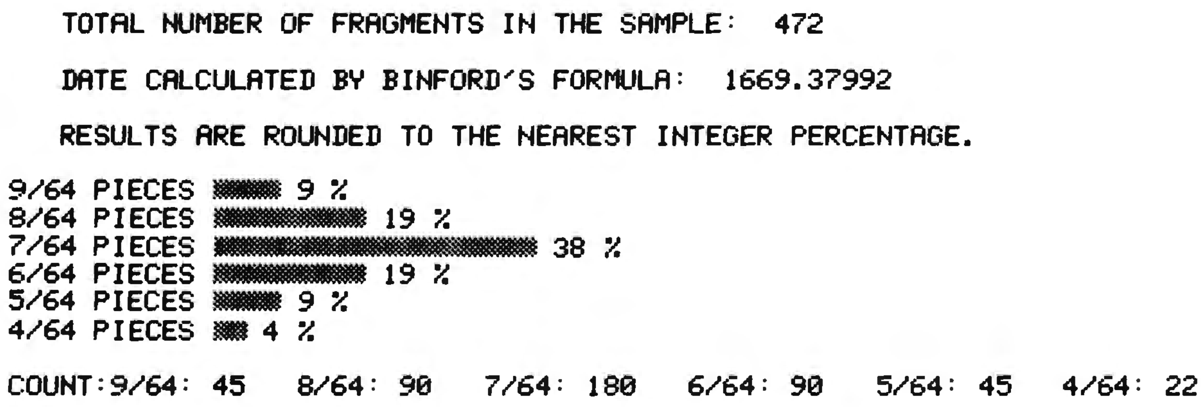

Figure 2: *The Pipes program's output, including a compact histogram. This printout is designed for incorporation in a site report.*

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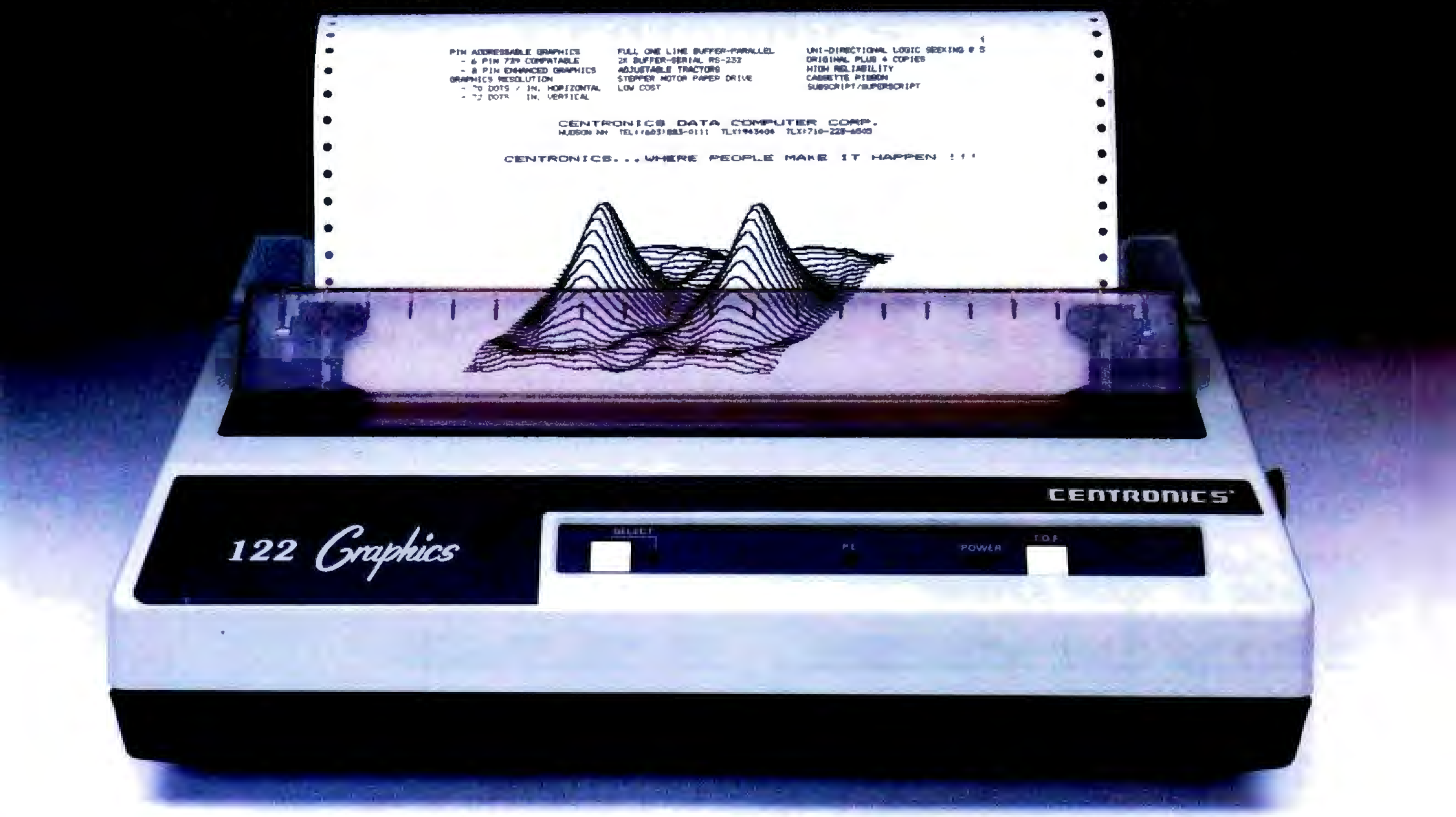

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manual operation becomes more cumbersome.

The calculations are extremely time-consuming, even though the operations are quite simple. One archaeologist complained that statistical analysis of a single artifact deposit took a whole day to calculate by hand. Even a simple site may contain dozens of different artifact deposits, containing thousands of specimens.

We wrote the Pots program to do the donkey work of calculating mean date, mean bracket date, and standard deviation, as well as to draw histograms of the results. Input takes less than 10 minutes, and the full repertoire of reports and graphics can be printed in a half hour on a slow printer.

Input is simple for an archaeologist. The user enters data on a work sheet copied from South's original article, which has become a professional standard. The type name and number flash on the screen in worksheet sequence, and the user is asked only to type the sherd count for that type or to hit return for a null entry. Screen prompts and menus guide the user through each step relatively painlessly. There is no manual, and none is needed. Listing 1 shows the summary sheet that the Pots program prints when the user has finished entering data.

The test came when a visiting archaeologist, with no computing experience, sat down at the computer without any prior instruction and successfully analyzed a collection. That's user-friendliness!

Listing 1: *The summary sheet produced by the Pots program. Based on the input listed, the program calculated a mean date of 1850 for the site where the ceramics were found (Liston Point, Delaware).*

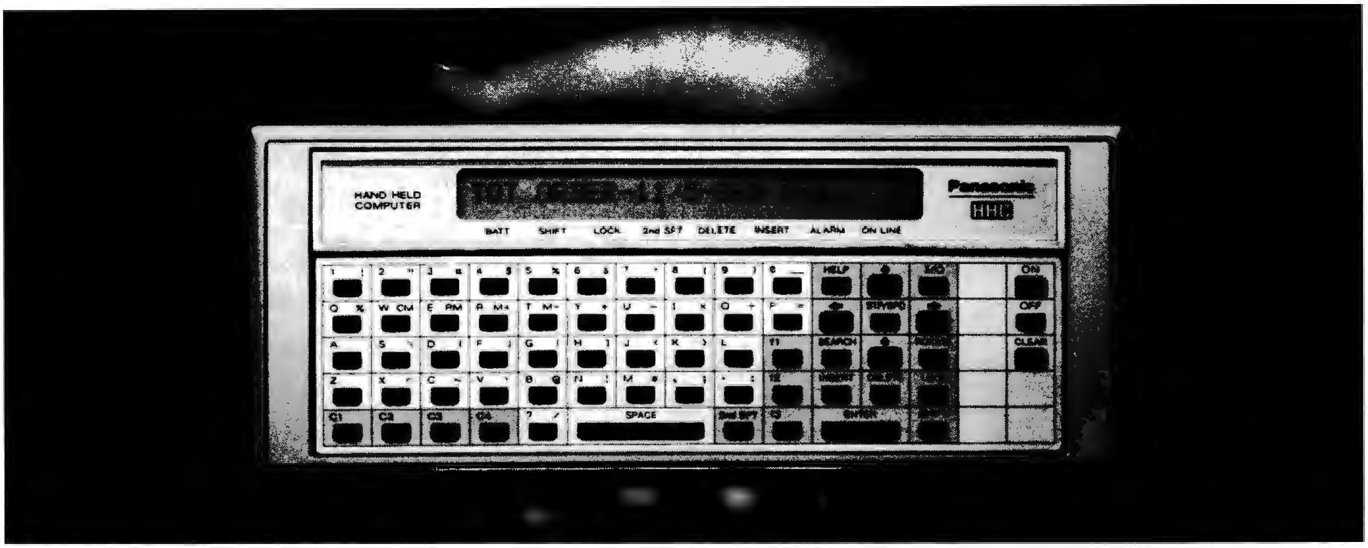
```
SUMMARY  OF  ALL  SPECIMENS

SITE: 79/157       DATE: 2/23/82
REPORTED BY: ALICE GUERRANT

NO BEGIN-END MEDIAN SHERDS PRODUCT     TYPE NAME (INH,1970)

 5 1800 1830  1815                    CANTON PORCELAIN
 7 1790 1825  1808                    OVERGLAZE ENAMEL CHINA TRADE PORCELAIN
26 1660 1800  1730                    OVERGLAZE ENAMEL CHINESE EXPORT PORCELAIN
31 1745 1795  1770      6     10620   ENGLISH PORCELAIN
39 1660 1800  1730                    UNDERGLAZE BLUE CHINESE PORCELAIN
41 1750 1765  1758                    LITTLER'S BLUE ON PORCELAIN
69 1574 1644  1609                    LATE MING UNDERGLAZE BLUE PORCELAIN
 1 1820 1900  1860                    BROWN STONEWARE INK, BEER BOTTLES
46 1700 1810  1755                    LUSTERED NOTTINGHAM STONEWARE
52 1700 1775  1738                    BURSLEM 'CROUCH' PALE BROWN STONEWARE MUGS
53 1690 1775  1733                    BROWN FULHAM SALT GLAZED MUGS
54 1690 1775  1733                    OTHER BRITISH BROWN STONEWARES
66 1620 1700  1660                    DETERIORATED BELLARMINE FACE BOTTLES
74 1550 1625  1588                    WELL-MOLDED BELLARMINE FACE BOTTLES
75 1540 1600  1570                    RHENISH BROWN GLAZED SPRIGGED, MOULD DECOR
44 1700 1775  1738                    WESTERWALD, STAMPED BLUE FLORAL DEVICES, 3
58 1650 1725  1668                    WESTERWALD, BLUE & MANGANESE, SPRIG MOLDED
59 1690 1710  1700                    EMBELLISHED HOHR GRAY RHENISH STONEWARE
77 1700 1775  1738                    WESTERWALD CHAMBER POTS
16 1740 1765  1753                    MOLDED WHITE SALTGLAZE STONEWARE
24 1765 1795  1780                    DEBASED 'SCRATCH-BLUE' WHITE SALTGLAZED ST
30 1755 1765  1760                    TRANSFER-PRINTED WHITE SALTGLAZE
34 1744 1775  1760                    'SCRATCH BLUE' WHITE SALTGLAZE STONEWARE
40 1720 1805  1763                    WHITE SALTGLAZE STONEWARE NOT PLATES AND M
41 1750 1765  1758                    LITTLER'S BLUE ON STONEWARE
43 1740 1775  1758                    WHITE SALTGLAZE STONEWARE  PLATES
48 1715 1775  1745                    SLIP-DIPPED WHITE SALTGLAZE STONEWARE
55 1720 1730  1725                    SCRATCH  BROWN OR TRAILED WHITE SALTGLAZED
 3 1813 1900  1857                    IRONSTONE OR GRANITE CHINA
27 1750 1820  1785                    BLACK BASALTES STONEWARE
28 1763 1775  1769                    ENGINE TURNED UNGLAZED RED STONEWARE
37 1690 1775  1733                    SPRIGGED REFINED UNGLAZED RED STONEWARE
50 1732 1750  1741                    RALPH SHAW BROWN SLIPPED STONEWARE
56 1670 1795  1733                    LEAD GLAZED COMBED YELLOW SLIPWARE
63 1650 1710  1680                    NORTH DEVON SGRAFFITO SLIPWARE
67 1612 1700  1656                    WROTHAM SLIPWARE
68 1630 1660  1645                    METROPOLITAN SLIPWARE
70 1610 1660  1635                    NORTH ITALIAN RED MARBELIZED SLIPWARE
```

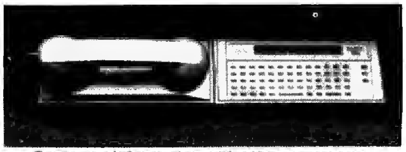
Listing 1 continued on page 90



The Link™ from Panasonic. The portable computer that lets you take the advantages of an office computer anywhere you go.

The Link.

It's the next major business tool because it's a full-logic computer that's fully portable.



Exchange information with other computers with the telephone modem.

By itself, it can perform a wide variety of sophisticated computer functions because it can store 4K bytes of information. Equally important, it can link you to the information and brainpower of your main office computer—wherever you go. You can program in Microsoft Basic.® Yet it's easy to operate, even if you've never worked with a computer before.

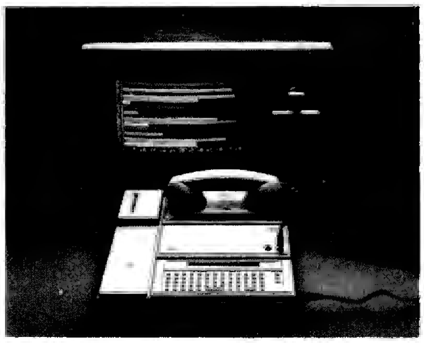
Imagine. Using just The Link, anyone in the field, the plant or on the sales floor—like salesmen, managers, engineers or retailers—can now answer questions that used to mean a trip back to the office. A sales engineer, for example, types data into The Link and gets detailed product information and specs on the spot.

And The Link is part of an entire computer system: By adding different optional components, you can create whatever kind of computer you need. Wherever you need it.

By adding the telephone modem, for example, a salesman can put his company's main office computer or a data bank to work for him from any telephone booth. He can check credit ratings and inventory, trace shipments, enter orders, make bids and estimates, and much more. So The Link can make him and his office computer much more productive.

By adding the microprinter, the salesman gets hard copies of information right on the spot—an instant record of his transactions.

By adding the TV adapter, he can display information and 8-color charts on any color TV



Display information and charts with the TV adapter.

screen. So he can use data from his office computer to develop a sales presentation in a motel room. And show it on a client's video monitor the next day.

If the salesman needs to work with a bigger program and more memory, other optional components increase The Link's capacity to 52K RAM plus 64K ROM. That's more than many desktop computers.

The Link measures only 9″ x 4″, weighs only 21 ounces,

Take The Link and all its components anywhere in its slim attaché case.

and runs on AC or rechargeable batteries.

And it costs only $600.00.* That's amazingly small when you realize the big change it could make in the way you do business.

*Manufacturer's suggested price.

Panasonic Company, Portable Computers
One Panasonic Way, Secaucus, N.J. 07094

☐ Please send me information on The Link.
☐ Please have a salesman call me.

NAME ______ PLEASE PRINT
TITLE ______
COMPANY ______
TYPE OF BUSINESS ______
ADDRESS ______
CITY ______ STATE ______ ZIP ______
PHONE NUMBER ______

Panasonic.
just slightly ahead of our time. B

The Link. It will change the way the world uses computers.

Circle 299 on inquiry card.

Listing 1 continued:

```
73 1580 1625  1603                 WANFRIED SLIPWARE
 2 1820 1900  1860   133   247380  WHITE REFINED EARTHENWARE
 6 1795 1890  1843                 MOCHA ON REFINED WHITE EARTHENWARE
29 1740 1780  1760                 'JACKFIELD'  WARE
33 1759 1775  1767                 GREEN GLAZED CREAM BODIED WARE
36 1740 1770  1755                 CLOUDED WARES, TORTOISESHELL, MOTTLED, CRE
42 1740 1775  1758                 REFINED AGATE WARE
51 1725 1750  1738                 'ASTBURY' WARE, WHITE SPRIGGED & TRAILED
78 1790 1840  1815                 LUSTER DECORATED WARES
35 1750 1810  1780                 COARSE AGATEWARE (NOT DOORKNOBS)
38 1745 1780  1763                 IBERIAN STORAGE JARS
47 1720 1775  1748                 BUCKLEY WARE
61 1650 1775  1713                 NORTH DEVON GRAVEL TEMPERED WARE
21 1775 1800  1788                 DEBASED ROUEN FAIENCE (ON BRITISH SITES)
32 1730 1830  1780                 PEDESTAL FOOT DELFT OINTMENT POT
45 1700 1800  1750                 EVERTED RIM, PLAIN DELFT OINTMENT POT
49 1600 1802  1701                 DECORATED DELFT (EIGHTEENTH CENTURY)
57 1750 1800  1775                 PLAIN DELFT WASH BASINS
60 1710 1740  1725                 MIMOSA PATTERN DELFT
62 1620 1720  1670                 ENGLISH DELFT (BLUE DASH CHARGERS)
64 1630 1700  1665                 CYLINDRICAL DELFT OINTMENT POTS
65 1640 1800  1720                 PLAIN WHITE DELFTWARE
71 1620 1775  1698                 MONOCHROME DELFT APOTHECARY JARS
72 1580 1640  1610                 POLYCHROME DELFT APOTHECARY JARS AND POTS
76 1660 1800  1730                 DELFT CHAMBER POTS
 8 1790 1820  1805                 FINGERPAINTED POLYCHROME SLIP ON CREAMWARE
14 1780 1815  1798                 ANNULAR WARES CREAMWARE
15 1775 1820  1798                 LIGHTER YELLOW CREAMWARE
18 1765 1810  1788                 OVERGLAZE ENAMELLED HAND PAINTED CREAMWARE
22 1762 1820  1791                 CREAMWARE
23 1765 1815  1790                 TRANSFER PRINTED CREAMWARE
25 1762 1780  1771                 DEEPER YELLOW CREAMWARE
41 1750 1765  1758                 LITTLER'S BLUE ON CREAMWARE
 4 1820 1840  1830                 UNDERGLAZE POLYCHROME PEARLWARE, DIRECT ST
 6 1795 1890  1843                 MOCHA PEARLWARE
 8 1790 1820  1805                 FINGERPAINTED POLYCHROME PEARLWARE
 9 1800 1820  1810                 EMBOSSED FEATHERS, SCALES, ETC. ON PEARLWA
10 1795 1840  1818                 WILLOW TRANSFER ON PEARLWARE
11 1795 1840  1818     3     5454  TRANSFER PRINTED PEARLWARE
12 1795 1815  1805                 UNDERGLAZE POLYCHROME PEARLWARE
13 1790 1820  1805     3     5415  ANNULAR WARES PEARLWARE
17 1780 1820  1800                 UNDERGLAZE BLUE HANDPAINTED PEARLWARE
19 1780 1830  1805     8    14440  BLUE & GREEN EDGED PEARLWARE
20 1780 1830  1805     4     7220  UNDECORATED PEARLWARE

RAW TOTAL OF SHERD COUNT:  157
RAW TOTAL OF PRODUCT:  290535
SHERD COUNT, ELIMINATING TYPES 26 AND 39:  157
PRODUCT, ELIMINATING TYPES 26 AND 39:  290535

MEAN DATE:    1850.5414

MEAN BRACKET DATES:

  1813.02548    AND    1887.96178


PRODUCED ON THE ARCHAEOLOGICAL REPORT GENERATING PROGRAM TITLED
'POTS' WRITTEN BY EDWARD F.HEITE AND COPYRIGHT©1981
BY EDWARD F. HEITE, P.O. BOX 53, CAMDEN, DELAWARE 19934.

FORMULA AND REPORTING FORMAT BASED ON STANLEY  SOUTH'S ARTICLE,
'EVOLUTION AND HORIZON AS REVEALED IN CERAMIC ANALYSIS IN
HISTORICAL ARCHAEOLOGY, PUBLISHED IN THE PAPERS OF THE CONFERENCE
ON HISTORIC SITE ARCHAEOLOGY 1971, JUNE 1972, PAGES 71-107
TYPOLOGY DERIVED FROM I. NOEL HUME'S CLASSIFICATION IN HIS BOOK,
```

Listing 1 continued on page 92

"IBM Personal Computer" USERS YOU DESERVE THE *BEST*!

choose what the professionals* use

Combo Card (User Upgradeable)
- MC-064 64K From $435
- MC-128 128K From $635
- MC-192 192K From $835
- MC-256 256K From $1035
- Suffix S = ASYNC comm. option $60
- Suffix P = parallel printer option $60
- Suffix SP = both options $120
- User upgrade document available for sale, order model MC-001SP
- Program compatible with IBM's

64KB-256KB Parity Memory
- MP-064: $395 • MP-128: $595
- MP-192: $975 • MP-256: $995
- User upgradeable
- Fully assembled, tested & burned-in
- 1-year warranty

Advanced Communication
- CC-232: $295
- 2 RS232 ports
- Capable of ASYNC, BISYNC, SDLC, HDLC

ASYNC Communication
- CC-032: $145 • CC-132: $275
- CC-032 offers 1 serial port
- CC-132 offers 2 ports
- Program compatible with IBM's Serial Com. Card

Hardware Prototype
- WW-068: $75 • WW-069: $55
- WW-068 wire wrap card (13" x 4.2")
- WW-069 extender
- Get both for $95

*Our customers include: IBM, TRW, Bell Labs, Visicorp, Softech Microsystems Inc., Information Unlimited Software, Context Management, Network Consulting Inc., etc.

AST
RESEARCH INC.
17925 Sky Park Circle, Suite B
Irvine, CA 92714 (714) 540-1333
Dealer Inquiries Welcome

Circle 3 on inquiry card.

Listing 1 continued:

```
A GUIDE TO ARTIFACTS OF COLONIAL AMERICA, PUBLISHED BY ALFRED A.
KNOPF, 1970.

MEAN BEGINNING AND ENDING DATES FROM TURNBAUGH AND TURNBAUGH
 IN HISTORICAL ARCHAEOLOGY VOLUME 11 FOR 1977
```

Histo-Grandma: A Permissive Histogram Program

Histograms are simple statistical reports, commonly used and understood even by people who are not inclined to express their thoughts in numbers. In our archaeological practice, we often use histograms to illustrate or simplify numerical relationships. Even rudimentary histograms require considerable drafting, scaling, and measuring. We wanted a simple drafting program that would let us draw a histogram, inspect the results, and then edit if necessary. Not being inclined to think in the abstract, we wanted a program that would help us visualize a finished result and redraw it until it was exactly what we wanted.

Histo-Grandma, a permissive bar-plot program, was the result. It lets you draft a histogram, inspect it, change it, and reprint it. It calculates and, if necessary, recalculates the scale, helps select symbols, and doesn't print a double line if you overrun the capacity of the line on the page. The edit routine can change anything in the illustration, except the number of bars, which would involve redimensioning arrays.

Grandma is written to be used by noncomputerists or to be modified by users with little computer experience. No manual is necessary. The program loops back through the edit routine until the user tells it to stop. Histo-Grandma's style is conversational, even breezy, on purpose, to help users feel more comfortable.

In writing the program, we spent as much effort on the screen prompts and on aesthetics as in developing the rather simple routines themselves. As a result, REM and PRINT statements constitute the bulk of the code. While the verbal paraphernalia is technically unnecessary, it is the prime ingredient in a user-friendly program. Programmers may be aghast at the apparently inelegant programming style, which in fact is designed to help inexperienced users follow the logic more closely.

Listing 2 presents Histo-Grandma in its entirety. The program uses Commodore BASIC, with PET graphics, but probably can be adapted for other machines with little difficulty. The print routine at line 10,000 uses formatting features peculiar to Commodore dot-matrix printers. With the details provided in REM statements, it should be fairly simple to adapt it for wider printers or for daisy-wheel printers.

Figure 3 shows two graphs generated by Histo-Grandma. We hope the program proves as useful to you as it has been to us.

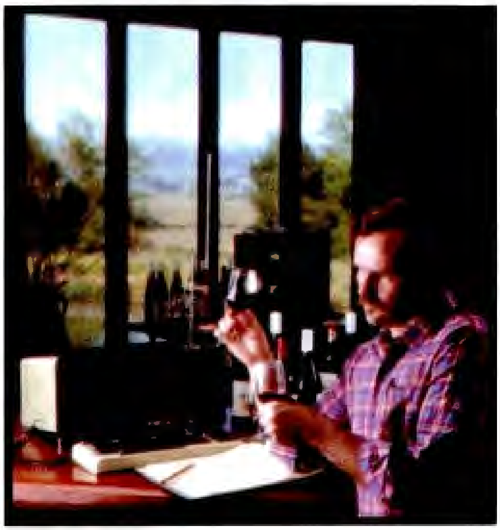
Photo 1: *An archaeological project involves painstaking record-keeping as well as massive earth-moving. In this excavation at Naamans, Delaware, workers are scraping the subsoil to reveal faint stains left by post holes and ditch lines in a garden.*

What Next?

With the advent of truly portable computers, we expect that archaeological field notes will be written on cassette tape in digital form. When

Text continued on page 102

Introducing the DMS-3/F "Fox." More than another portable— it's a low-cost stand-alone or network station.



With its 9" diagonal screen, "The Fox" has <u>triple</u> the capacity of the most popular portable. Yet the outstanding feature of the 30 lb. portable "Fox" is its performance on or off the HiNet™ Local Area Network.

HiNet is a complete hardware/software network—so <u>inexpensive</u> that you can add a computer anywhere your business requires for about the cost of a good typewriter. Because HiNet is a <u>network of interconnected computers</u>, you can get information from other departments instantly.

And HiNet electronic mail saves wasted telephone time and aids interoffice communication.

The CP/M®-based "Fox" combines a 64K Z80A processor, local storage, drives, four RS-232C serial ports, an 8 bit bidirectional parallel port, the HiNet networking port, and 32 (x3) programmable function keys. It's also capable of emulating any terminal. The DMS-3/F "Fox." Catch one now.

Digital Microsystems

Because man was not meant to work alone.

1840 Embarcadero, Oakland, CA 94606 (415) 532-3686, TWX 910-366-7310 / Extel House, East Harding St., London, EC4P-4HB 01-353-1080 Telex 23721

Circle 136 on inquiry card.

How to mak
work like a

First, neatly cut out the "370" label.

Now, when nobody's looking, nonchalantly tape it to your terminal, just under the "IBM," as if it really belonged there.

Then wait for your chance and quickly slip a dBASE II™ disk into your main drive.

That's it.

Your IBM Personal Computer is now ready to run a relational database system, the kind that IBM put on their mainframes last year.

And you're ready with more data handling power than you would have dreamed possible before dBASE II.

You'll wonder how you managed without it.

You'll find that dBASE II, because it's a relational database management system (DBMS), starts where file handling programs leave off.

dBASE II handles multiple databases and simplifies everything from accounting to department staffing to monitoring rainfall on the Upper Volta.

With a word or two, you CREATE databases, APPEND new data instantly, UPDATE, MODIFY and REPLACE fields, records and entire databases. Organize months worth of data in minutes with the built-in REPORT. Do subfield and multi-field searches, then DISPLAY some or all of the data for any condition you want to apply.

And you've just begun to tap the power of dBASE II.

Easy to look at, easy to use.

Input screens and output forms couldn't be easier—just "paint" your format on the CRT and what you see is what you'll get.

You can do automatic calculations on fields, records and databases, accurate to 10 digits.

And you can use dBASE II interactively for answers right now. Or save your instructions, then repeat everything with two words: DO Manhours, DO ProjectX, DO whatever has to be done.

Use dBASE II to help make your choice:

If you've got a 96k IBM PC, send us $700 and we'll send you a copy of dBASE II to use free for 30 days.

e your micro mainframe.

Instead of just poring over a manual, run it and make sure that it does what you need done.

Then if you find it isn't right for you, send it back and we'll return your money, no questions asked.

But if you do that, you'll have to remove that label. Because nothing short of a mainframe works like dBASE II.

Call (213) 204-5570 today or drop by your local computer store for the rest of the story.

Ashton-Tate, 9929 Jefferson Blvd., Culver City, CA 90230.

Ashton-Tate

Listing 2: *Histo-Grandma, a program that prompts the user for input and then generates histograms based on the data entered. Written in Commodore BASIC, Histo-Grandma produces bar graphs but does not require the user to know any technical terms. The formatting routine starts at line 13, the input routine at line 250, the print routine at line 10000, the revision routine at line 32075, and the edit routine at line 35000.*

```
1 PRINT"]THIS PROGRAM IS CALLED HISTO-GRANDMA":PRINT
2 PRINT"BECAUSE IT LETS YOU DO ANYTHING YOU":PRINT
3 PRINT"WANT WITH HISTOGRAMS. IT SPOILS YOU.":PRINT
6 PRINT"HISTO-GRANDMA WILL NOT CRITICIZE OR":PRINT
7 PRINT"CORRECT YOU; SHE IS VERY PERMISSIVE":PRINT
8 PRINT"IN LETTING YOU BE CREATIVE.":PRINT:PRINT:PRINT:PRINT:PRINT
10 INPUT"TO START, HIT ▣RETURN■   X■■■";Z$:PRINT"]"
13 REM*********************************************************** FORMATTING ROUTINE *
15 INPUT"HOW MANY BARS IN THIS GRAPH   0■■■";A :PRINT:PRINT
17 PRINT"WHAT IS THE TITLE FOR THE TOP OF THE"
18 INPUT"GRAPH   X■■■";C$:PRINT:PRINT
20 PRINT"NOW WE NEED A MAGNITUDE FOR THE WHOLE":PRINT
21 PRINT"GRAPH. YOU HAVE ABOUT 65 BLOCKS TO USE":PRINT
22 PRINT"IN CONSTRUCTING YOUR BARS. PICK A VALUE":PRINT
23 INPUT"FOR EACH BLOCK   1■■■";C:PRINT:PRINT
24 B=(C*65):PRINT:PRINT"]MAXIMUM VALUE ON A BAR IS":PRINT:PRINTB:PRINT
25 PRINT"NOW,DEFINE THE MINIMUM VALUE THAT WILL":PRINT
26 PRINT"BE DISPLAYED. IF YOU HIT RETURN, IT'LL":PRINT
27 INPUT"DEFAULT TO ZERO   0■■■";D:PRINT
40 PRINT"]▣NOW IT IS TIME TO CREATE YOUR GRAPH■":PRINT:PRINT:PRINT
42 PRINT"EACH BAR WILL HAVE A NAME, LIMITED":PRINT
44 PRINT"TO SEVEN CHARACTERS, INCLUDING":PRINT
45 PRINT"SPACES. YOU WILL ALSO BE ABLE TO":PRINT
46 PRINT"DECIDE WHICH GRAPHIC CHARACTER WILL BE":PRINT
47 PRINT"USED IN THAT PARTICULAR BAR. YOU MAY":PRINT
48 PRINT"ALSO SKIP A SPACE BY HITTING  ▣RETURN■":PRINT
49 PRINT"WHEN IT ASKS FOR THE VALUE.":PRINT
55 INPUT"PRESS ▣RETURN■ TO CONTINUE   0■■■";Z$
200 DIMJ$(A):DIMX$(A):DIMY$(A):DIMY(A):DIMV(A):PRINT"]"
250 REM************************************************************ INPUT ROUTINE **
300 FORJ=1TOA:PRINT:PRINT:PRINT:Y$(J)=""
315 PRINT"▣CREATING BAR NUMBER■":PRINT:PRINT
316 PRINT"           "J:PRINT:PRINT
320 INPUT"NAME THIS BAR   X■■■";J$(J)
330 PRINT INPUT"SYMBOL FOR THIS BAR   ▒■■■";X$(J):PRINT
340 INPUT"VALUE OF THIS BAR   0■■■";V(J)
345 Y(J)=V(J)-D
350 FORX=1TOY(J)STEPC
360 Y$(J)=X$(J)+Y$(J)
365 IFV(J)<=DTHENY$(J)=""
366 NEXTX
367 PRINT:PRINT"THIS WILL APPEAR AS FOLLOWS:":PRINT
368 PRINTV(J);J$(J);Y$(J)
370 NEXTJ
373 PRINT"▣BE SURE THE PRINTER IS SET UP TO PRINT■"
375 FOR J=1TO5000
400 NEXT J
2500 GG=D+(10*C)
2505 HH=GG+(10*C)
2510 JJ=HH+(10*C)
2520 KK=JJ+(10*C)
2530 LL=KK+(10*C)
2540 MM=LL+(10*C)
5000 PRINT"]QQQQQQQQQQ          ▣ PRINTING  ■"
10000 REM*********************************************************** PRINT ROUTINE *
10010 OPEN2,4,2
10015 G$="        "
```

Listing 2 continued on page 98

HEATH/ZENITH & YOU... ONE STRONG PARTNERSHIP.

Buying a computer is only the beginning of a long-term partnership between you and the people from whom you buy. Your ongoing need for software, peripherals and accessories requires a partner who will stand by you. With a growing line of products to meet your needs with professional service and support, Heath/Zenith is that strong partner. Look at what we have to offer:

THE ALL-IN-ONE COMPUTER – The heart of the Heath/Zenith line is the stand-alone *89 Computer.* It's a complete system with built-in 5.25-inch floppy disk drive, professional keyboard and keypad, smart video terminal, two Z-80 microprocessors and three RS-232C Serial I/O Ports. It comes with 48K bytes of RAM, expandable to 64K.

PERIPHERALS AND ACCESSORIES – These include the popular *Heath/Zenith 19 Smart Video* Terminal, loaded with professional features. We also offer color and black and white monitors, modems, computer language courses, and high-speed typewriter-quality printers.

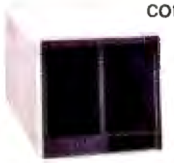
SOFTWARE – Our complete library of software includes the SuperCalc Spreadsheet and Condor Data Base Management System. *Word processing,* includes three different programs. *Small Business Programs* feature Peachtree's P5 Series, General Ledger and Inventory Control. *HUG, Heath Users' Group,* offers members a library of over 500 low-cost programs for home, work or play.

PROGRAMMING LANGUAGES – To write your own programs, Microsoft BASIC (compiler and interpreter), FORTRAN and COBOL Languages are available.

APPLICATIONS SOFTWARE – Expand the performance range of your computer with a broad selection of software, including the best of *Digital Research and Micropro* – as well as the complete line of *Softstuff*™ products.

OPERATING SYSTEMS – Three versatile systems give you the capability to perform your specific tasks. *CP/M by Digital Research* makes your system compatible with thousands of popular CP/M programs. *UCSD P-System with Pascal* is a complete program development and execution environment. And *HDOS, Heath Disk Operating System* gives you a sophisticated flexible environment for program construction, storage and editing.

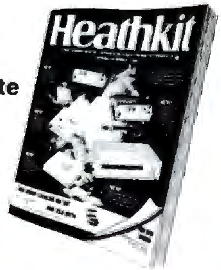
DISK SYSTEMS – *The new Heath/Zenith 67 Winchester Disk System,* for commercial use, adds nearly 11 megabytes of storage to your 89 computer. It includes an 8-inch floppy disk drive for data portability. *The new 5.25-inch 37 disk system,* available with 1 or 2 drives, adds up to 1.28 megabytes of storage. Both plug-in systems have write protection.



SERVICE AND SUPPORT – Prompt and professional service and assistance is available nationally through Heathkit Electronic Centers, Zenith Data Systems for commercial users or through Heath factory servicing and phone-in technical assistance.

Complete, integrated computer hardware and software, designed to serve and grow with you – that's what to look for in a strong partner. And with Heath/Zenith, you get it all.

Heath/Zenith computer products are sold nationwide through Heathkit Electronic Centers* (check your white pages for locations). For a FREE colorful full-line catalog, write: Heath Co., Dept. 334-914, Benton Harbor, MI 49022.



HEATH/ZENITH
Your strong partner

Product specifications are subject to change without notice.
Heath Company and Veritechnology Electronics Corporation are wholly-owned subsidiaries of Zenith Radio Corporation
*Heathkit Electronic Centers are operated by Veritechnology Electronics Corporation

CP-210R1

Listing 2 continued:

```
10019 H$="9999       9999       9999       9999       9999       9999       9999"
10021 H$=G$+H$:PRINT#2,H$:OPEN1,4,0:OPEN3,4,1:PRINT#1,"□"
10111 PRINT#1,CHR$(1)C$CHR$(10)
10113 PRINT#3,D,GG,HH,JJ,KK,LL,MM
10122 E$="________|_________|_________|_________|_________|_________|______"
10133 F$="          "
10134 E$=F$+E$:PRINT#1,E$:PRINT#1,CHR$(10):CLOSE2:CLOSE3:OPEN5,4,2
10170 F$="AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA"
10180 G$="9999 AAAAAAA  AA"
10190 F$=G$+F$:PRINT#5,F$:OPEN3,4,1:N=0:FORJ=1TOA:N=N+V(J)
10200 PRINT#5,F$
10220 PRINT#3,V(J),J$(J),CHR$(29),Y$(J):PRINT#1,CHR$(10)CHR$(10):NEXTJ
10221 REM          ****************************************
10222 REM          **** PROGRAMMER'S NOTE:             ****
10223 REM          **** TO COMPRESS SPACE BETWEEN      ****
10224 REM          **** BARS, DELETE CHR$(10) IN 10220****
10225 REM          ****                                ****
10226 REM          ****************************************
10227 PRINT#1,E$CHR$(10)CHR$(10)"N ="N
10236 PRINT#1,CHR$(19):CLOSE1:CLOSE3:CLOSE5:GOSUB32000
31999 REM******************************************** SELECT REVISION ****
32000 PRINT"□DO YOU WANT TO REVISE ANY ASPECT":PRINT
32050 PRINT"OF THE GRAPHIC YOU HAVE PRINTED?":PRINT
32060 INPUT"IF SO, STRIKE ▓Y■ AND ▓RETURN■   N■■■";Q$
32070 IFQ$="Y"THEN GOTO32090
32071 IFQ$<>"Y"THEN END
32075 REM********************************************* REVISION ROUTINE **
32090 PRINT"□▓REVISION ROUTINE BEGINS■":PRINT:PRINT:PRINT:PRINT
32100 PRINT"THE MAGNITUDE OF EACH INCREMENT OF THE"
32105 PRINT:PRINT"BAR IS "C:PRINT:PRINT"IS THIS SATISFACTORY?":PRINT
32115 PRINT:PRINT"TO CHANGE IT, HIT THE ▓Y■ AND ▓RETURN":PRINT
32120 INPUT"KEY   N■■■";Q$
32125 IF Q$="Y" THEN GOTO 32130
32126 IF Q$<>"Y"THENGOTO35000
32130 INPUT"NEW VALUE IS   0■■■";C
33340 FOR J=1TOA:Y$(J)="":Y(J)=V(J)-D:FORX=1TOY(J)STEPC:Y$(J)=X$(J)+Y$(J)
33365 IFV(J)<DTHENY$(J)=""
33370 NEXTX
33375 NEXTJ
35000 REM******************************************** TITLE EDIT ROUTINE **
35001 PRINT"□THE TITLE AT THE HEAD IS:"
35005 PRINT:PRINTC$:PRINT:PRINT"IF YOU WISH TO CHANGE THIS TITLE,"
35015 PRINT:PRINT"PRESS THE ▓Y■ AND ▓RETURN■ KEYS;" PRINT
35020 PRINT"OTHERWISE, PRESS THE ▓RETURN■ KEY ALONE":PRINT
35120 INPUT"   N■■■";Q$:IFQ$="Y"THENGOTO35130
35126 IF Q$<>"Y"THENGOTO36000
35130 INPUT"NEW NAME IS   0■■■";C$
36000 REM********************************************* BAR EDIT ROUTINE ***
36005 PRINT"□WE WILL NOW BEGIN EDITING THE BARS"
36010 PRINT"ON YOUR CHART. YOUR HUMBLE MECHANICAL"
36015 PRINT"SERVANT WILL FLASH EACH BAR'S DATA"
36020 PRINT"ON THE SCREEN, AND WILL ASK YOU FOR"
36030 PRINT"A JUDGMENT ON IT. IF THE BAR IS OK,"
36035 PRINT"SIMPLY PRESS THE ▓RETURN■ KEY, AND THE"
36040 PRINT"NEXT BAR WILL BE PROJECTED ON THE"
36045 PRINT"SCREEN FOR YOUR PERUSAL.":PRINT:PRINT
36100 PRINT"IF YOU WISH TO USE THIS ROUTINE,"
36110 PRINT"PRESS THE ▓Y■ KEY AND THE ▓RETURN■"
36120 INPUT"KEY   N■■■";Q$:PRINT:PRINT:PRINT:PRINT
36125 IF Q$="Y" THEN GOTO 36129
36126 IF Q$<>"Y"THENGOTO37000
36129 FORJ=1TOA
36130 PRINT"THE VALUE OF BAR NUMBER "J:PRINT:PRINT"IS "V(J):PRINT
36160 PRINT"AND THE SYMBOL IS "X$(J):PRINT
```

Listing 2 continued on page 100

SBC-I SBC-I

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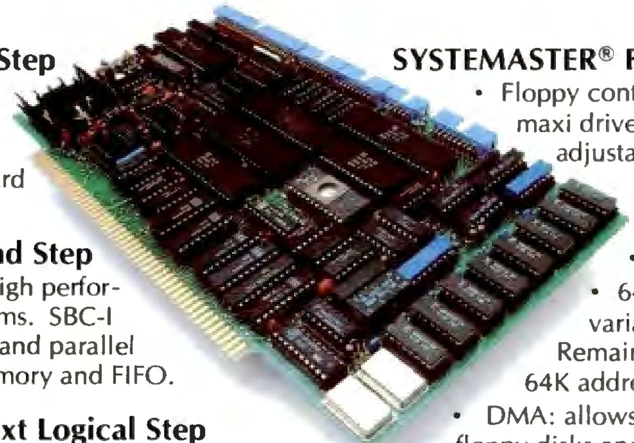

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Listing 2 continued:

```
36170 PRINT"NAMED "J$(J):PRINT:PRINT:PRINT
36180 INPUT"DO YOU APPROVE   Y■■■";Q$:PRINT:PRINT:PRINT:PRINT
36190 IF Q$<>"Y" THEN GOTO 36200
36195 IF Q$="Y"THENGOTO36999
36200 REM*************************************************** CORRECT BARS ****
36310 Y$(J)=""
36320 INPUT"NAME THIS BAR   X■■■";J$(J)
36330 INPUT"SYMBOL FOR THIS BAR   ▒■■■";X$(J)
36340 INPUT"VALUE OF THIS BAR   0■■■";V(J)
36345 Y(J)=V(J)-D
36350 FORX=1TOY(J)STEPC
36360 Y$(J)=X$(J)+Y$(J)
36365 IFV(J)<=DTHENY$(J)=""
36370 NEXTX
36375 PRINTJ$(J);Y$(J)
36999 NEXT J
37000 GOTO2500
39000 REM*************************************************** VARIABLES LIST ****
61000 REM  A=NUMBER OF BARS AND DIMENSION OF ARRAYS
61005 REM  B=TOTAL POSSIBLE VALUE OF EACH BAR ON THE GRAPH
61010 REM  C$=TITLE OF GRAPH LIMITED TO FORTY CHARACTERS
61015 REM  C=VALUE OF EACH GRAPHIC CHARACTER BLOCK
61020 REM  D=MINIMUM VALUE SHOWN IN GRAPHIC REPRESENTATION
61025 REM  E$=INDEX LINE AT TOP AND BOTTOM
61030 REM  F$=TEMPORARY FORMATTING VARIABLE
61040 REM  G$=THIRTEEN BLANK SPACES
61045 REM  H$=FORMAT STRING FOR SCALE LABELLING
61050 REM  J=SUBSCRIPT OF ARRAY DURING MAIN FOR-NEXT LOOPS
61055 REM  J$=BAR NAME
61060 REM  N=TOTAL NUMBER OF ITEMS COUNTED
61065 REM  Q$=INPUT VARIABLE IN REVISION SUBROUTINE
61070 REM  V=VALUE OF EACH BAR AS INPUT BY THE USER
61075 REM  X=LOOP DEFINITION VARIABLE FOR NESTED FOR-NEXT LOOPS
61080 REM  Y$=UTILITY INPUT VARIABLE
61085 REM  Y=MAGNITUDE OF BAR UNDER CONSTRUCTION
61095 REM  Z$=UTILITY INPUT VARIABLE
62000 REM  GG=D+(10*C)---TEN SPACES LABEL
62100 REM  HH=GG+(10*C)---TWENTY SPACES LABEL
62200 REM  JJ=HH+(10*C)----THIRTY SPACES LABEL
62300 REM  KK=JJ+(10*C)-----FORTY SPACES LABEL
62400 REM  LL=KK+(10*C)------FIFTY SPACES LABEL
62500 REM  MM=LL+(10*C)-------SIXTY SPACES LABEL
```

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Text continued from page 92:
the cassette is returned to the lab, the field notes can be printed out on clean sheets of paper and electronically merged into the report. Electronic recording would be a tremendous labor-saver, since the present method of transcribing and retranscribing from smudged and dirty field notes is the source of many errors.

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The principal bottlenecks in archaeology, where work slows and errors creep in, are retyping and reproofing. Every archaeological report passes through several review and rewrite processes, which in the past have been among the most costly aspects of the profession. Some offices add as much as 140 percent overhead, largely for unproductive clerical work. In

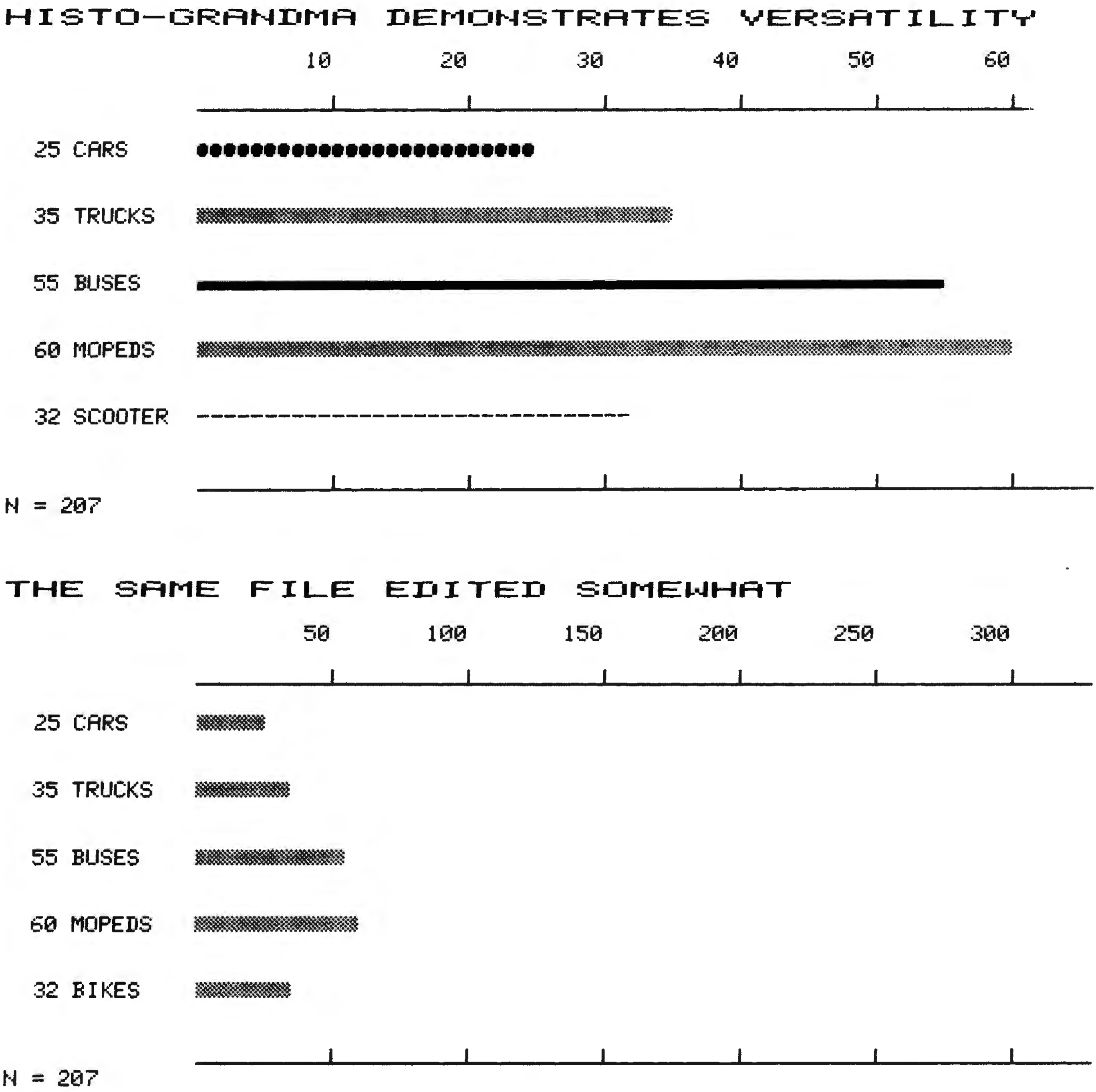

Figure 3: *Two graphs that Histo-Grandma produced from the same input data. This illustrates the power of Histo-Grandma's edit routine, which begins at line 35000 of listing 2.*

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our office, professionals draft their reports directly into a word processor, from field notes to finished copy, without any retyping. Reports are cleaner, better organized, and at least $1500 less expensive, even for the simplest job. The obvious professional and financial advantages of eliminating clerical typing may, in fact, be the key to expanded microcomputer use in the social sciences and humanities.

Social scientists have learned that human activity obeys certain statistically expressed rules, provided the sample is large enough to eliminate anomalies caused by individual differences between people. The corollary of this statement is that researchers will continue to use large samples in order to derive general principles. The practical limit is about 1500 cases, which is well within the abilities of a microcomputer. It naturally follows that social scientists will need many new application programs tailored to their professions and in a language that these scholars can easily understand. Some of these needs probably will be met by such shortcuts as the use of Visicalc overlays or front-end programs added to existing systems. In many cases, however, wholly new programs must be written.

Unfortunately, most subdisciplines in the humanities and social sciences are too small to support commercial development of the specialized, user-friendly microcomputer software that is needed immediately. Such systems already are available for the large legal, medical, and retail markets. The most practical way to market software for social scientists and humanists for some applications may be through modified off-the-shelf systems. We may see an "after-market" develop for customized database programs already being sold.

But until the microcomputer community begins to communicate in plain English, microcomputers will be slow to arrive on the humanistic market.■

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Microcomputers in the Study of Politics

Predicting Wars with the Richardson Arms-Race Model

A Pascal program gives insight into arms races and other two-party conflicts.

Philip A. Schrodt
Associate Professor of Political Science
Northwestern University
Evanston, IL 60201

Mention the words "computer" and "war" and the image comes to mind of either massive Pentagon electronic brains monitoring the global military situation or civilization reduced to radioactive dust through some minor computer glitch. ("Drat!" says the programmer, mushroom clouds billowing on the horizon. "It was only a *little* bug. . . .") While the big machines may tend to these matters, political scientists are extensively using microcomputers for the study, prediction, and, perhaps, eventual prevention of war.

Computers have long been associated with the biological and physical sciences, but they are also beginning to find uses in the social sciences. Many political science departments are acquiring microcomputers or minicomputers to supplement existing remote terminals, and students taking political science are as likely to use the computer as their peers in physics or engineering. The Political Science Department at Northwestern University has spent more than $30,000 to equip a computer laboratory with terminals and microcomputers. At the University of Iowa, the Political Science Department decided to forgo an additional typist and purchased dozens of Commodore microcomputers for word processing, statistical work, and simulation.

Traditionally, the primary use of computers in political science has been for statistical analysis. Computers are now being applied more and more to the study of formal models of political systems. Some of these models are large-scale simulations with memory requirements exceeding the microcomputer's capability, but many are small enough to be programmed into a machine with only 64K bytes of RAM (random-access read/write memory). This article presents the Richardson arms-race model, including a Pascal program for its implementation.

The Richardson Arms-Race Model

In 1918, British meteorologist Lewis F. Richardson returned from ambulance service in World War I shocked by the violence and destruction he had seen. A skilled mathematician who would soon achieve recognition for his pioneering work in numerical weather forecasting, Richardson was determined to apply his mathematical skills and modern scientific techniques to the understanding of war.

Since an arms race had preceded World War I, Richardson turned his attention to this phenomenon. From his work in physics, he was well acquainted with differential equations, which are used to model dynamic processes. Arms races, he reasoned, are also a dynamic process and could be approximated with a mathematical model.

After experimenting with dozens of detailed mathematical formulations, Richardson finally settled on a relatively simple model involving only three factors. First, nation X feels threatened by the arms of its opponent, nation Y. The more arms Y has, the more arms X will want to acquire. At the same time, however, nation X must meet basic social needs and can't devote its entire economy to producing weapons. Hence, the more arms X has, the fewer additional arms it will be able to acquire. Finally, Richardson reasoned, past grievances also affect the overall arms levels

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The Distributed Processing Specialists Billings and are unaffected by the current levels. The same logic that applies to nation X also applies to Y, which has a similar equation. Mathematically, this reduces to:

$$X(t+1) = kY(t) - aX(t) + g$$
$$Y(t+1) = mX(t) - bY(t) + h$$

The constants k, m, a, and b are all positive; g and h are either positive or negative depending on whether the two nations are basically hostile or basically friendly toward each other. The terms $X(t)$ and $Y(t)$ are the values of the arms levels at time t; $X(t+1)$ and $Y(t+1)$ are those values for time $t+1$. I have presented the model as a pair of finite difference equations, rather than using Richardson's original differential equations, because that is the form used in most research and the form most easy to compute.

The beauty of the Richardson model is that it is self-contained: if you know the values of the coefficients, and the values of the arms levels X and Y for one year, you can predict the arms levels for all future years. This gives the model the potential, in theory, of predicting the future. Richardson hoped that if politicians could predict wars, they could learn to avoid them.

Richardson's strikingly original work was ignored for decades. He continued his efforts in the field of mathematical international relations throughout his career and into his retirement, but achieved no recognition for it in scholarly or political circles. Richardson died in 1953, famed for his work in mathematical meteorology, but unknown in the field of political science.

Reviving Richardson

In the late 1950s, a group of mathematical social scientists at the universities of Chicago and Michigan—Anatol Rapoport, Quincy Wright, Nicolas Rashevsky, Kenneth Boulding, Frederick Mosteller, and others—rediscovered Richardson's work and began to publicize it. Rapoport's new *Journal of Conflict Resolution* devoted an entire issue to

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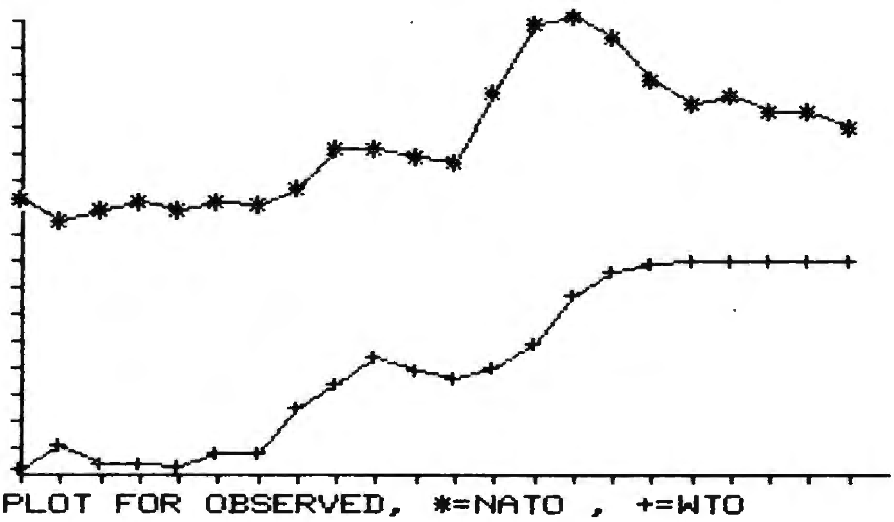

Figure 1: *A plot of the total defense expenditures of NATO and the Warsaw Treaty Organization. The y axis shows expenditures in constant dollars adjusted for inflation; the x axis shows the passage of years. The plot, for the years 1955-1978, shows a stable arms race.*

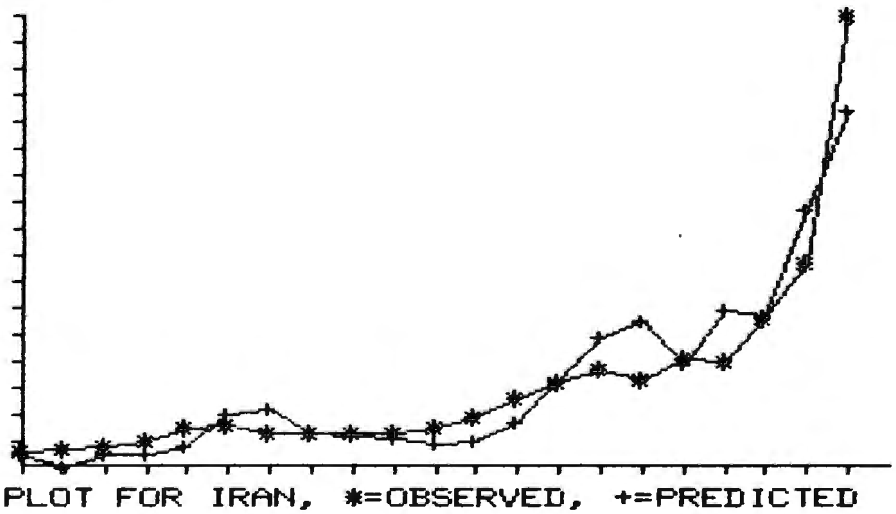

Figure 2: *A plot of the observed and predicted arms expenditures of Iran, engaged in an unstable arms race with Iraq. The data, for the years 1954-1975, shows how closely actual expenditures approached those predicted by the Richardson model.*

Richardson. Publication of Richardson's two microfilmed manuscripts, *Statistics of Deadly Quarrels* and *Arms and Insecurity*, was arranged, and his work became a keystone in the new field of mathematical international relations. By the 1970s, the model had been tested on dozens of different arms races in hundreds of variations.

And the Richardson model worked. Not perfectly, by any means. God gave the easy problems to the physicists, as Charles Lave and James March point out; political scientists have to deal with the messiness of human behavior. But the model works well for short-term predictions and, more important, no other self-contained model works better. From the European confrontation between NATO and the Warsaw Pact, to the massive arms races of the countries in the Middle East, to the tragic 30-year war in Southeast Asia, the Richardson arms-race model captures the basic characteristics of the arms race. And over the years, another feature of the model came to light.

Arms-Race Stability and War

An important characteristic of the Richardson model is stability. Experimenting with the model, you will find that it usually produces one of two forms. These are illustrated in figures 1 and 2. Figure 1 gives the total defense expenditures of NATO and the Warsaw Pact. It is a stable arms race—arms levels converge on two values, an equilibrium, and stay there. If the arms levels are moved from the equilibrium, as they were during the Vietnam War period for NATO, they will return to it after the disturbance is removed.

Figure 2 illustrates the observed and predicted values of one nation in an unstable arms race—Iran, which reacts unstably to Iraq. In an unstable race, once arms levels start increasing, they continue increasing indefinitely. In the model, they go to infinity—or to the point at which the computer crashes with an overflow error. In the real world, war would usually intervene first.

War was Richardson's interest in the beginning. The arms-race model has proven to be a good predictor of war since almost all modern wars are preceded by unstable arms races. Richardson postulated this in his original work, and it has been verified in more systematic studies.

In the late 1970s, Michael Wallace of the University of British Columbia found that arms-race instability correlated strongly with war. Using a somewhat more complicated definition of an arms race than Richardson, but one based on Richardson's models, Wallace found that in 28 serious international disputes involving an arms race during the 1816-1965 period, 23 resulted in war. In 71 disputes where no arms race was involved, only 3 resulted in war.

Iran and Iraq: A Prediction Comes True

Another example will further illustrate this point. In 1976, W. Ladd Hollist, then at Northwestern University, studied four arms races using the Richardson model and defense expen-

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diture data from the Stockholm International Peace Research Institute *Yearbooks*, a standard source for such figures. The arms races involved the United States and Russia, India and Pakistan, Iran and Iraq, and Israel and Egypt, covering the period 1948-1973. Of the four cases, all but the United States/Russia race were unstable. That presented something of a problem. India/Pakistan and Israel/Egypt were unstable, and had resulted in war, as Richardson predicted. United States/Russia was stable, and had not resulted in war, also as predicted. The Iran/Iraq arms race was unstable and should have resulted in war, but did not—until 1980. Four years after Hollist's article, the long-simmering dispute between Iran and Iraq finally erupted into war. The Iran/Iraq arms race had been stable until the late 1960s, only becoming unstable in the 1970s, further narrowing the prediction of when war might occur.

In short, the Richardson model, forgotten for decades, has become one of the most widely studied models in political science. Its short-term accuracy is relatively high—figure 2 provides one demonstration of this in a relatively difficult arms race, achieving an accuracy of roughly plus or minus 15 percent. The predictions for the stable NATO/Warsaw Pact race are even better—plus or minus 3 percent.

The Richardson model is not, of course, a flawless crystal ball for predicting international conflict. Several limitations must be kept in mind when using the model. For starters, the coefficients of the model may change as governments and political climates change. Therefore, the model is only accurate for a few years. Unstable arms races can often be detected only a couple of years before a war breaks out, by which time it is normally too late to do anything about them. While arms races increase the likelihood that a serious international dispute will escalate to war, predicting when those disputes will occur is a more difficult problem. Finally, in Richardson's scheme, the threat and economic burden coefficients should be positive. In practice, however, they often are not, and may take on ridiculous values. This is due in part to a statistical problem called multicollinearity, wherein it is very difficult to sort out the effects of data points that are moving in similar directions. In such situations, the predictions of the model are accurate, but interpreting the parameters is difficult.

Other Applications

The Richardson arms-race model was developed for a very specific international problem that most people are unlikely to encounter unless they do political risk analysis. The "Richardson process," however, may be applied more generally. In many social, political, and economic situations, two opposing parties are driven to increase some behavior by mutual

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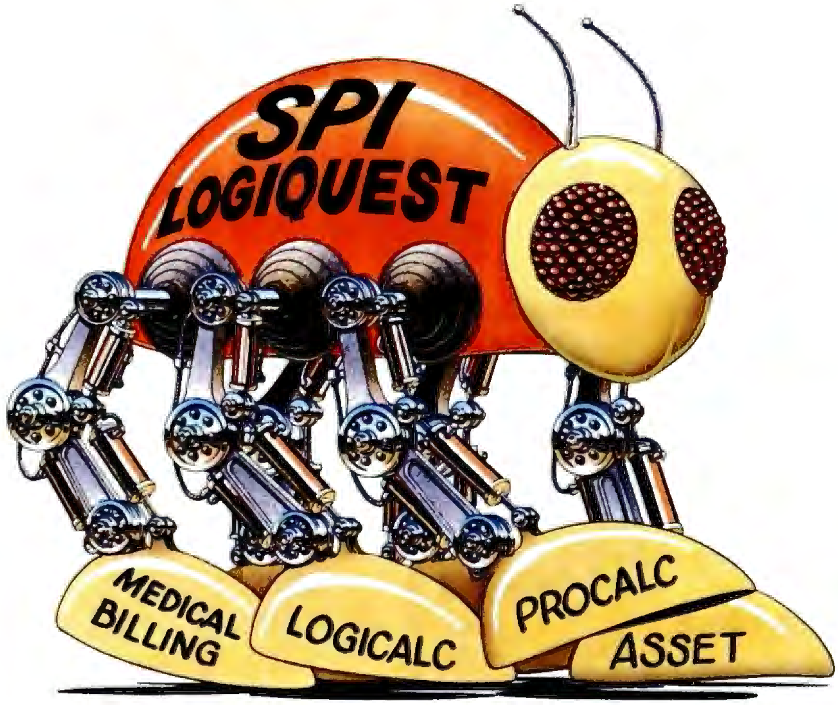
threat, but are constrained from further increases by economic factors or other consequences. Some examples of this, ranging from the trivial to the potentially useful, follow:

- Two tennis players are competing fiercely to become the champion of the Swinging Singles Apartment Complex. Each realizes that additional practice time will improve his game. The more one practices, the more the other will practice. But the practice time of each is constrained by the fact that practicing tennis detracts from the remainder of his social life, which the status as tennis champion was supposed to improve.
- Two gas stations are engaged in a price war. The prices are going down, rather than up, but the pattern is the same. Each station feels compelled to decrease prices to match the price decreases of its competitor, but is constrained by the necessity of maintaining a profit margin.
- Two Silicon Valley firms are attempting to hire each other's programmers by offering higher salaries and benefits. As each raises salaries, the other must match the raise or lose valuable employees. Both, however, are constrained by the need to maintain some level of profits and investment. Much as we programmers would like this race to be unstable, it will either level out at an equilibrium or the two firms will go bankrupt.
- The Democratic and Republican parties compete every four years in the presidential campaign. William Linehan, a political scientist at the State University of New York at Stony Brook, has pointed out that until campaign expenditure controls were passed, each successive election saw higher levels of spending by each side, based in part on projections based on previous spending by the other party, and constrained by the difficulties in raising money. This pattern should follow a Richardson model.
- Two firms are trying to acquire a company by bidding competitively for its stock. Each bid by one firm must be met by the other, but both are constrained by the total amount available for acquisition. More gen-



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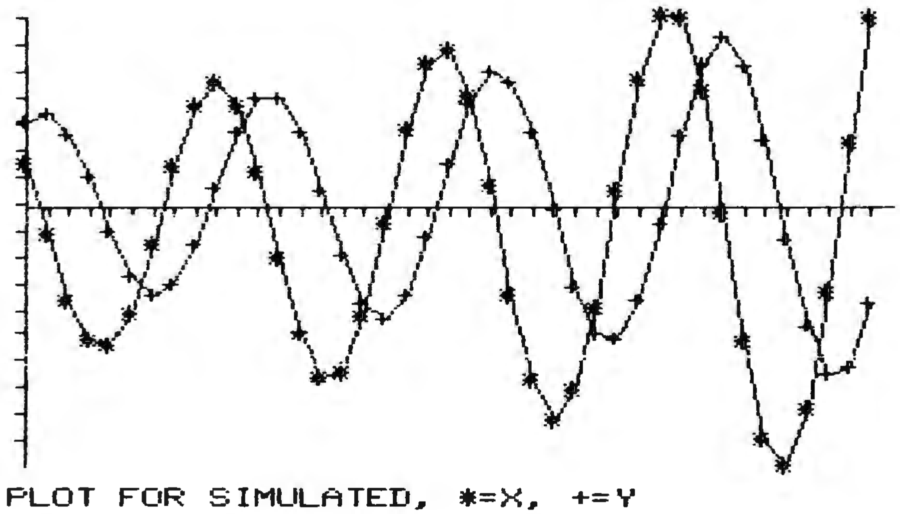

Figure 3: *A plot of the arms levels in a hypothetical arms race in which the Richardson model predicts cyclical behavior.*

erally, most competitive bidding situations are candidates for following a Richardson model in the short run.

These examples should suffice to make the point. The Richardson model will not fit perfectly—in some instances it may not fit at all—but in some situations it may provide insight into the underlying process. Furthermore, the issue of stability could prove important—it could, for example, predict whether bidding on a stock price will continue to very high levels, or whether it will level out at an equilibrium, and give the value of that equilibrium. In some situations, the Richardson model generates cyclical behavior, as illustrated in figure 3. It has been suggested that Richardson-like processes may account for some of the apparently cyclical behavior observed in political and economic processes.

The Richardson model has not been extensively explored in these other applications—I present them only as cases in which the model might apply. But just as the obscure work of a quiet British meteorologist in 1918 can be used to predict the wars of our time, so might that same model have applications outside the field of international relations.

The RICHDEMO Program

RICHDEMO is a Pascal program for demonstrating the characteristics of the Richardson model. Listing 1

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presents RICHDEMO in its entirety. Written and tested on an Apple II, RICHDEMO should work with little or no modification on any UCSD Pascal system. It is designed for either classroom demonstrations or experimentation with the properties of the model. The program contains three modules, which are called by typing the first letter of the module's name.

E)STIMATE

The E)STIMATE module estimates the parameters of the model from a set of data. You can enter data from a text file or from the keyboard. Creating the text files (via the Pascal Editor) is advisable for anything but the most cursory use of the program.

You enter data in this order: the two nations' names, the number of data points, and the data points themselves. Enter two values—the arms levels of nations X and Y—for each year, separating the values with a blank. Due to memory constraints, you can enter a maximum of 50 points, though you may be able to enlarge this slightly. The program provides prompts for keyboard entry.

The data is entered from the file in the same order as from the keyboard,

Text continued on page 128

Listing 1: *RICHDEMO, a Pascal program that demonstrates the Richardson arms-race model. The E)STIMATE module takes a set of data and estimates the parameters of the model. The C)HANGE PARAMETERS module lets the user experiment with the model's behavior. The P)LOT module draws plots like those in figures 1, 2, and 3.*

```
PROGRAM RICHDEMO;
(* PROGRAM FOR ESTIMATING AND DEMONSTRATING
            THE RICHARDSON ARMS RACE MODEL

   PHILIP A. SCHRODT, NORTHWESTERN UNIVERSITY
                         MARCH, 1982
 *)
(*$S+ *) (* PUT COMPILER INTO SWAPPING MODE *)

USES TURTLEGRAPHICS,TRANSCEND;

CONST MAXNY=50; (* SIZE OF DATAVECT'S -- CONSTRAINED BY MEMAVAIL... *)

TYPE DATAVECT=ARRAY[0..MAXNY] OF REAL;
      MATRIX=ARRAY[1..2,1..2] OF REAL;
      VECT2=ARRAY[1..2] OF REAL;

VAR VMIN,HMIN,HHI,HLO,VHI,VLO,HDIM,VDIM,NY,KA,KB,KC:INTEGER;
     XO,YO,RK,RM,RA,RB,RG,RH:REAL;
     MAXVAL,PR,ABER,VSCL,HSCL,RR,G:REAL;
     SE,DET,XN,YS,YSA:REAL;
     YS1,YS2,YP1,YP2,Y1,Y2,X1,X2:DATAVECT;
     YV,XS,B,SB:VECT2;
     NATNAM:ARRAY[1..2] OF STRING;
     INF:TEXT;
     S:STRING;
     CH:CHAR;
     XM:MATRIX;
     AUTOSCALE:BOOLEAN;

PROCEDURE ESTIMATE;FORWARD;

PROCEDURE CLEARSCREEN;(* BLANKS OUT SCREEN  *)
BEGIN WRITE(CHR(12));END;

(* ******** PROCEDURES FOR E)STIMATE ******** *)

FUNCTION COVAR(XA,X1,X2,N:REAL):REAL;
(* COMPUTES VARIANCE OR COVARIANCE *)
BEGIN COVAR:=(XA - (X1*X2/N))/N; END;

PROCEDURE SOLVL2(VAR R:VECT2;XM:MATRIX;Y:VECT2);
(* SOLVES SET OF TWO LINEAR EQUATIONS *)
VAR DET:REAL;
BEGIN DET:=XM[1,1]*XM[2,2] - (XM[1,2]*XM[2,1]);
   IF DET<>0.0 THEN BEGIN
      R[1]:=(Y[1]*XM[2,2] - (XM[2,1]*Y[2]))/DET;
      R[2]:=((Y[2]*XM[1,1]) - (XM[1,2]*Y[1]))/DET; END
   ELSE BEGIN
      R[1]:=0.0; R[2]:=0.0;
      WRITELN('ZERO DETERMINANT IN SOLVL2; R SET TO ZERO ');END;
 END;

PROCEDURE COMPVAR;
(* COMPUTE COVARIANCES *)

BEGIN YSA:=COVAR(YSA,YS,YS,XN);
   YV[1]:=COVAR(YV[1],YS,XS[1],XN);
   YV[2]:=COVAR(YV[2],YS,XS[2],XN);
```

Listing 1 continued on page 122

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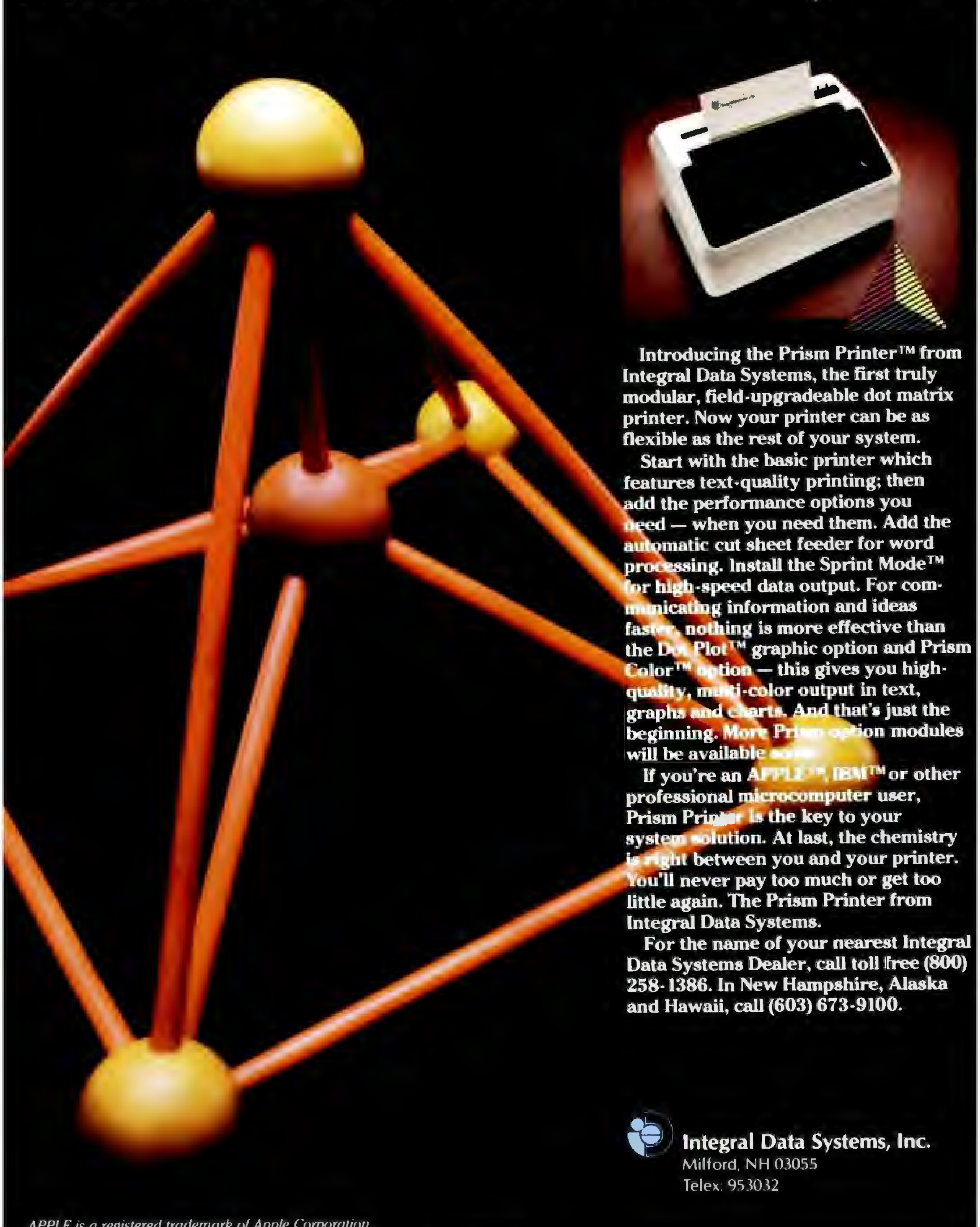

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Listing 1 continued:

```
   XM[1,1]:=COVAR(XM[1,1],XS[1],XS[1],XN);
   XM[2,2]:=COVAR(XM[2,2],XS[2],XS[2],XN);
   XM[1,2]:=COVAR(XM[1,2],XS[1],XS[2],XN);
   XM[2,1]:=XM[1,2];END;

 PROCEDURE LINREGRESS(Y,X1,X2:DATAVECT);
 (* LEAST-SQUARES FIT OF Y WITH X1,X2 *)
 BEGIN XN:=NY;YS:=0.0;YSA:=0.0;
    (* DO ASSORTED SUMS OF SQUARES  *)
    FOR KA:=1 TO 2 DO BEGIN XS[KA]:=0.0;YV[KA]:=0.0;
       FOR KB:=1 TO 2 DO XM[KA,KB]:=0.0;END;
    FOR KC:=1 TO NY DO BEGIN (* MAIN SUMMING LOOP *)
       YS:=YS+Y[KC];YSA:=YSA+SQR(Y[KC]);
       XS[1]:=XS[1]+X1[KC];XS[2]:=XS[2]+X2[KC];
       XM[1,1]:=XM[1,1]+ SQR(X1[KC]);
       XM[2,2]:=XM[2,2]+ SQR(X2[KC]);
       XM[1,2]:=XM[1,2] + X1[KC]*X2[KC];
       YV[1]:=YV[1]+Y[KC]*X1[KC];
       YV[2]:=YV[2]+Y[KC]*X2[KC]; END;
(* SOLVE FOR COEFFICIENTS *)
   COMPVAR;
   SOLVL2(B,XM,YV);
   G:=(YS - B[1]*XS[1] - B[2]*XS[2])/XN;
(* COMPUTE R-SQUARE, AVE % ERROR, STANDARD ERRORS *)
   SE:=0.0;ABER:=0.0;
   FOR KC:=1 TO NY DO BEGIN
       PR:=Y[KC]-B[1]*X1[KC] - B[2]*X2[KC] - G;
       IF Y[KC]<>0.0 THEN ABER:=ABER+ABS(PR/Y[KC]);
       SE:=SE + SQR(PR);END;
   ABER:=ABER/XN; RR:=1.0 - (SE/(XN*YSA));
   DET:=XN*(XM[1,1]*XM[2,2]) - (XM[1,2]*XM[2,1]);
   SB[1]:=SQRT((SE/(XN-2.0))*XM[2,2]/DET);
   SB[2]:=SQRT((SE/(XN-2.0))*XM[1,1]/DET);
END;

PROCEDURE PREDICT(VAR YP:DATAVECT;X1,X2:DATAVECT;B1,B2,A:REAL);
(* PREDICTS YP FROM X1*B1 + X2*B2 + A *)
BEGIN YP[0]:=X2[1];
   FOR KA:=1 TO NY DO YP[KA]:=B1*X1[KA] + B2*X2[KA] + A; END;

PROCEDURE CHECKNY;
(* CHECKS BOUNDS ON NY -- USED IN READDATA *)
BEGIN IF NY>MAXNY THEN BEGIN
         WRITELN('Program can only handle ',MAXNY,' points ');
         NY:=MAXNY;END;
      IF NY<=0 THEN BEGIN WRITELN(' Negative?!? -- try again... <RETURN>');
                          READLN(S);EXIT(ESTIMATE);END;
END;

PROCEDURE READDATA;
(* READS IN DATA VECTORS *)
BEGIN CLEARSCREEN;

    WRITE('Read data from a file? -- ');READ(CH);WRITELN;
    IF (CH='Y') OR (CH='y') THEN BEGIN
       WRITE('Enter .TEXT file name-   ');READLN(S);S:=CONCAT(S,'.TEXT');
       RESET(INF,S);
       READLN(INF,NATNAM[1]);READLN(INF,NATNAM[2]);
       READLN(INF,NY);CHECKNY;
       FOR KA:=1 TO NY DO READLN(INF,G,X1[KA],X2[KA]); END
    ELSE BEGIN
       FOR KA:=1 TO 2 DO BEGIN
          WRITE('Enter name of nation ',KA, ' --> ');
          READLN(NATNAM[KA]);END;
       WRITE('Enter number of data points-->');READLN(NY);
       CHECKNY;
       WRITELN('Enter two values for each year, separated by a blank');
       FOR KA:=1 TO NY DO BEGIN
       WRITE('Data for year ',KA:3,' -->');READLN(X1[KA],X2[KA]);END;
    END;
    (* MOVE DATA INTO Y1,Y2 *)
    FOR KA:=1 TO NY-1 DO BEGIN
    Y1[KA]:=X1[KA+1]; Y2[KA]:=X2[KA+1];END;
    NY:=NY-1; X0:=X1[1];Y0:=X2[1];X1[0]:=X0;X2[0]:=Y0;
    Y1[0]:=X0;Y2[0]:=Y0;
END;

PROCEDURE WRITEIGEN;
(* COMPUTES AND WRITES EIGENVALUES *)
VAR R,DISC,EA,EB:REAL;STABL:BOOLEAN;
BEGIN GOTOXY(0,17);
    DISC:=(SQR(RA-RB) + 4.0*RM*RK)/4.0; R:=(RA+RB)/(-2.0);
    IF DISC<0.0 THEN
       BEGIN DISC:=SQRT(-DISC);
          WRITELN('EIGENVALUES COMPLEX:REAL PART=',R: 8:4);
          WRITELN('                     COMPLEX PART=',DISC:8:4 );
          WRITELN('MODEL IS OSCILLATING');
          END
       ELSE BEGIN DISC:=SQRT(DISC);EA:=R+DISC;EB:=R-DISC;
          STABL:=((ABS(EA)<1.0) AND (ABS(EB)<1.0));
          WRITELN('EIGENVALUES : ',EA:10:5,'                ');
          WRITELN('              ',EB:10:5,'                ');
```

Listing 1 continued on page 124

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Listing 1 continued:

```
          WRITE('MODEL IS ');
          IF STABL THEN WRITELN('STABLE          ')
                   ELSE WRITELN('UNSTABLE        ');
       END;
END;

PROCEDURE WRITERES(S:STRING);
(* WRITES LEAST-SQUARES RESULTS *)
BEGIN WRITELN;WRITELN('                  EQUATION FOR ',S);
   WRITELN('              THREAT  ECON BURDN  GRIEVNC');
   WRITELN('COEFF:     ',B[1]:10:5,'  ',B[2]:10:5,'  ',G:10:5);
   WRITELN('STD ERROR:',SB[1]:10:5,'  ',SB[2]:10:5);
   WRITELN('R-SQUARE: ',RR:10:5);
   WRITELN('MEAN ABSOLUTE PERCENT ERROR:',ABER:10:5);
END;

PROCEDURE ESTIMATE;
(* DRIVING PROCEDURE FOR E)STIMATE *)
BEGIN READDATA; CLEARSCREEN;
   WRITELN('       *** ESTIMATED COEFFICIENTS ***');
   LINREGRESS(Y1,X2,X1); RA:=-B[2];RK:=B[1];RG:=G;WRITERES(NATNAM[1]);
   LINREGRESS(Y2,X1,X2); RB:=-B[2];RM:=B[1];RH:=G;WRITERES(NATNAM[2]);
   WRITEIGEN;
   PREDICT(YP1,X1,X2,RA,RK,RG); PREDICT(YP2,X1,X2,RM,RB,RH);
   GOTOXY(10,23);WRITE('<RETURN> TO MONITOR ');READLN(S);
END;

(* ******** PLOTTING ROUTINES ********* *)

PROCEDURE SCALE (YA,YB:DATAVECT);
(* FINDS SCALING FACTORS FOR PLOT *)
VAR MAX,MIN:REAL;
BEGIN MIN:=YA[1];MAX:=YA[1];
  FOR KA:=0 TO NY DO BEGIN
      IF YA[KA]<MIN THEN MIN:=YA[KA];IF YB[KA]<MIN THEN MIN:=YB[KA];
      IF YA[KA]>MAX THEN MAX:=YA[KA];IF YB[KA]>MAX THEN MAX:=YB[KA];END;
  VSCL:=(VDIM)/(MAX-MIN+1); VMIN:=TRUNC(MIN-1.0);
  HSCL:=HDIM/(NY+1);HMIN:=0;
END;

(* FUNCTIONS FOR COMPUTING SCREEN COORDINATES FROM CURRENT SCALING *)
FUNCTION YCORD(Y:REAL):INTEGER;
BEGIN YCORD:=ROUND((Y-VMIN)*VSCL)+VLO;END;
FUNCTION XCORD(X:INTEGER):INTEGER;
BEGIN XCORD:=ROUND(((X-HMIN)*HSCL))+HLO;END;

PROCEDURE DRAWAXIS(NAT,LA,LB:STRING);
(* DRAWS THE X AND Y AXII (AXISES,WHATEVER...) *)
BEGIN (* Y-AXIS *)
   INITTURTLE;GRAFMODE;
   MOVETO(HLO,VLO);PENCOLOR(WHITE);MOVETO(HLO,VHI);
   TURNTO(180); KA:=VLO+10;
   REPEAT PENCOLOR(NONE);MOVETO(HLO,KA);PENCOLOR(WHITE);MOVE(3);
          KA:=KA+10; UNTIL KA>VHI;
(* X-AXIS *)
   KB:=YCORD(0.0); IF (KB>VHI) OR (KB<VLO) THEN KB:=VLO;
   PENCOLOR(NONE);MOVETO(HLO,KB);PENCOLOR(WHITE);MOVETO(HHI,KB);
   TURNTO(270);
   FOR KA:=0 TO NY DO BEGIN PENCOLOR(NONE);MOVETO(XCORD(KA),KB);
                            PENCOLOR(WHITE);MOVE(3);END;
   PENCOLOR(NONE);MOVETO(0,0);
(* WRITE PLOT LABEL *)
   S:=CONCAT('PLOT FOR ',NAT,', *=',LA,', +=',LB);WSTRING(S);
END;

PROCEDURE PLOTCHAR(I:INTEGER);
(* PLOTS CHAR I CENTERED AT CURRENT TURTLE POSITION *)
VAR XP,YP:INTEGER;
BEGIN XP:=TURTLEX;YP:=TURTLEY;PENCOLOR(NONE);TURNTO(225);MOVE(5);
      PENCOLOR(WHITE);WCHAR(CHR(I));PENCOLOR(NONE);
      MOVETO(XP,YP);PENCOLOR(WHITE);END;

PROCEDURE PLOTDATA(Y:DATAVECT;IC:INTEGER);
(* PLOTS DATAVECT Y WITH CURRENT SCALING, LABELING WITH CHR(IC) *)
BEGIN
   PENCOLOR(NONE);MOVETO(XCORD(0),YCORD(Y[0]));PLOTCHAR(IC);
   PENCOLOR(WHITE);CHARTYPE(14);
   FOR KA:=1 TO NY DO BEGIN MOVETO(XCORD(KA),YCORD(Y[KA]));PLOTCHAR(IC);END;
END;

PROCEDURE SIMULATE;
(* GENERATE SIMULATED VALUES USING CURRENT COEFFICIENTS *)
VAR TR:BOOLEAN;
BEGIN TR:=FALSE;
   YS1[0]:=X0;YS2[0]:=Y0;
   FOR KA:=1 TO NY DO BEGIN
        YS1[KA] := RK*YS2[KA-1] - RA*YS1[KA-1] + RG;
        YS2[KA] := RM*YS1[KA-1] - RB*YS2[KA-1] + RH;
        IF ABS(YS1[KA])>MAXVAL THEN BEGIN TR:=TRUE;YS1[KA]:=MAXVAL;END;
        IF ABS(YS2[KA])>MAXVAL THEN BEGIN TR:=TRUE;YS2[KA]:=MAXVAL;END;
   END;
```

Listing 1 continued on page 126

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Listing 1 continued:

```
    IF TR THEN BEGIN GOTOXY(0,22);
               WRITELN('NOTICE --  VALUES TRUNCATED IN SIMULATE ');END;
END;

PROCEDURE DRAWPLOT(YA,YB:DATAVECT;LM,LA,LB:STRING);
(* DRAWS A PLOT OF VECTORS YA AND YB, LABELED WITH LM,LA,LB *)
BEGIN
  IF AUTOSCALE THEN SCALE(YA,YB);
  DRAWAXIS(LM,LA,LB);
  PLOTDATA(YA,42);PLOTDATA(YB,43);
  READLN(CH);TEXTMODE;
END;

PROCEDURE PLOTS;
(* DRIVING PROCEDURE FOR P)LOT *)
BEGIN REPEAT CLEARSCREEN;
   WRITELN(' ENTER PLOTTING OPTION -->                   ');
   WRITELN('       1. OBSERVED DATA');
   WRITELN('       2. OBSERVED AND PREDICTED FOR ',NATNAM[1]);
   WRITELN('       3. OBSERVED AND PREDICTED FOR ',NATNAM[2]);
   WRITELN('       4. SIMULATED DATA');
   WRITELN('       5. QUIT');
   WRITELN;WRITELN('TO STOP PLOT PRESS RETURN');
   GOTOXY(27,0);READ(CH);
   WRITE(' PLOTTING...');
   CASE CH OF
    '1':DRAWPLOT(Y1,Y2,'OBSERVED',NATNAM[1],NATNAM[2]);
    '2':BEGIN PREDICT(YP1,X1,X2,-RA,RK,RG);
          DRAWPLOT(Y1,YP1,NATNAM[1],'OBSERVED','PREDICTED');END;
    '3':BEGIN PREDICT(YP2,X1,X2,RM,-RB,RH);
          DRAWPLOT(Y2,YP2,NATNAM[2],'OBSERVED','PREDICTED');END;
    '4':BEGIN SIMULATE;
            DRAWPLOT(YS1,YS2,'SIMULATED',NATNAM[1],NATNAM[2]);END;
    END; (* CASE *)
    UNTIL (CH='5') OR (CH='Q');
 END;

(* ******** CHANGE PARAMETER VALUES ******* *)

PROCEDURE WRITEVALUES;
(* WRITES OUT CURRENT VALUES OF PARAMETERS *)
BEGIN CLEARSCREEN;
   GOTOXY(8,0);WRITELN('RICHARDSON''S ARMS RACE MODEL');
   GOTOXY(10,2);WRITELN('X(T+1) = KY(T) - AX(T) + G');
   GOTOXY(10,3);WRITELN('Y(T+1) = MX(T) - BY(T) + H');
   GOTOXY(0,5);WRITELN('K= ',RK:10:4,'    M= ',RM:10:4);
   WRITELN('A= ',RA:10:4,'    B= ',RB:10:4);
   WRITELN('G= ',RG:10:4,'    H= ',RH:10:4);
   WRITELN('X(0) = ',X0:10:3);
   WRITELN('Y(0) = ',Y0:10:3);
   WRITELN('NUMBER OF YEARS =',NY);  (* 11 *)
   GOTOXY(0,12);
   WRITELN('HORIZONAL SCALE: ',((NY+1)*HSCL/HDIM): 7:3,'  (''R'' TO CHANGE)');
   WRITELN('VERTICAL  SCALE: ',(10.0/VSCL):10:3);
   WRITELN('LOWEST VALUE :   ',VMIN);
   IF AUTOSCALE THEN S:='TRUE' ELSE S:='FALSE';
   WRITELN('SCALING AUTOMATIC:',S);  (* 16 *)
   WRITEIGEN;
   GOTOXY(0,21);WRITELN('CHANGE PARAMETER  -->');WRITELN('Q TO Q)UIT');
   GOTOXY(22,21);
END;

PROCEDURE READPAR(VAR R:REAL;X,Y:INTEGER);
(* MOVES CURSOR TO (X,Y), BLANKS OUT NUMBER, READS NEW VALUE *)
BEGIN GOTOXY(X,Y);WRITE('            ');
      GOTOXY(X,Y);READLN(R);END;

PROCEDURE CHANGEPAR;
(* CHANGES PARAMETER VALUES *)
BEGIN
   REPEAT READ(CH);
   CASE CH OF
      'K':READPAR(RK,4,5);'M':READPAR(RM,20,5);
      'A':READPAR(RA,4,6);'B':READPAR(RB,20,6);
      'G':READPAR(RG,4,7);'H':READPAR(RH,20,7);
      'X':READPAR(X0, 7,8);'Y':READPAR(Y0, 7,9);
      'N':BEGIN REPEAT READPAR(RR,17,10);
                     IF TRUNC(RR)>MAXNY THEN BEGIN
                        GOTOXY(20,11);WRITE('N MUST BE <=',MAXNY);END;
                     IF RR<0.0 THEN BEGIN GOTOXY(20,11);
                        WRITE('N MUST BE > 0 ');END;
                UNTIL (TRUNC(RR)<=MAXNY) AND (RR>0.0);
          GOTOXY(20,11);WRITE('                 ');NY:=TRUNC(RR);END;
      'R':BEGIN READPAR(RR,18,12);HSCL:=HDIM*RR/(NY+1);END;
      'V':BEGIN READPAR(RR,18,13);VSCL:=10.0/RR;END;
      'L':BEGIN READPAR(RR,15,14);VMIN:=TRUNC(RR+1.0);END;
      'S':BEGIN CH:= ' ';
            WHILE (CH<>'T') AND (CH<>'F') DO BEGIN
               GOTOXY(18,15);WRITE('      ');GOTOXY(18,15);READ(CH);END;
            IF CH='F' THEN WRITE('ALSE') ELSE WRITE('RUE');
```

Listing 1 continued on page 128

Listing 1 continued:

```
              AUTOSCALE:=(CH='T');END;
        END; (* CASE *)
   IF CH IN ['K','A','M','B'] THEN WRITEIGEN;
   GOTOXY(22,21);WRITE(' ');GOTOXY(22,21);
   UNTIL CH='Q';
END;

(* ****** MAIN PROCEDURES ****** *)

PROCEDURE MONITOR;
(* MAIN DRIVING PROCEDURE *)
BEGIN CLEARSCREEN;GOTOXY(0,5 );
   WRITELN('   **** DEMONSTRATION PROGRAM FOR ****');
   WRITELN(' **** RICHARDSON''S ARMS RACE MODEL ****');WRITELN;
   WRITELN(' ENTER OPTION -->');
   WRITELN('       E)STIMATE ');
   WRITELN('       C)HANGE PARAMETER VALUES  ');
   WRITELN('       P)LOT');
   WRITELN('       Q)UIT  '); GOTOXY(18,8 );READ(CH);
   CASE CH OF
      'E':ESTIMATE;
      'C':BEGIN WRITEVALUES;CHANGEPAR;END;
      'P':PLOTS;
      'Q':EXIT(PROGRAM);
   END (* CASE *)
END;

PROCEDURE INITPROG;
(* SETS ASSORTED PROGRAM PARAMETERS *)
BEGIN
   HLO:=5;HHI:=275;VLO:=15;VHI:=185;
   HDIM:=HHI-HLO;VDIM:=VHI-VLO; (* SETS DIMENSIONS OF PLOT *)
   MAXVAL:=PWROFTEN(12);
   (* IDIOT-PROOF BY INITIALIZING PARAMETERS TO SOMETHING SAFE... *);
   RK:=0.2;RA:=0.4;RG:=1.0;RM:=0.3;RB:=0.5;RH:=2.0;
   X0:=10.0;Y0:=20.0;
   IF MAXNY>30 THEN NY:=30 ELSE NY:=MAXNY;
   NATNAM[1]:='X';NATNAM[2]:='Y';
   AUTOSCALE:=TRUE ;
   HSCL:=1.0;VSCL:=1.0;VMIN:=0;
   SIMULATE;
   FOR KA:=0 TO NY DO BEGIN YP1[KA]:=YS1[KA];YP2[KA]:=YS2[KA];
                            Y1[KA]:=YS1[KA];Y2[KA]:=YS2[KA];
                            X1[KA]:=YS1[KA];X2[KA]:=YS2[KA];END;
END;

(*MAIN PROGRAM *)
BEGIN
INITPROG;
REPEAT MONITOR UNTIL FALSE;
END.
```

Text continued from page 120:

with the exception that the first number in each line of arms data is skipped, which allows the file to contain year numbers or other identifying numbers. For example, the first lines from the file used to produce figure 2 are:

IRAN		
IRAQ		
21		
1954	78	75
1955	107	67
1956	126	94
1957	151	102
1958	243	110
1959	271	129
. . .		

Note that the program automatically supplies the .TEXT suffix for the file name.

The coefficients for the model are estimated using ordinary least-squares estimation. The program computes the coefficients of the model, the standard error of those coefficients, and two measures of the fit of the prediction. The correlation coefficient R-square is a statistical measure of the fit of the predicted and observed values—an R-square of 0.0 means there is no fit, an R-square of 1.0 means there is a perfect fit. The *mean absolute percent error* is a more conventional measure: the average error of the prediction as a percentage of the value that is being predicted.

The standard error of the coefficients gives a rough idea of whether the coefficients are distinct from zero—in other words, whether a nation is actually reacting to threat or economic burden. In large samples, a

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coefficient that is twice the size of its standard error means that you can be 95 percent certain that the coefficient is actually nonzero and was not produced by chance. It should be noted that many processes appear to fit a Richardson model when no interaction is taking place and the model

$$X(t + 1) = aX(t) + g$$
$$Y(t + 1) = bY(t) + h$$

would fit as well as the Richardson model. If the fit of the model is good, but the standard error of the threat coefficient is large, this is probably what is happening.

Missing

Do To

Page

Mis-Feed

parameter list, which is displayed by entering C. Alternatively, you can skip the estimation and set the parameters manually to experiment with the behavior of the model. You change parameters by entering the first letter of the parameter and typing in the new value. You can also change the scales on the plots and the number of years in the same way.

Three scaling parameters are contained in this module. When horizontal scaling is equal to 1, all years of data are displayed. Setting horizontal scaling greater than 1.0 will expand the graph horizontally, and some later years will not be plotted. Setting the horizontal scaling to less than 1 will squeeze the graph into a smaller space. Note that horizontal scaling is changed with 'R' rather than 'H.' The vertical scaling is the number of units between tic marks on the vertical axis; the lowest value is the value at the bottom of the screen. The horizontal axis is drawn at the value 0 if that is on the plot; otherwise, the horizontal axis is drawn at the lowest value.

This module also computes the eigenvalues of the model. These two numbers are a function of the parameters k, m, a, and b and determine the stability of the model. If both eigenvalues are real and less than 1 in absolute value, the model is stable; otherwise, it is unstable. Complex eigenvalues produce oscillating behavior. The larger the eigenvalues, the more rapidly the arms levels change.

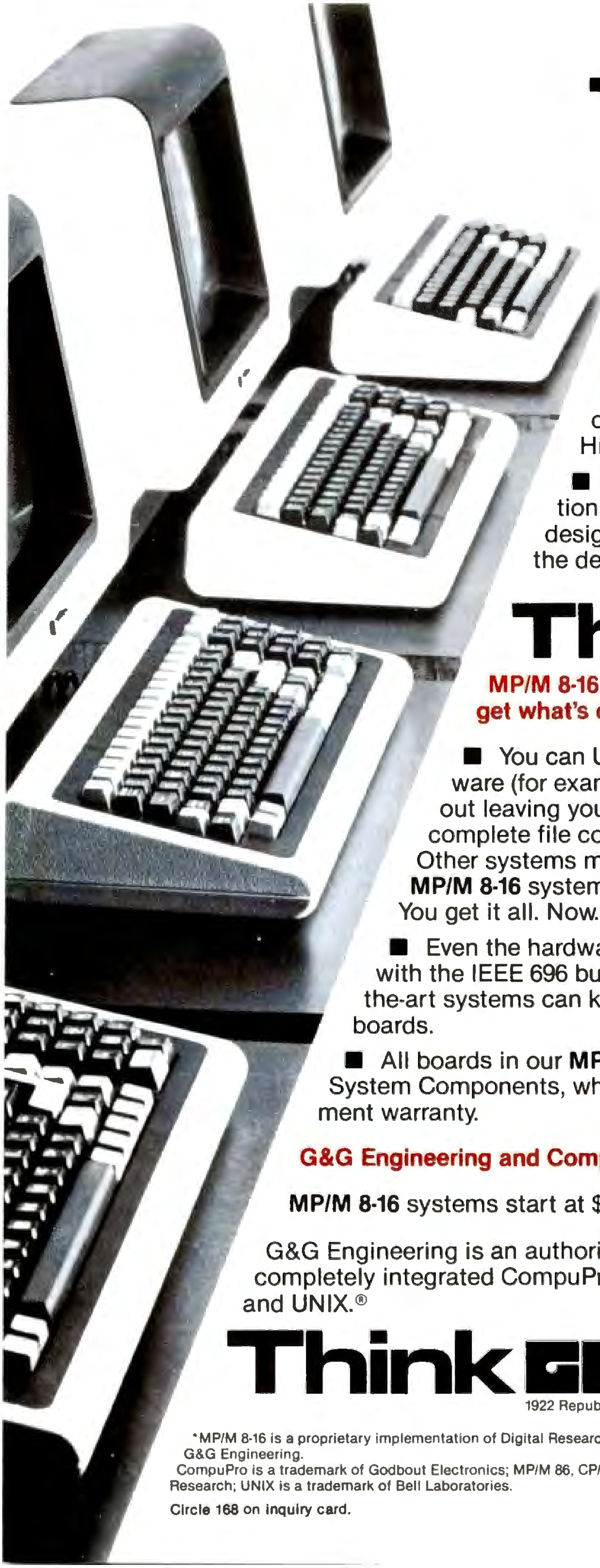
Parameters can be set manually to experiment with the behavior of the model.

P)LOT

This module draws a screen plot of either (1) the data points entered in E)STIMATE; (2, 3) the observed and predicted values of one of the nations entered in E)STIMATE; or (4) the values produced by simulating the behavior of the system using the equations and the initial values X0,Y0.

Figures 1, 2, and 3 were produced by P)LOT options 1, 2, and 4, respectively. In options 2 and 3, the program makes predictions from the previous year's data at each point—in other words, the predictions are short-term rather than long-term. Each axis is marked with tic marks that correspond to the scales given in the C)HANGE procedure. Each plot is rescaled to fit the entire screen unless you have set automatic scaling to FALSE in C)HANGE. Predicted values are done using the current parameters set in C)HANGE.

Option 4 simulates the behavior of the system using the current parameters and initial values, without comparing them to actual data. The parameters are displayed and



changed in C)HANGE. This procedure is useful for experimenting with the behavior of the model. If the values of the model become too large, the program truncates the simulation to avoid overflow errors.

Option 4 provides a nice demonstration program for showing the behavior of systems of linear difference equations. Of course, such systems apply to many phenomena other than arms races. A few minor modifications would enable the program to handle a differential equation system. In classroom discussions of linear models, I've found this to be an effective way of demonstrating the influence of the eigenvalues on the behavior of the system. ■

Availability of the Programs

If you wish to avoid typing, this program is available on disk as part of a package of three political science programs:

RICHDEMO: Estimation and demonstration of the Richardson arms-race model.
BANZDEMO: Computation and demonstration of the Banzhaf Index of voting power in weighted voting situations. Includes options for direct and Monte-Carlo computations, and for excluding coalitions.
VOTEDEMO: Demonstration of the majority, plurality, Condorcet, Copeland, Borda, and STV voting systems for a given set of preference orderings.

All programs are written in Apple Pascal and require the Apple Language System. They are available on disk from the author at the Department of Political Science, Northwestern University, Evanston, IL 60201. The cost is $25 prepaid.

References

1. Olnick, Michael. *An Introduction to Mathematical Models in the Social and Life Sciences*. Reading, MA: Addison-Wesley, 1978.
2. Rapoport, Anatol. *Fights, Games and Debates*. Ann Arbor: University of Michigan Press, 1974.
3. Richardson, Lewis F. *Arms and Insecurity*. Chicago: Quadrangle Books, 1960.
4. Zinnes, Dina A. *Contemporary Research in International Relations*. New York: Free Press, 1976.

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Software Tools for Writers

A programmer describes his experiences developing tools that make writing easier.

Wayne Holder
Oasis Systems
2765 Reynard Way
San Diego, CA 92103

Word processors have changed the way I think about writing. To be honest, I don't think I would even try to write if I didn't have a computer and a good text editor. A word processor lets me *experiment* with my prose. It removes the fear of making a mistake. Nothing takes the fun out of writing faster than having to retype pages over and over again.

My word processor also gives me a copy of my writing that my computer can read, which makes it easy for my computer to do more than just help me type neat pages. In this article I'm going to talk about some of the ways in which computer programs that read and analyze writing can help you write better. I'll also present listings of two assembly-language routines that are useful in dictionary programs.

Your computer can help you improve your writing in many ways. A spelling checker is an obvious example. Computers also can analyze how "readable" your writing is by using various statistical formulas that measure how easy your writing is to comprehend. Or they can check your punctuation, grammar, use of passive voice, and overuse of words and phrases.

Once you get used to the idea of a computer looking over your shoulder while you write, I think you'll realize that writing can be fun! Then you'll start wanting your computer to do more than just make your writing OK. You'll want programs that make it easier for you to experiment with your text, rearranging it in novel ways.

I based much of this article on my experience writing such programs. My interest began when I started planning a commercial spelling-checker program. While researching the project, I discovered that many other people had developed interesting computer aids for writers. Inspired by these aids, I began to modify my plans as I considered making the spelling checker the basis of a much more ambitious writing analysis system for microcomputers.

Sources of Inspiration

The most inspirational software package I came across was The Writer's Workbench, developed at Bell Laboratories for the Unix operating system. The Writer's Workbench is a system of programs that work with the existing Unix text editors and formatters to do prose evaluation. Many of the programs can be used only on the Unix system, but The Writer's Workbench served as a helpful guide to the kinds of computer analysis that could be useful to writers.

I was also inspired by the book *Software Tools* by Brian W. Kernighan and P. J. Plauger (see reference 6). I wanted my system to grow as I added new kinds of analysis programs, so the idea of "software tools" appealed to me greatly. Kernighan and Plauger advocate writing programs as small, multipurpose

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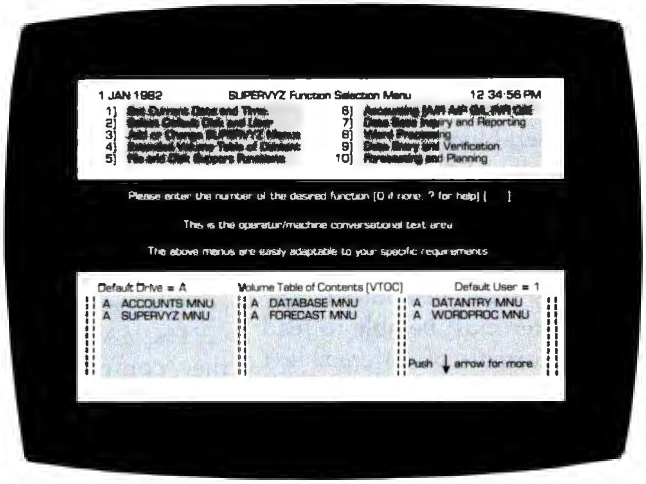

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ABANDON	3NDON
ABANDONING	7ING
ABANDONMENT	7MENT
ABASEMENT	3SEMENT
42 characters	26 characters

Figure 1: *The technique of text compression in a computerized dictionary. A letter count replaces the number of letters at the beginning of a word that are the same as the letters at the beginning of the previous word. The number of letters in the words is reduced in this example from 42 to 26. Listing 1 shows how this technique was coded in 8080 assembly language.*

units that can be strung together in different ways to achieve a more sophisticated result. I knew right from the start that I wouldn't be able to foresee all of the things that people might want to do with my system, nor would I know exactly what sort of new analysis programs I might write in the future. So a *modular* approach seemed the most flexible.

Spelling Checkers Reduce Anxiety

It is my personal conviction that people shy away from writing because they can't spell properly. I know that the fear of embarrassing myself because of my "creative" spelling has been a problem for me. Computerized spelling checkers are a great way of reducing "misspeller's anxiety." They let you write text privately at your computer terminal and quickly check and correct spelling errors before anyone else can see them.

One of the first spelling checkers was written by Ralph Gorin for the DEC-10 computer at Stanford University in 1971. Gorin's program was the model for others to come. The Unix operating system, a later development, provides two spelling checkers called SPELL and TYPO. TYPO uses a statistical approach to find spelling errors by looking at pairs and triplets of letters called *digrams* and *trigrams* (see reference 2). TYPO works by noting that certain combinations of letters are very rare. Words using these combinations are likely misspellings. This technique is not as accurate as one that uses an on-line dictionary because it will not locate misspelled words that contain legal trigrams and digrams. However, I want to discuss this idea again a bit later because it offers a way to catch typos and spelling errors as you type in your text.

The Word is a series of programs that I planned originally as a spelling-checker system. During development I tested my program on my wife, Nancy, who writes and publishes romantic fiction. Her comments as a novice computer user helped me make the programs more flexible and useful.

The Word has a program called SPELL that is similar in principle to the Unix program of the same name. The Word, however, works on the CP/M operating system. I designed SPELL to check for misspellings by looking up words in a dictionary. I did not use any form of "suffix stripping" (removing suffixes from words before checking the spelling of the root) because I felt that it would compromise the accuracy of the program.

In order to be useful, a microcomputer-based spelling checker must overcome several limitations of small microcomputers: limited size and hardware specificity. A good spelling checker needs a reasonably large dictionary, and the dictionary must fit onto a floppy disk. In addition, the spelling checker must be able to read the text file formats of different text editors and word processors.

Dictionary Compression

To fit a large dictionary onto a microcomputer, some form of text compression must be used. The Word has a dictionary of about 45,000 words, which, in a text file, require over 440K bytes of disk space. A dictionary for a spelling checker is simply an alphabetized list of words, and such lists can easily be compressed. The first few letters of successive dictionary words usually share identical letter combinations at the beginning of each word as a result of alphabetical ordering. To avoid this redundancy, the compression program removes common letters from successive words and replaces them with a one-byte count. Figure 1 gives an example. This compression method, when combined with several other techniques, squeezed the dictionary into 136K bytes of space.

Listing 1 shows an early version of the dictionary compression program. In later versions, I added some improvements that resort to esoteric programming, so for clarity I have left them out. The program in listing 1 reads characters from an input file via the subroutine GET$UPPER (not shown). The program writes compressed output to a file via the subroutine WRT (also not shown). Words are delimited by setting the MSB (most significant bit) of the last character. When the program detects an EOF (end-of-file) code it branches to the Exit routine. The program expects the Exit routine to close the output file and exit to the operating system. The program is written in 8080 assembly language and conforms to CP/M file conventions.

Listing 2 shows a subroutine that does the inverse operation to "uncompress" words and pass them back to a calling program. On each call, the subroutine reads a single word from the dictionary and returns it in WORD$BUFFER. The end of the word in the buffer is delimited by a null byte. The subroutine assumes that it can read characters from the compressed dictionary by calling GET$CHAR. You should not alter the content of WORD$BUFFER because the subroutine needs it to "uncompress" subsequent words.

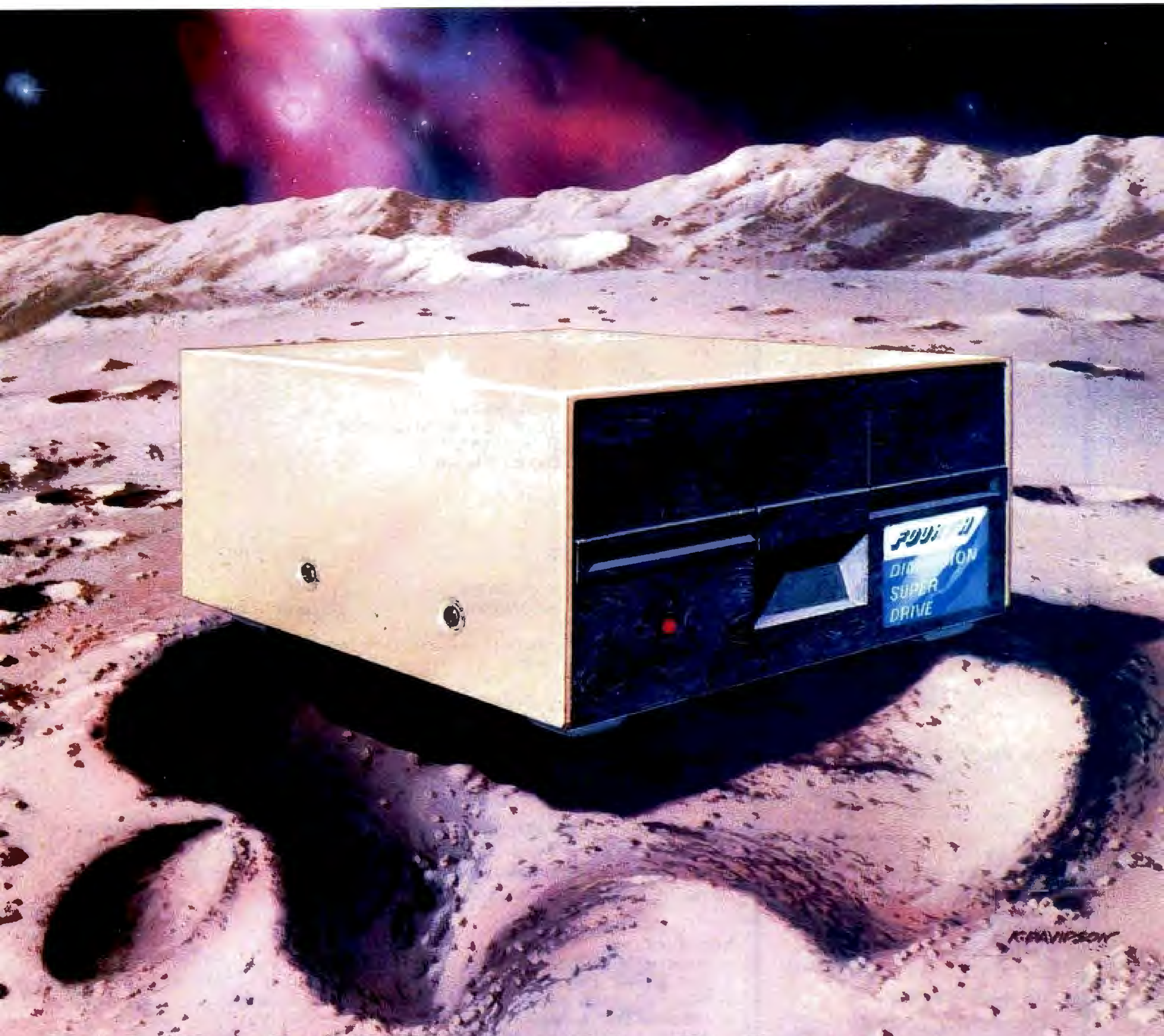
Compatibility with Text Editors

My biggest headache in developing SPELL was designing it to read text files from many different word processors. Document files composed

Listing 1: *An early version of The Word's dictionary compression routine. Written in 8080 assembly language, the routine reads in a word list by calling the subroutine GET$UPPER (not shown) and writes a compressed file by calling the subroutine WRT (also not shown). The compression routine compares a word to its predecessor, counts the number of beginning letters that are the same, and then replaces the beginning letters in the second word with the count of the duplicates. The rest of the second word is stored literally. Figure 1 illustrates the technique embodied in this subroutine.*

```
 ; This program reads an alphabetized word list as input
; via calls to GET$UPPER (returns characters converted
; to upper case) and writes a compressed file via calls
; to WRT.  At the end of the input file the program exits
; to EXIT.
;
COMPRESS:
; Read a word from input file into 'WORD$BUFFER'.
; Words can only begin with a letter, but may contain
; letters and apostrophes
        LXI     H,WORD$BUFFER
        MVI     B,0
        CALL    GET$UPPER
        CPI     1AH                     ; CP/M End of File?
        JZ      EXIT
        CPI     'A'
        JM      WORD$READ
        CPI     'Z'+1
        JP      WORD$READ
; Get here when input character is a letter
ALPHA$READ:
        MOV     M,A
        INR     B
        INX     H
        CALL    GET$UPPER
        CPI     27H             ; apostrophe
        JZ      ALPHA$READ
        CPI     'A'
        JM      WORD$END
        CPI     'Z'+1
        JM      ALPHA$READ
WORD$END:
; Get here with word in 'WORD$BUFFER' and B=Length
; set MSB of last character in word
        DCX     H
        MOV     A,M
        ORI     80H
        MOV     M,A
        MOV     A,B
; Reject words of less than 2 characters
        CPI     2
        JM      WORD$READ
; Compare new word to old word
        LXI     H,WORD$BUFFER
        LXI     D,LAST$WORD
        MVI     C,0
COMP$LOOP:
        PUSH    B
        MOV     A,M
        ANI     7FH
        MOV     C,A
        LDAX    D
        ANI     7FH
        CMP     C
        POP     B
        JNZ     COMP1
        INR     C
        LDAX    D
        ORA     M
        INX     H
        INX     D
        ANI     80H
        JNZ     COMP1
        DCR     B
        JNZ     COMP$LOOP
COMP1:
; Write compression count and remaining characters to disk
```

Listing 1 continued on page 144



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Listing 1 continued:

```
; Words with less than 2 letters compressed are written intact
        MOV     A,C
        ORA     A
        JZ      WORD$WRITE
        DCX     H
        CPI     1
        JZ      WORD$WRITE
        INX     H
        CALL    WRT             ; Compression count
WORD$WRITE:
        MOV     C,M
        CALL    WRT
        INX     H
        MOV     A,C
        ANI     80H
        JZ      WORD$WRITE
; Move new word into old word buffer
        LXI     H,WORD$BUFFER
        LXI     D,LAST$WORD
WORD$MOVE:
        MOV     A,M
        STAX    D
        INX     H
        INX     D
        ANI     80H
        JZ      WORD$MOVE
        JMP     WORD$READ       ; get another word
;
; LAST$WORD is initialized to zero to prevent accidental
; match of first word.
LAST$WORD:
        DW      0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
;
WORD$BUFFER:
        DS      32
```

Listing 2: *A subroutine that "uncompresses" words and passes the reconstituted words back to the calling program. This subroutine reverses the operation done in listing 1. Note that the subroutine assumes that it can read characters from the compressed dictionary by calling the subroutine GET$CHAR (not shown).*

```
MAIN$READ:
; Read a word from compressed dictionary via GET$CHAR
; and put into DICT$BUFFER.  Last character's MSB is
; set.  Return carry set if end of input file.
; Subroutine assumes that previously read word is
; still in DICT$BUFFER.
        LXI     H,DICT$BUFFER
        CALL    GET$CHAR
        CPI     1AH             ; CP/M End of File
        STC
        RZ                      ; End of dictionary
        ORA     A
        JM      SINGLE$LETTER
        CPI     'A'
        JP      NOT$COMPRESSED
; Reconstruct compressed word
        LXI     H,DICT$BUFFER
        MOV     E,A
        MVI     D,0
        DAD     D
        DCX     H
        MOV     A,M
        ANI     7FH
        MOV     M,A
        INX     H
        JMP     MAIN$READ$LOOP
NOT$COMPRESSED:
; Get here if word is not compressed
        MOV     M,A
        INX     H
```

Listing 2 continued on page 146

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Listing 2 continued:

```
MAIN$READ$LOOP:
; Read remaining letters of word
        CALL    GET$CHAR
SINGLE$LETTER:
        MOV     M,A
        INX     H
        ANI     80H
        JZ      MAIN$READ$LOOP
        RET
;
DICT$BUFFER:
        DB      40
```

only of text do not cause much of a problem. However, most word processors include special control codes to indicate underlining, superscripting, and hyphenation. You can ignore most of these codes, but if the word processor has inserted them in the middle of a word (as with optional hyphenation points), SPELL must remove them before processing the word.

SPELL also had to be designed to ignore formatter commands. Word processors and text formatters use these codes (sometimes called dot commands) to convey information about page length, margin settings, etc. Formatting commands are usually on a line beginning with a special character, such as a period. Or, in some cases, they are bordered by special characters, such as back slashes.

I designed SPELL to read the text file formats of most of the currently available word processors and text editors. The only ones that I had any real problems with were the more advanced, such as Wordstar and Magic Wand. Wordstar has the nasty habit of setting the MSB of certain file characters. This bit controls the justification of words on a line. Clearing the bit, if set, partially solves the problem. However, when reading and altering a Wordstar document file, programmers must be careful to restore the setting of this bit before writing the altered file to disk.

Deciding what to do about hyphenated words was another challenge in designing a spelling checker. If you treat a hyphenated word as a single word, what do you do with constructs such as *state-of-the-art*? Do you add all hyphenated words to the dictionary, even if the individual words are already there?

SPELL breaks hyphenated words into their component words except when the hyphen occurs at the end of a line of text. When that happens, it usually means that the word has been divided to fit onto the line. Divided words must be reassembled before processing. SPELL also ignores so-called soft hyphens that are inserted into words as optional hyphenation points, regardless of where they occur.

Automatic Hyphenation

My idea of a useful computer program is one that performs tasks that I find tedious. Looking up the proper place to divide a word at the end of a sentence is tedious. Several word-processor programs currently provide features to hyphenate lengthy words as they are entered, but all rely on fairly simple hyphenation algorithms that do not perform very well in practice. Adding hyphenation information to the on-line dictionary would seem to be one way of solving the hyphenation problem. After considering this solution, however, I concluded that dictionary-based hyphenation would be too slow and would greatly reduce the compression of the dictionary. I did find a very good solution in Donald Knuth's book *TEX and METAFONT: New Directions in Typesetting* (see reference 7). Knuth discusses an efficient algorithm that uses a series of rules for dividing words. The rules are supplemented by a list of words that disobey them.

The Word's hyphenation tool, called HYPHEN, which is designed around Knuth's rules, can operate in

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two ways. You can use it as an on-line hyphenation dictionary, or you can have it read a file and automatically insert soft hyphens into words that exceed a specified length. When used in this way, HYPHEN is very handy for setting narrow column text such as would be needed for periodicals and newsletters. Used for on-line lookup, HYPHEN accepts words typed in at the console and prints back an acceptable hyphenation.

How a Spelling Checker Works

Now that you know about most of the problems in designing spelling checkers, let's see how they actually work. The principle is simple. First, you find a word, and then you see if it's in the dictionary. However, looking up each word as you find it in the text would be extremely slow because of the time needed to read from a floppy disk. So instead, SPELL reads the text file and builds a list of all of the file's unique words. The word *microcomputer*, for example, would be saved only once. SPELL keeps the list in memory for speedy access. After compiling the list, the program looks up each word in the dictionary. SPELL looks up words by matching them sequentially against the dictionary. Words are removed from the list when they are found in the dictionary. When the program finishes, the remaining list of words contains those suspected of being misspelled.

In designing The Word, I decided to split the entire spelling checking process into three phases: one to find the incorrect words, one to help review them, and one to fix them. A separate program handles each phase. Each program, therefore, has the greatest amount of memory available to build word lists. In addition, this modularity allows you to use the programs for other purposes. I'll describe some of these uses later.

I just described phase one, the suspect-word finder, above. The program for phase two, REVIEW, helps you review the list of suspect words. This program provides several helpful features, such as an automatic lookup that searches the dictionary to locate possible correct spellings of

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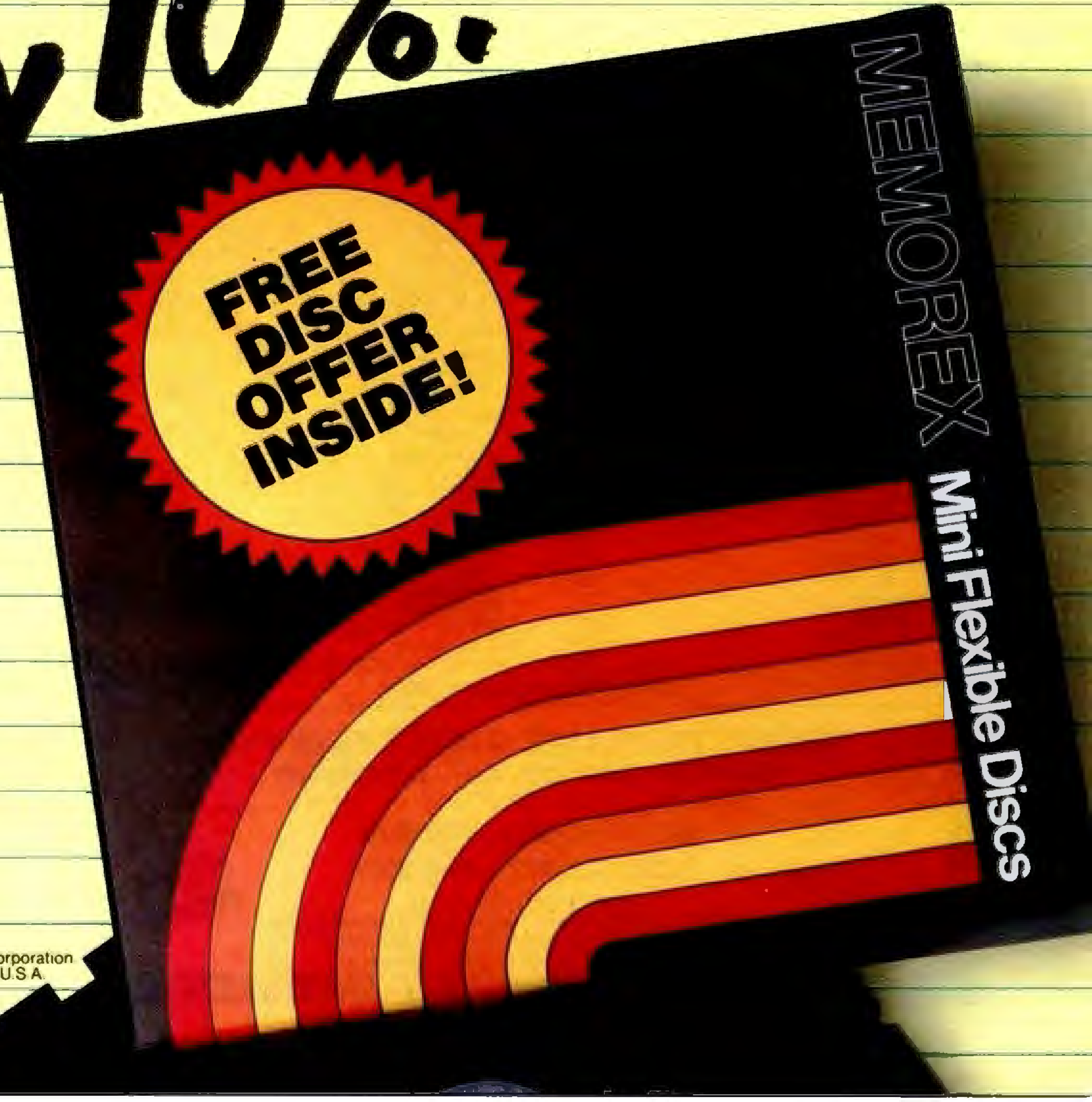

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suspect words. In addition, the program can display the context of the word in the original document by using information provided by SPELL in a special file. Once you know the correct spelling, you can pass it on to the next program, which will automatically correct it in the original document. If words are found that are correctly spelled, REVIEW will add them, at the press of a key, to an extension of the main dictionary.

The third program in the series corrects the mistakes in your document. MARKFIX reads in a list of misspelled words (and corrections, if supplied) and then reads the text file. Then MARKFIX either marks words in the text file that match words in the list of misspelled words by placing a special character in front of them or corrects a misspelling by replacing it with the correct spelling. When replacing a word, MARKFIX changes the capitalization of the replacement word to match the word being replaced.

MARKFIX expects to read a list of corrections from a CP/M text file in the following format:

misspelled/replacement

When used for spelling correction, the review phase produces the word list file automatically. However, MARKFIX doesn't care where it gets its list file from. This allows several really useful auxiliary applications.

Automated Rewrite

For example, say you had written a story about two characters, Jim and Mark, who live in Centerville and Smallton. After finishing the manuscript, you decide to shift the setting to Costa Rica and change the names of the characters to Raul and Julio, and the towns to Limon and Guadalupe. With most text editors, that would require many passes through the file, making it a tedious job. MARKFIX simply needs the following replacement list to get the job done.

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MARK/JULIO
CENTERVILLE/LIMON
SMALLTON/GUADALUPE

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MARKFIX will also preserve possessive endings of the corrected names.

MARKFIX can also rewrite something for you. Because MARKFIX can replace a word with more than a single word, you can build the following kind of replacement list:

I'LL/I WILL
I'VE/I HAVE

Consider also the potential for deflating stuffy writing by making a replacement list to change words like *utilize* to the generally better *use*. Of course, if you want to "pump up" your prose, you can also do the reverse.

All sorts of additional uses will no doubt occur to you. One suggestion I've received mentions using a tool like this to shift tone and mood in a piece of writing. Consider:

SOFT/HARSH
SOFTLY/HARSHLY
WHISPER/BLAST
WHISPERED/SHOUTED

MARKFIX's ability to mark words within a text file also offers a way of finding misused homonyms. Homonyms are words that sound alike but have different spellings. Examples are *there* and *their*, or *stationary* and *stationery*. You can compile a list of troublesome homonyms and feed it into MARKFIX, which will then mark them in your document for closer review with your text editor

Word Counting

No computerized writing system is complete without a program to count words. I use my word-counting program every time I write. I originally wrote the program for my wife, who is extremely concerned about the length of the chapters in her novels. She also uses the counting program to pace herself by setting daily word goals and writing to meet them.

A word loses its force if you use it too often. I have the habit of using the word *simply* far more than I should. I know this because of a program I wrote called WORDFREQ. It prints a list for me of all the words I used in a particular document and shows me how often I used each word. Thus, I can use this program to help reduce the problem of overused words.

Catching Typos at the Source

Spelling checkers are great for catching typos and spelling errors. If used faithfully, these programs can help you produce virtually error-free text. Using a checker does take an extra minute or two. For short documents, such as one-paragraph letters, there is a temptation to save time and skip the spelling check altogether. Rather than try to change everyone's habits, I decided to implement a simple way to catch spelling errors as words are typed in. This program catches a lot of typos without doing a separate check. I based the technique on the trigram and digram analysis mentioned previously.

A lookup table for letter trigrams takes up only slightly over 2700 bytes. I wrote a very simple on-line checker that monitors letters typed on the keyboard, looks up trigrams, and beeps the console bell whenever an illegal combination is entered. This technique will fail to catch many misspelled words, but it will catch many common typos and also alert typists whenever they slip on the keyboard. TYPO is designed to link into a CP/M system in such a way as to be invisible to the resident text editor or word-processing software.

Punctuation Checking

There are several common writing problems that a computer can check for, such as doubled words, unbalanced quotes and parentheses, and inconsistent capitalization. I built a program called CLEANUP to indicate when these errors occur. CLEANUP is similar to MARKFIX because it indicates trouble spots in your file by placing a marking character at the site of the problem. In future revisions of CLEANUP, I want it to detect proper use of commas before conjunctions.

Words at Play

Writing the spelling checker was

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tedious at times. To distract myself, I wrote several programs that use the spelling checker's dictionary in unusual ways.

The first such program is called FIND. FIND lets you search the dictionary for words that match what I call word patterns. For example, if you want to find a five-letter word that starts with *s* and ends in *ed*, you would give FIND the pattern "S??ED". Later I extended the program to allow the asterisk character to cause a match of one or more letters. With this feature you can give FIND a pattern that can locate rhyming words. An example is "*ING", which will print all words ending in *ing*.

FIND was so much fun that I decided to write more programs to use the dictionary. LOOKUP helps creative spellers look up the correct spelling for words they can *almost* spell. Inspired by several "misspellers' dictionaries," in which words are looked up by their most common misspellings, I designed LOOKUP to find words in the dictionary that are *close* in spelling to the word entered. People tend to misspell words according to four "rules." They get one letter wrong, leave out a needed letter, add a letter they don't need, or reverse two letters. Applying these rules in reverse, LOOKUP can usually locate the correct spelling of commonly misspelled words. LOOKUP proved so useful that I added it to the word-review part of the spelling checker to assist in correcting misspelled words.

More recently, I added a new program to the collection that can solve *anagrams* (sometimes called word jumbles). An anagram is a word that is made from exactly the same letters as some other word. For example, *star*, *arts*, and *rats* are all anagrams of one another. The program also makes sensible words out of jumbles of letters and can be used to solve cartoon puzzles that you can find in many newspapers.

Making Your Writing Easier to Read

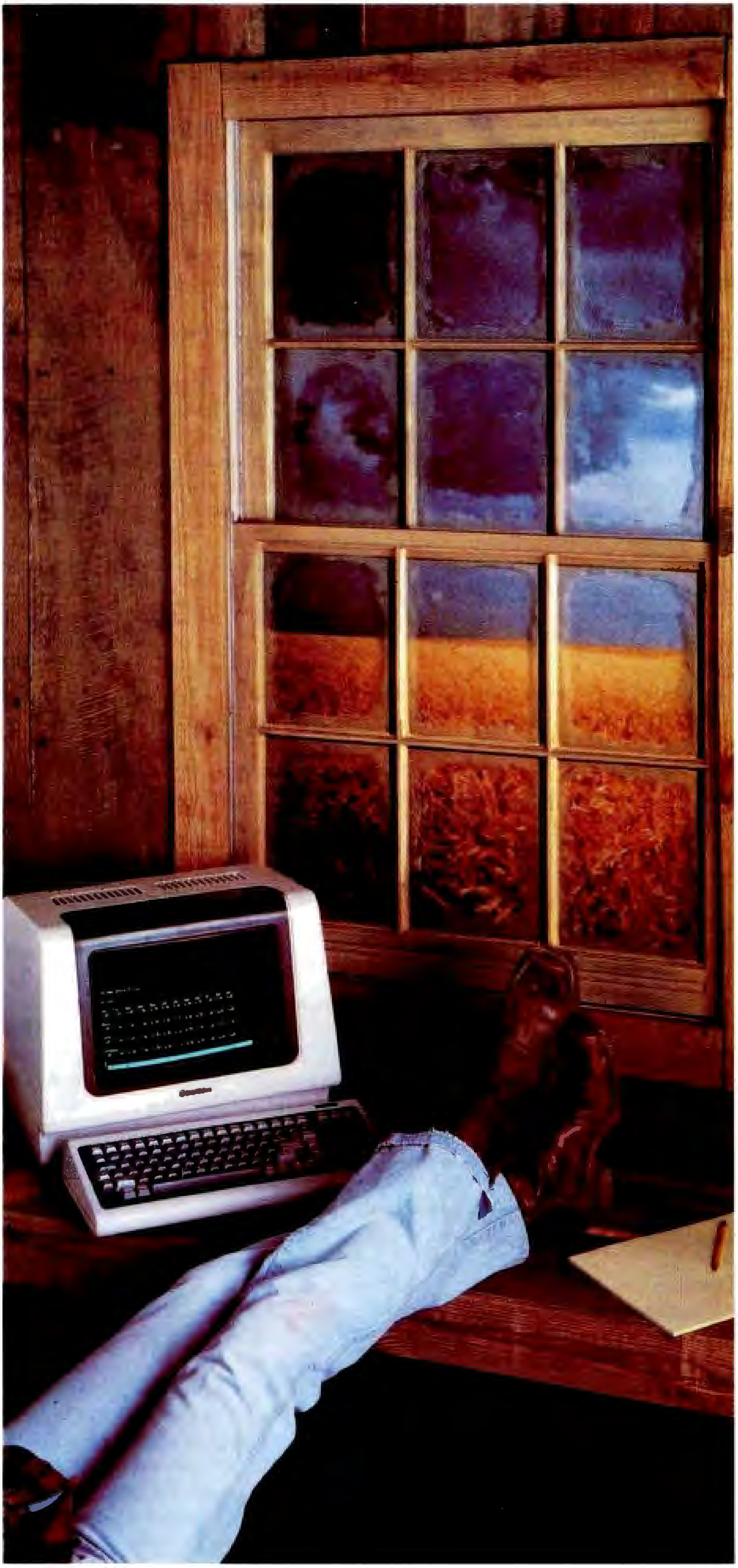
If you want to write something that reads easily, there are several guidelines you should follow. Don't use big words, and don't write long rambling sentences. If you write user's manuals or instructions for repairs, these rules become even more crucial. After all, you're writing to be understood, not to impress someone with your vocabulary.

"Readability formulas" are useful ways to check up on just how easy your writing is to read. To calculate a "readability index," you need to select several samples of text from your document. Then count the length of the sentences, number of syllables, etc., and plug these values into a formula.

Most readability formulas will yield a value that is supposed to show what grade level of education a person would need to understand your writing. However, there are a few pitfalls in getting meaningful results from these formulas. Most of the formulas work best on certain kinds of writing. For example, many produce scores that discourage the use of words with many syllables. The idea is to reduce the number of words that might not be understood by the reader. In most technical writing, however, there are many long words that are commonly used and easily understood.

A second problem is the temptation to take the results of the analysis too literally. Because the formulas try to encourage short words and short sentences, you can easily fool them by arbitrarily chopping sentences and blindly substituting short words for long ones. Obviously, this will result in good readability scores but meaningless writing.

Despite these limitations, a program to read text and compute readability scores can be useful. My program ANALYZE will read a text file as input and print a variety of statistics such as average sentence length, length of longest and shortest sentences, total number of sentences in file, average syllables per word, etc. In addition, the program calculates and prints readability indexes using several formulas. If you are interested in more information



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about specific readability formulas, I suggest you see references 3, 4, and 5.

Counting the Words in a Sentence

Calculating a readability score requires first that you know the number of sentences and syllables in your text. At first glance, writing a program to count the number of words in a sentence seems easy. Just start counting words until you find a period, question mark, or exclamation point. However, what about the other uses for a period? Consider what to do about abbreviations like Mr., Mrs., or Ms. What about sentences like the preceding one that end in an abbreviation? Looking to see if the next word is capitalized can sometimes help but not always: for instance, "I know a man named Mr. Smith." Also, any analysis should exclude pieces of text that are not part of a sentence (such as a section heading).

I wanted to understand and conquer this problem because I knew it would pop up in any type of text analysis. I didn't find a perfect solution, but the one I use works satisfactorily. It's based upon work done for The Writer's Workbench (see reference 1). Words that are followed by a period are checked against a small dictionary containing common abbreviations. When an abbreviation is found, the next word is checked for capitalization. If the first letter is lowercase, the program ignores the period. Otherwise, the word is checked against a list of function words (i.e., the, when, etc.). If the word is not found in the list, the program ignores the period. Periods embedded within digits (i.e., $200.00) are ignored, as are isolated periods and the extra periods in ellipses.

Counting Syllables

I tried several methods other people had developed for counting syllables and wasn't completely satisfied with any of them. The best was suggested by Richard Parry in an article "Minding Your P's and Q's" (see reference 9), which is about writing a readability analyzer in BASIC. Using Parry's technique, the program first isolates words from the text, then counts the number of vowels (plus the pseudovowel *y*) that are separated by a consonant. It also counts double vowels, as in *read*, only once and ignores the trailing *e* in words such as *since*, *force*, and *nice*. I extended Mr. Parry's work by counting the *e* in words that end in *le* if the letter before the *l* is not a vowel. This catches the ending syllable in words such as *sample* and *babble* but does not count an ending syllable in *agile* or *console*.

Analyzing Writing Styles

OK! You spell perfectly, even Strunk and White couldn't improve your punctuation, and the readability analyzer says you're writing at just the right level. But people still say your writing puts them to sleep. What's wrong? Can your computer help?

Revising Prose (see reference 8) is a remarkable book about how to restore body and substance to limp, lifeless writing. Written by Richard A. Lanham, it presents a relatively simple way of identifying what's wrong and how to fix it. In addition, most of Lanham's techniques fit easily into computerized analysis.

Lanham's book rebels against what he labels "The Official Style." If you've ever read documents produced by bureaucrats, you'll probably recognize the problem. In modern government, no one wants to take responsibility for anything. This results in a peculiar style of writing that has become so popular that many people don't recognize it for what it is—evasive double-talk. Worse yet, many people have adopted it as the way in which documents *must* be written.

Bureaucrats don't write, "We must fix this problem." They write, "It has been determined that effective utilization of our resources will require allocation of manpower to the target problem area." This bloated style of writing stems from overuse of passive verbs and prepositional phrases.

With sentences written in the passive voice, you can't tell who is doing what to whom. Instead of saying, "I did this," you say, "It was done." In scientific and technical writing, many people believe that writing in the pas-

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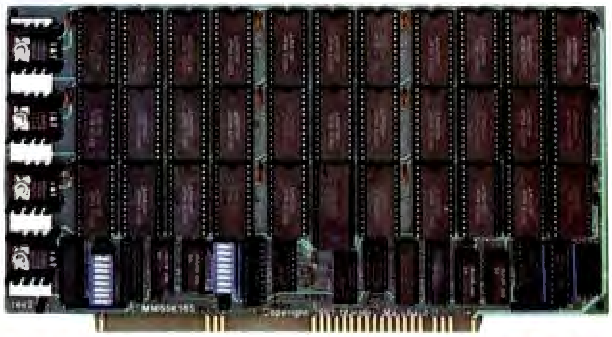

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sive voice makes the writing sound more objective. I think the passive voice makes writing harder to read and boring.

Prepositional phrases are important, but using them too much fills up sentences with nouns and squeezes out the action. People like to read something with punch—not, "After discussing many options for controlling the situation in the event that there is a lack of suitable alternatives to the primary plan of action, it was decided to study the issue further in order to facilitate rapid response to future requirements."

Lanham's book has many useful "prescriptions" to help improve writing style. He suggests circling passive verbs and prepositions in the section to be revised. This shows you where the problem is. Then with the marked copy you can apply Lanham's techniques and rewrite your prose into something clearer and easier to read.

REVISE is a program I'm currently working on that will mark such sentences for you. In addition, REVISE will mark occurrences of the same word used too closely together in a document. This will show you where you might substitute a synonym in order to achieve variation. Of course, you still have to revise the sentences yourself, but the principles outlined in Lanham's book should be easier to apply with REVISE to help you.

The Future

I believe that the future will reveal new ways in which computers can help people to write and communicate better. I haven't had time in this article to discuss even a significant fraction of the possibilities. What should you watch for? Well, reading some of the articles mentioned in the bibliography should give you an idea of what other people are working on. My own ideas extend to such concepts as computerized "ghost writer" programs, which can take an outline for a piece of fiction, for example, and write a novel from it. (See Kevin McKean's article "Computers, Fiction and Poetry," page 50 in this issue.) Perhaps a form of fiction might come into vogue in which programmed "books" would tell a different story each time you read them. The only limit on the imaginative use of computers in writing is the imagination of the programmer. Who knows?■

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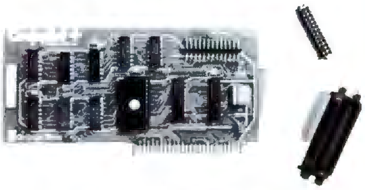

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The computer with its ability to manipulate and analyze data at a phenomenal speed has been responsible for significant changes in historical research methods and the teaching of history. The emergence of the microcomputer is but the latest and an important step in the interaction between hardware and history.

To understand what a historian would use a computer for, you only have to realize that since the rise of modern states in the seventeenth century, vast amounts of information about economic, social, and political behavior have been stored in numerical form: numbers of people; amounts of money; casualties from war, famine, and disease; votes for or against almost anything; grain tonnage; tax records; and so on.

No competent student of social change can afford to ignore this quantitative information because it provides so much of the background within which the lives of historical figures have been framed. Everybody knows something about, say, Napoleon or Thomas Jefferson. But to learn more than just a little, you must come to terms with the economic, demographic, and sociological conditions of their times. This is what quantitative history is about.

Quantitative history involves professionals such as political scientists, economists, and sociologists, as well as historians. Although the Quantitative Research Committee of the American Historical Association was one of the early efforts to stimulate and guide interest in this work, subsequent initiatives have gone beyond the historical profession. These include the *Journal of Interdisciplinary History*, edited by scholars at the Massachusetts Institute of Technology (MIT) and Princeton, the computerized Historical Data Archive at the University of Michigan's Center for Political Studies, and the Social Science History Association, with headquarters at Southern Illinois University. Clearly, the use of computers in research and teaching has affected many disciplines.

The Hardware Shift, 1960–1980

In the late fifties, computer systems at universities were comparatively small and difficult to use. For these reasons they could also be described as elitist. Access was limited to a tiny minority of the campus population—engineers and scientists who needed the computer's arithmetic skills. The social scientists who used these machines were few and far between, and the days of sophisticated data-management and statistical-analysis packages that have become so important to us were still in the future. But the large computer installations that began to make their appearance in the sixties changed all of that. The size of machines such as IBM's 7090 or Control Data's 6600 together with their comparatively fast processing times resulted in both a centralization of computing and a substantial increase in the number of users. Because the machines were very expensive to acquire and to maintain, even large universities could not contemplate supporting more than one of them. Management of the big, new machines required considerable technical skill and a sizable bureaucracy to serve efficiently the increasingly diverse body of users.

The huge, multimillion-dollar installations of the sixties and early seventies were largely responsible for producing the first generation of computer scientists. Moreover, large-scale instruction in computer programming became common. Computer literacy became one of the common campus buzzwords. All this resulted in more people clamoring for time on the machines. Historians were often at the bottom of the priority list. In the end, each computer user found himself in a very long line where the most relevant question was always, "What's turnaround like today?"

The new state of affairs, however,

About the Author

Don Karl Rowney is professor of Russian and Soviet history at Bowling Green State University where he also teaches quantitative methods in history. Rowney is currently Chairman of the American Historical Association's Committee on Quantitative Research in History, and is first vice-president of the International Committee on Soviet and East European Studies.

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did have some benefits. Big, fast, and comparatively cheap computing made low-priority work (such as historical research) possible on a large scale. It certainly seems fair to say that many historical projects and collections of data used for historical research would simply not have been possible without the million-dollar computers that made individual jobs relatively inexpensive.

Moreover, as prices in the computer industry began to drop in the seventies, software (such as the Statistical Package for the Social Sciences) and hardware (such as teleprinters and video-display terminals) became more readily available. These by-products of economies of scale often made the research process incomparably easier.

Source of a New Shift

Eventually some universities began to acquire microcomputers to take over some of the load previously carried by terminals that were connected to mainframes. This precipitated the shift away from crowded computer centers to personal computing. At the same time, microcomputers moved out of the hobbyists' domain and into the office.

Microcomputers are much more easily obtained by small institutions and individuals than big computers, and they need not present the same magnitude of technical and organizational problems usually associated with large mainframe installations. I see both positive and negative consequences of this changed state of affairs.

The advent of the microcomputer means that scholars who previously would not have used computers will now do so. I've used a microcomputer for less than a year, and I find that it has become indispensable for applications that had never even occurred to me before. For example, I now take research notes on the computer (using Software Publishing Corporation's Personal Filing System). Bibliographic materials, essential for my work as a professional historian, are easily stored on the computer and are more easily retrieved by subject, author, title, and date or place of publication than through any card-file system. I maintain a subject- and source-ordered current events file that is based on several news sources and that has become an essential support database for consulting work I do.

Even more important, my word processor has transformed for me the process of turning ideas and research materials into text. Even though I have free access to excellent secretarial help, I prefer to use the word processor. Essentially, it's a more efficient way of producing manuscripts.

Special Headaches

The experience of having a computer dedicated to your own research problem was common in the early days of computing because of the nature of machines like the IBM 1620 (the first computer I used). In the case of these early machines time was reserved in advance because it was frequently necessary to alter the computer by inserting the appropriate circuit boards. When the computer was actually being used, it was completely dedicated to the user who had reserved it. Very importantly, turnaround was immediate because all peripheral devices were located in the same room as the computer and were, like the computer, dedicated to the user. Thus, one knew at once whether a run was successful: the gratification of success was just as immediate as the frustration of failure. This, of course, was an experience largely unknown to those who had experience only with the batch processers of the sixties and seventies. Even remote terminals, although they are designed to give the impression of exclusive access, are often handicapped by delayed response time and by the location of peripherals such as printers and data-storage devices in other places. With the coming of microcomputers, it is clear that the experience of using a dedicated computer is becoming common again. Nevertheless, user experiences with the "dedicated" 1620 and today's microcomputers are far from identical.

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accompanying bureaucratization generally weren't responsible for basic decisions concerning both hardware and software. People familiar with computers decided what equipment and programs were needed. The purchaser of a microcomputer, however, is often obliged to make decisions about software and hardware purchases himself, regardless of his technical knowledge.

Difficulties are compounded by the very advantages that we associate with microcomputers. Just as computing itself has been decentralized by microcomputers, so information about them—about what they can do, how they do it, and how much it will cost—is now vastly decentralized. There seems to be no one place to go for information that will help you make an intelligent decision about what to buy to fit your specific needs. Inevitably, decisions that sometimes involve thousands of dollars are made in a relative information vacuum.

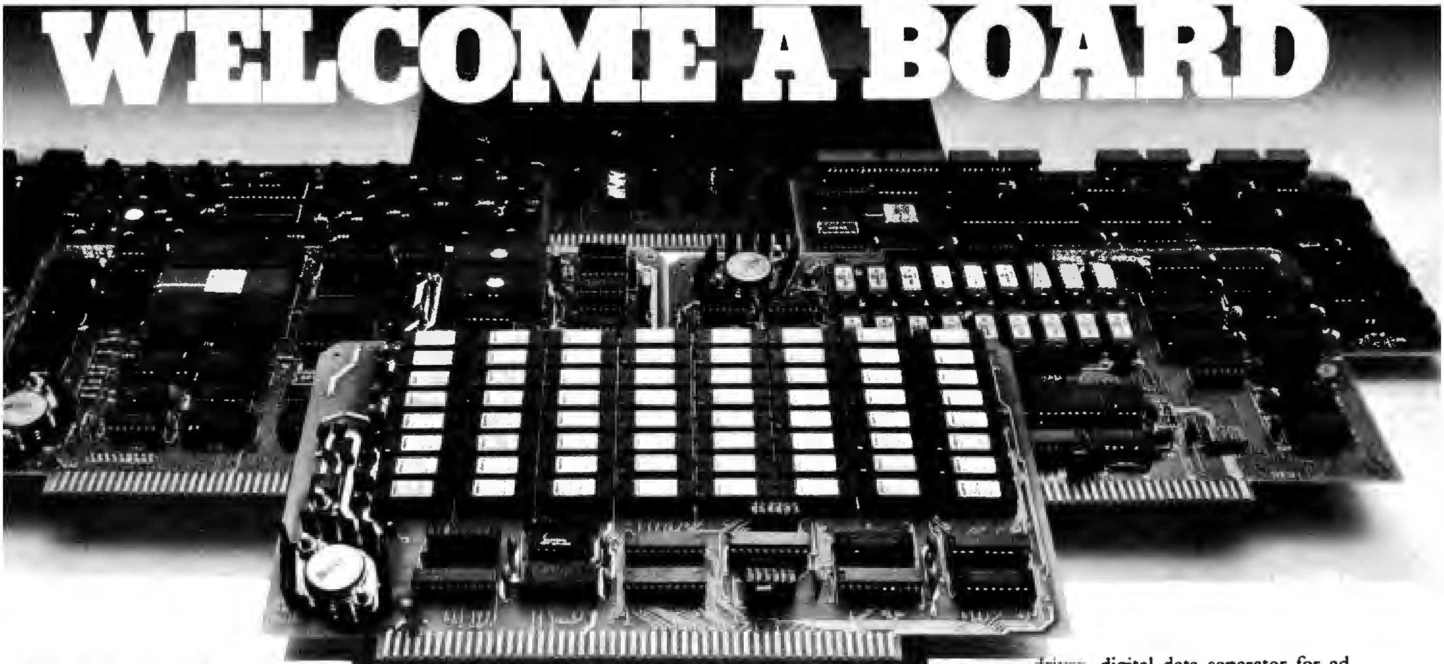
For instance, a social scientist who wants to know where to get a package of statistical programs that will suit his needs may find himself engaged in a major research project just to uncover this information. Computer stores—at least in my experience—are of very little help with problems like these because their biggest markets, even in large university towns, are small businesses and home users.

Moreover, many of the established resources for solving computing problems are not helpful with microcomputers. For example, since the early seventies, a standard tool for solving statistical analysis and data-management problems has been the Statistical Package for the Social Sciences (SPSS).

At this writing, any scholar who has hungered for an SPSS for microcomputers is fated to disappointment. SPSSG, the "miniversion" of SPSS, is designed to run on systems with fewer than 128,000 bytes of main core storage. Some microcomputers such as the new IBM Personal Computer and the Apple III are designed to operate at these levels and above. (At least two RAM [random-access read/write memory] cards that will boost the Apple II into the 192K-byte range have been announced recently.) Nevertheless, there does not yet exist a microcomputer-oriented SPSS package. According to a representative of SPSS Inc., plans for a package suited to the IBM Personal Computer are in the works, but it's unlikely that anything concrete will emerge before 1983.

In fact, interest in developing software resources for microcomputers and in disseminating information about these developments appears to be quite casual among members of the social science research and education community. For example, I contacted Science Research Associates, the IBM subsidiary, to inquire about its plans for development of programmed instruction packages in history, the social sciences, or statistics. I was told that there was little done as yet by way of concrete planning and that if I wanted to send them ideas or, better yet, finished programs, they would be given careful consideration!

Apart from direct research applications such as statistical analysis and data management, one of the crying needs at the moment is for imaginative and effective simulation and programmed instruction in history. The possibilities are obvious and virtually endless. If we can replay the major naval engagements of World War II (with Avalon Hill's Midway Campaign, for example), we should certainly be able to replay the major nineteenth-century presidential elections. Anyone who has the programming skills to create one of the many imaginative games around can surely recreate the interaction of the components essential to the origin of World War I. And if it's a question either of specific subjects or of the relevant and necessary information to be included, I am quite prepared to make well-documented recommendations just as other historians would be. Developments in these areas and information about new developments are remarkably scarce.



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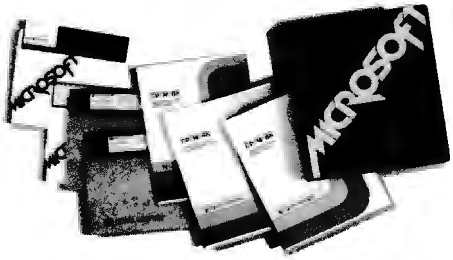

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Hope in Ann Arbor

This is not to say that progress is nonexistent. Although it is slow in appearing, some help does seem to be at hand. One oasis of rationality in the creative chaos of microcomputers is in the Institute for Social Research at the University of Michigan. Under the auspices of Gregory A. Marks of the Inter-university Consortium for Political and Social Research a union of hardware and software is actually taking place. For example, many Zenith Z-89s complete with disk drives are wired to two Prime minicomputers and to the university's Amdahl mainframe. The combination, as Marks puts it, aims to give the user the number-crunching power of big machines under the friendly facade of microcomputers.

An industry. . .that aims to make its product the bicycle of the information world clearly needs to give software development a higher priority.

At the same time, Marks and his colleagues are making efforts to take the mystery out of using microcomputers in the social sciences. Their efforts include preparing introductory literature on microcomputers and their uses for distribution to members of the Inter-university Consortium. As well, they hold seminars designed to introduce the uninitiated to microcomputing (open, for a fee, to outsiders). As part of this effort, they're developing a combination statistical package/training program. The idea is to produce a program that would run on a microcomputer and that would help students grasp the uses of both statistics and computers in social research by letting them work with real historical, social, and political data.

Other hopeful signs are evident in the trade magazines. Statistical and data-management packages, such as those available from Blue Lakes Computer or Ecosoft, seem promising. Strategic Simulations offers a simulation of presidential elections that appears to include some historical data and that aims to put the player in the place of a campaign strategist.

Before committing limited resources to any of these products, you will want to know whether they fit your needs; a visit to a computer store often provides only the most limited information—even if the product happens to be in stock. Product reviews in trade magazines are useful, of course, but they may be difficult to find and are often superficial. Catalogs that contain lists of products with discussions of their virtues are also helpful.

At present, making decisions about software for microcomputers is a lot like trying to direct-dial long distance in total darkness: it requires great care and experience. Learning can be frustrating, and mistakes will inevitably be costly.

A Call for Changes

I have some specific suggestions for changes that would make life easier for scholars like me who use microcomputers.

The computer revolution, sociologically speaking, is an information revolution. It should not be surprising, then, that information management has become the most central problem for computer users. The kind of information problems I have in mind here, however, concern software and hardware products that are available to solve certain problems.

Up-to-date, reliable information about available products is badly needed. The market, consisting of researchers and teachers, is an intelligent one and it generally knows what it wants. High-pressure salesmanship and elaborate packaging are, therefore, likely to be counterproductive.

One of the most imaginative marketing techniques I have seen is Context Management Systems' offer to send prospective customers a disk that demonstrates its "Context Connection." I would like to see this approach used widely.

I propose that manufacturers retain a computer network, such as the

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DISK STORAGE: Two double density 5¼" floppy disk drives with 195K bytes each
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VIDEO DISPLAY: Green phospher P31 9" display, 80 columns x 24 rows with scrolling capability
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The alpha-numeric keyboard of the *KAYCOMP II* is truely a beauty. The keys have all been sculptured for your handling convenience. NLS provides a 14 key numeric pad with its own RETURN key for more efficient numeric data entry. Cursor control keys have also been added for calculating wide-word processing or numeric spreads. You will never want to use another keyboard again. For added flexibility and comfort, the keyboard is detachable so it may be positioned away from the body of the machine.

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As an extra value to you, there is a **FREE** package of software to help you get started. By using a CP/M® controller, the *KAYCOMP II* allows you access to hundreds of applications or user programs already available at a moderate price. This free software package includes the CP/M® operating system, Topaz Programming's S/BASIC language, PROFIT PLAN™ electronic spreadsheet, and SELECT™ word processing software. S/BASIC™ will allow you to talk to your computer and even try your hand at programming. PROFIT PLAN™ will help you analyze data, plan your personal investments, and simplify your family budget. SELECT™ is a word processing program that turns your computer into an electronic typewriter. It also has an optional spelling checker, no more typos!

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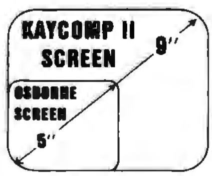

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BANDWIDTH	60 MHz/50 MHz ‡	100 MHz	50 MHz	35 MHz
SENSITIVITY	20 mV/DIV-5mV/DIV ‡	5mV/DIV	1mV/DIV	5mV/DIV
SWEEP SPEED SELECTION	50 ns/DIV to .5 s/DIV x 10 pull	20 ns/DIV to .5 s/DIV x 10 pull	50 ns/DIV to .5 s/DIV x 10 pull	.2 µ s/DIV to .2 s/DIV x 10 pull
VERTICAL MODES	CH 1, CH 2, ALT CHOP, ADD	CH 1, CH 2, ALT CHOP, ADD TRIG A VIEW TRIG B VIEW	CH 1, CH 2, ALT CHOP, ADD TRIG A VIEW	CH 1, CH 2 DUAL, ADD DIFF
WIDE RANGE VERT. SENSITIVITY	2 mV to 100 V /DIV*	500 µ V to 50V /DIV†	1 mV to 50 V /DIV†	1 mV to 50 V /DIV†
DELATED OR INTENSIFIED SWEEP	YES	YES	YES	NO
DELAY TIMES	.5 µ s to 4 ms	10 ns to 5 s/DIV	25 ns to 5 s/DIV	FIXED
DUAL TIME BASE MEASUREMENTS	A, B, ALT w/B INTENSIFIED	A, B, ALT w/B INTENSIFIED B INTENSIFIED	A, B, ALT w/B INTENSIFIED	———
TRIGGER "A" MODES	AUTOMATIC TV FIELD VERT MODE LINE EXTERNAL	AUTOMATIC TV VERTICAL TV HORIZONTAL LINE EXTERNAL SINGLE SWEEP	AUTOMATIC TV VERTICAL TV HORIZONTAL LINE EXTERNAL SINGLE SWEEP	AUTOMATIC TV (+, -) LINE EXTERNAL
TRIGGER "B" MODES	+, - SLOPE INTERNAL ONLY	+, - SLOPE INTERNAL EXTERNAL	+, - SLOPE INTERNAL EXTERNAL	———
ALTERNATE SWEEP SEPARATOR	YES	YES	NO	———

*USING X10 PROBE
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‡We had to obtain this specification by phone from Tektronics because it was not listed in the literature

SPEC	TEK 2215	HITV1050B	HITV550B	HITV352
CRT	8 x 10 DIV INT. GRATICULE P31 PHOSPHOR 10KV ACCEL V	8 x 10 DIV INT. GRATICULE P31 PHOSPHOR 20KV ACCEL V	8 x 10 DIV INT. GRATICULE P31 PHOSPHOR 10KV ACCEL V	8 x 10 DIV INT. GRATICULE P31 PHOSPHOR 5.2KV ACCEL V
CRT CONTROLS	BRIGHTNESS, AUTO FOCUS BEAM FINDER TRACE ROTATION	BRIGHTNESS AUTO FOCUS BEAM FINDER TRACE ROTATION	BRIGHTNESS AUTO FOCUS TRACE ROTATION	BRIGHTNESS FOCUS TRACE ROTATION
SCALE ILLUMINATION	NONE	YES	YES	YES
CHANNEL 2 INVERT	YES	YES	YES	NO
TRIGGER VIEW	NONE	A, B	A	NONE
HF REJECTION	NONE	SWITCHABLE YES	SWITCHABLE YES	NONE
LF REJECTION	NONE	SWITCHABLE YES	SWITCHABLE YES	NONE
BAND WIDTH LIMIT	NONE	YES 20 MHz	NONE	NONE
X - Y MEASUREMENTS	YES	YES	YES	YES
CAMERA BEZEL	YES	YES	YES	NO
MULTI POSITION HANDLE	YES	YES	YES	YES
JITTER	10,000:1	20,000:1	20,000:1	———
Z AXIS BANDWIDTH 0 - 5 Vpp	DC to 5 MHz	DC to 3.5 MHz	DC to 3.5 MHz	DC to 2 MHz
POWER CONSUMPTION	90 WATTS	60 WATTS	45 WATTS	45 WATTS
PROBE CALIBRATOR	YES	YES	YES	YES
MTBF	NOT GIVEN	20,000 HRS TARGET VALUE	20,000 HRS TARGET VALUE	20,000 HRS TARGET VALUE
A, B CHANNEL GATE OUTPUT	NO	YES	NO	NO
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Tymnet or Telenet systems, to archive their advertisements in the Dialog Information Retrieval Service (see "Information Unlimited" June 1981 BYTE, page 88). New products could be described and demonstrated through this medium. The system could be updated constantly, and potential consumers could search for only those items they want.

Pricing and Distribution

Producers of software need to rethink their pricing policies. Universities and local school boards don't have the resources to buy a complete set of software for each microcomputer. Even if the resources were there, multiple purchases of the same software would be regarded as wasteful. Manufacturers' insistence on single-machine use of a program is simply unrealistic and would seem to invite illegal copying of materials. Given the speed with which materials of this sort become obsolete, a general lease agreement with each institution would be more likely to produce desirable results.

In any case, software manufacturers will probably come to the same realization that book and computer manufacturers reached long ago: universities and schools require special marketing techniques and probably special marketing divisions.

Statistical Packages

One of the most serious needs at the moment is for reliable, well-documented statistical and data-management packages similar to those that social scientists and historians have been using on large computers. Obviously, the requirements for computer memory and rapid processing place certain limits on what can be achieved on microcomputers at the moment. But, as I suggested earlier, some of these limitations are disappearing. Plug-in memory—lots of it—is beginning to make its appearance among microcomputers. As this happens, the adaptability of microcomputers to scholarly work will grow. For 20 years the absence of adequate software has made using computers difficult if not frustrating. In the case of microcomputers, history is clearly repeating itself. An industry that aims—as Steve Jobs of Apple Computer put it—to make its product the bicycle of the information world clearly needs to give software a higher priority.

I am not a trained programmer in any computer language and I have no plans to study such a language. Having already studied Russian, French, German, Latin, Hebrew, and Greek, I think enough is enough! This means that I need the services of good programmers just as badly as I need the products of computer engineers. I believe I'm speaking here for thousands of other scholars and scientists.

Revolutions, if they are to survive, have to be institutionalized. It is the social experience—the use that society makes of the revolution—that provides the crucial clues as to the appropriate institutional forms. Speaking as a historian, I can say that society learns most of what it knows through experience. Development of mechanisms for storing and communicating past experience is absolutely essential to social progress. This is one of the reasons that societies tend to attach some value to the work that historians do.

Ironically, one of the great problems with the computer revolution, a revolution of information, is that it has tended to pay little attention to its accumulating experiences. The impact of hardware changes on research behavior, for example, is appreciated very little in any systematic sense. It should not be surprising, then, that we don't have a very sound understanding of what to expect in the face of fresh changes in technology or that there is a lag in the development of some of the resources that are necessary to exploit these changes.

The effort that is represented by this issue of BYTE is an illustration of what needs to be done on a continuing basis. What these observations mean so far as the microcomputer revolution is concerned is that the users' experience has to be discovered, analyzed, and then incorporated into any realistic notion of what the next step in the revolution will be. In this sense, it's time to stop playing games.■

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The speech routines can be called from other programs for any purpose you can conceive. Here are a few suggested uses:

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- Access 64 phonemes at any of 4 pitch levels to add filtered, contoured sound to the Atari audio repertoire.

GAMES
- Program aliens to hiss threats, moan when destroyed.
- Devise weird, non-human tongues for dungeon dwellers.
- Insert cryptic spoken clues in maze games.

COMPUTER OPERATION
- Code verbal prompts and error messages that command attention and leave the current display intact.

EDUCATION
- Gain an introduction to the principles of phonetics.
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Simulating Neighborhood Segregation

A BASIC program gives surprising insights into some of the forces that hamper integration.

Professor Edwin Dethlefsen
Department of Anthropology
and
Associate Professor Carlisle Moody
Department of Economics
College of William and Mary
Williamsburg, VA 23185

Computers have never enjoyed a good name among some educators. Resisters have claimed that the absence of a teacher's warm body will have adverse psychological effects on the students. Some say, out of fear and ignorance perhaps, that young children exposed to computers early in their school years would turn into hard, cold, and uncompassionate adults.

Nowadays, though, for better or worse, there is at least one microcomputer in almost every neighborhood, and the children are learning faster than their teachers that despite past fears computers are here to stay. Consequently, teachers either are adopting more positive views of computers or they are being replaced by teachers eager to use the most modern devices and techniques.

The computer has shown many of us new ways of thinking about practically everything. Going farther than merely showing us new approaches to problem solving, the computer is exposing us to a whole new spectrum of notions and methods of problem definition and problem evaluation. We no longer have a valid excuse for jumping to conclusions, for we can now test assumptions by manipulating within a relatively short time mountains of data that once would have taken lifetimes to process.

We hope that the computer's special ability to foster careful thinking will be put to many more applications, especially in the social sciences. The natural sciences enjoy a particular advantage over the social sciences in their long tradition of laboratory experimentation. While social science teachers must expound social theories, physics teachers can provide concrete illustrative demonstrations and have their students deliberately experiment with and test the principles that are considered important.

Although people are not as easy to manipulate as pulleys, temperatures, and pressures, social scientists presume to employ the same scientific methods so handy to "hard" scientists. The absence of a "social science laboratory" and the general impossibility of performing controlled social experiments, however, frequently allow and even encourage impressionistic explanations based on the most unscientific of social science analyses. Popular social values and conventions often seriously distort and bias social scientists' approach to research. Let's look at an example, and then consider how the computer might be used to simulate a social science laboratory.

Why a Model?

If one were to ask a group of students why the neighborhoods of most multiracial communities are generally more segregated than integrated, the students would probably say that the segregation was due

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to prejudice, racism, or the like. Their explanations might come from selected personal experiences or they might simply be restatements of what the students have been told. In fact, there is little hard scientific evidence on which to decide whether "prejudice" is actually a cause or a consequence of segregation.

If we had a "human laboratory," we might test this hypothetical question by creating a racially random neighborhood, populating it with people who were known to be "without prejudice," and observing whether or not in fact the neighborhood remained stable in the integrated state, recording whatever changes were observed. This experiment would certainly cast light on the process of neighborhood development, but it would obviously be so difficult to control and so expensive that it could never be performed. Furthermore, the experimenters would all die of old age before the study had processed more than a couple of generations of residents.

Until the computer era we would have been out of luck, but now we have an alternative that is in some ways better than the real thing. We can now simulate whatever variables we wish, create a situation, set the controls, and let the computer simulate the process quickly and without extraneous variables. The unique contribution of microcomputers to this process is that now this kind of computer simulation is available to almost everyone. You no longer have to have access to an expensive computer; every microcomputer is a potential social science laboratory.

Simulation Guidelines

The program presented here, based on the work of Thomas Schelling, is designed primarily for the student user-operator. In it we allow simulation of neighborhood formation using two identifiable types of individuals (or ethnic groups) represented by graphic images on the screen and referred to in the text as Xs and Os, whose attitudes toward their neighbors are under the experimenter's control.

We have had several surprises in the process of developing this simulation, and they've generated so much discussion between us that we see it as a potentially valuable learning tool, especially because at every stage we are provided with a map of the ethnic distribution of our hypothetical community. We feel that the element of surprise stimulates learning.

In our simulation, for example, we can begin with two types of persons who don't necessarily dislike each other. In fact, they may both prefer to live in an integrated neighborhood, but let's suppose that each would prefer not to be in the minority with respect to his immediate neighbors. This differentiation does not have to be ethnic or racial. One person's preference for classical music to the other's preference for rock (which is not to say that one actually dislikes the preferred music of the other) is an example of a nonethnic distinction. It's not that you can't stand the other's music, it's just nice to have a few neighbors of like taste to trade tapes with.

Let's assume, for the sake of our experiment, that each household regards only the four households on its north, south, east, and west as its immediate neighbors. If we begin with a randomly arranged neighborhood composed of equal numbers of Xs and Os, let's also begin with the supposition that every household abutted by *more than* two neighbors of the alternative type will eventually want to move to a more compatible neighborhood. The possibilities outside our experimental neighborhood are infinite, of course, so the households that move away simply vanish into the outside world. When the first such outnumbered household moves out, the space vacated can be filled only by a household of the alternative type. But when the latter moves in, it may upset the balance of another neighbor that in turn will move out, leaving yet another space to be filled only by a member of the other group.

The succession of moves results in a ripple effect that eventually makes itself felt over a large part of the neighborhood. Because each family

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moving out is replaced by a family of the alternative preference, the community must gradually become more segregated. Thus a high degree of segregation can develop in our random community, even though neither group feels any particular aversion to the other, except for a discomfort at being in the minority.

As Schelling has pointed out (*Micromotives and Macrobehavior*, New York: W.W. Norton & Co., 1979, pp. 147-155) this process can be demonstrated by placing pennies and dimes on a checkerboard, or through the use of a high-speed computer. However, the checkboard technique is painfully tedious and the results are crude and oversimplified, and the use of the big computer is not instructive because it doesn't give the student a hands-on experience. Our microcomputer simulation tries to combine the best of both approaches in that it allows the student to control an experiment involving 384 households and view the process in a more vivid and dramatic form on the screen. Further, the video output from the computer can be displayed so that many students can see the results as they occur.

Analysis of the Program

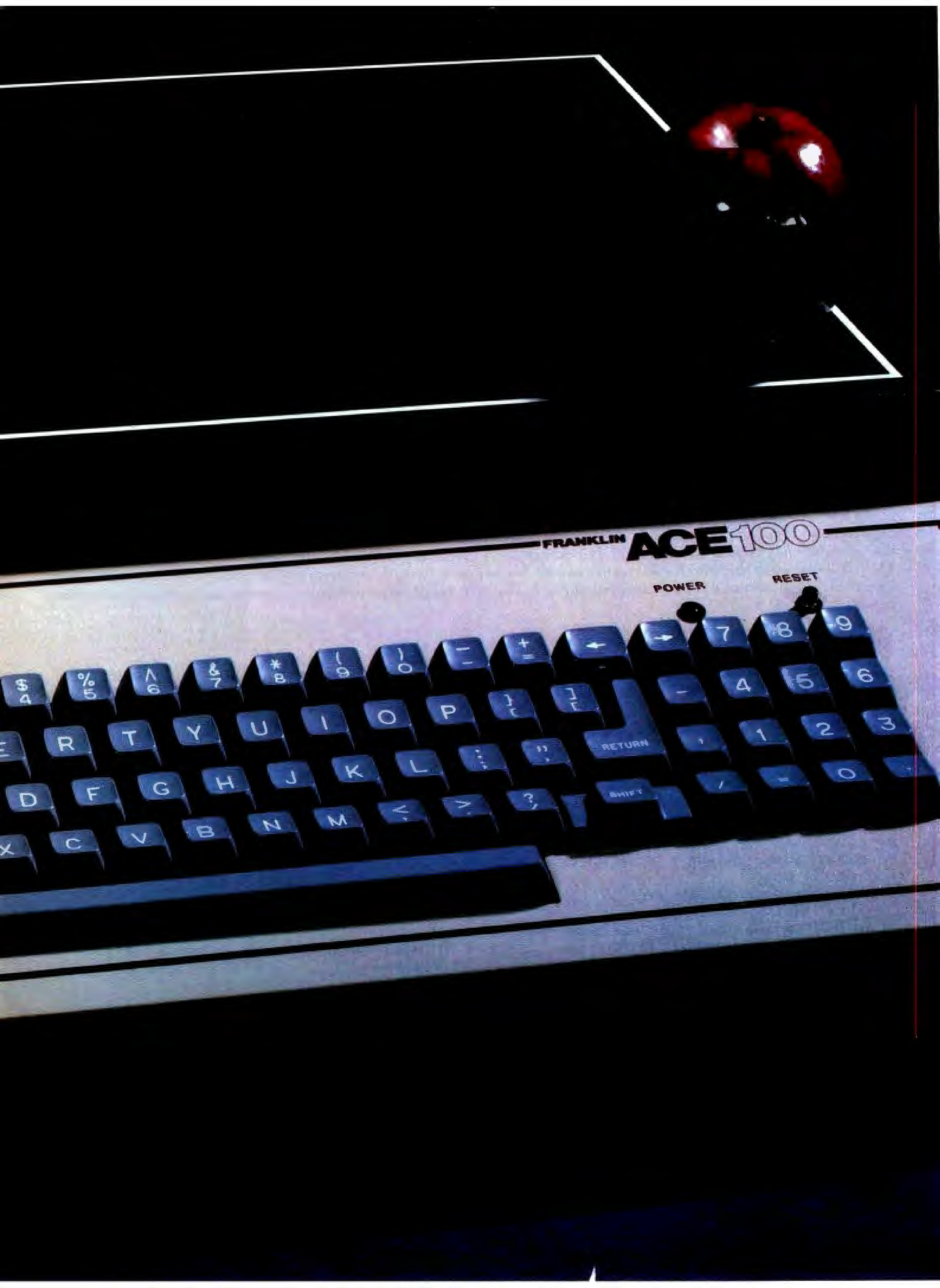
The best way to discuss the program and its ramifications is to go through it step by step. The main body of the program begins at line 60 (see listing 1), which calls the introduction subroutine at lines 8000-8660. In this subroutine, the program first asks whether execution of the program will require halts between iterations. Although the halts will slow the execution of the program, they allow time for careful observation of intermediate stages and for discussion of the changes in the neighborhood. In the classroom, the halts allow the instructor to ask students to predict changes in the shape of the community: for example, to predict which households will vacate, which type of household will move in to occupy the vacancies, what effect the changes will have on

Text continued on page 192

Listing 1: *The neighborhood-segregation program. Written in Microsoft BASIC, the program first goes to an introduction subroutine at line 8000. At lines 8070-8080, the program lets you choose to start with either a planned, integrated neighborhood or a random neighborhood. If you choose the planned neighborhood, the program assumes that both types of residents want at least half of their four immediate neighbors to be members of their own group. If you choose the random neighborhood, the program asks (at lines 8180-8200) how many neighbors the Xs require to be Xs, and (at lines 8270-8290) how many neighbors the Os require to be Os. The integration index, computed in the subroutine starting at line 7000, shows the proportion of dissimilar neighbors surrounding the average household.*

```
1 REM *** NEIGHBORHOOD SEGREGATION              ***
2 REM *** BY CARL MOODY AND EDWIN DETHLEFSEN ***
3 REM *** COLLEGE OF WILLIAM AND MARY           ***
4 REM *** WILLIAMSBURG, VA. 23185               ***
5 REM *** (804) 253-4377                        ***
10 RANDOM
20 DEFINT A-Z
30 DIM A(14, 34)
40 CLS
50 GOSUB 12000
60 GOSUB 8010
70 IF B=1 THEN L=768: W=192: GOTO 120
80 CLS
90 PRINT @ 15,"UNHAPPY HOUSEHOLDERS MOVE OUT"
100 GOSUB 4020
110 IF D=1 THEN GOSUB 6010
120 CLS
130 PRINT @ 19,"NEW HOUSEHOLDERS MOVE IN"
140 PRINT @ 69,"ITERATION NO.";Y;" PERCENT ";CHR$(134);"=";INT((W/(384-F))*100);
" INTEGRATION INDEX=";INT((L/(((384-F)*4)-88))*100)
150 K=128
160 FOR I=2 TO 13
170 FOR J=2 TO 33
180 GOSUB 5010
190 IF A(I, J)=1 THEN PRINT @ K, CHR$(134)
200 IF A(I, J)=2 THEN PRINT @ K, CHR$(143)
210 K=K+2
220 NEXT J
230 NEXT I
240 Y=Y+1
250 IF D=1 THEN GOSUB 6010
255 FOR ZZ=1 TO 2000:NEXT ZZ
260 GOTO 80
3000 REM *** CHECKING NEIGHBORS SUBROUTINE ***
```

Listing 1 continued on page 186


FRANKLIN ACE 100
POWER
RESET
RETURN
SHIFT

Listing 1 continued:

```
3010 H=0
3020 IF A(I-1, J)=A(I, J)OR A(I-1, J)=0 THEN H=H+1
3030 IF A(I+1, J)=A(I, J)OR A(I+1, J)=0 THEN H=H+1
3040 IF A(I, J-1)=A(I, J)OR A(I, J-1)=0 THEN H=H+1
3050 IF A(I, J+1)=A(I, J)OR A(I, J+1)=0 THEN H=H+1
3060 RETURN
4000 REM *** MOVING OUT SUBROUTINE ***
4010 F=0
4020 L=0
4030 E=0
4040 W=0
4050 K=128
4060 F=0
4070 FOR I=2 TO 13
4080 FOR J=2 TO 33
4090 IF A(I, J)=0 THEN PRINT @ K,"":F=F+1: GOTO 4170
4100 GOSUB 3010
4110 L=L+(4-H)
4120 IF A(I, J)=1 THEN W=W+1
4130 IF A(I, J)=1 AND H<M THEN A(I, J)=0: PRINT @ K,"": E=E+1
4140 IF A(I, J)=2 AND H<N THEN A(I, J)=0: PRINT @ K,"": E=E+1
4150 IF A(I, J)=1 THEN PRINT @ K, CHR$(134)
4160 IF A(I, J)=2 THEN PRINT @ K, CHR$(143)
4170 K=K+2
4180 NEXT J
4190 NEXT I
4200 IF E=0 GOTO 11010
4210 FOR ZZ=1 TO 2000:NEXT ZZ
4220 RETURN
5000 REM *** MOVING IN SUBROUTINE ***
5010 IF A(I, J)<>0 THEN RETURN
5020 A(I, J)=1
5030 GOSUB 3010
5040 Q=H
5050 A(I, J)=2
5060 GOSUB 3010
5070 R=H
5080 IF Q>=M AND R>=N THEN A(I, J)=RND(2)
5090 IF Q>=M AND R<N THEN A(I, J)=1
5100 IF Q<M AND R>=N THEN A(I, J)=2
5110 IF Q<M AND R<N THEN A(I, J)=0
5120 RETURN
6000 REM *** INKEY ROUTINE ***
6010 PRINT @ 979,"TO CONTINUE PRESS ANY KEY"
6020 IF INKEY$ ="" THEN 6020
6030 RETURN
7000 REM *** INTEGRATION INDEX SUBROUTINE ***
7010 L=0
7020 W=0
7030 FOR I=2 TO 13
7040 FOR J=2 TO 33
7050 IF A(I, J)=1 THEN W=W+1
7060 GOSUB 3010
7070 L=L+(4-H)
7080 NEXT J
7090 NEXT I
7100 RETURN
8000 REM *** INTRODUCTION SUBROUTINE ***
8010 PRINT @ 512,"DO YOU WANT THE PROGRAM TO STOP BETWEEN ITERATIONS (Y/N)?"
8020 D$=INKEY$
8030 IF INKEY$ <>"" THEN 8040
8040 IF D$="Y" THEN D=1
8050 IF D$<>"Y" AND D$<>"N" THEN GOTO 8020
8060 CLS
8070 PRINT @ 512,"TO START WITH A PLANNED INTEGRATED NEIGHBORHOOD, PRESS 1"
8080 PRINT @ 576,"TO START WITH A RANDOM NEIGHBORHOOD, PRESS 2"
```

Listing 1 continued on page 188

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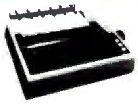

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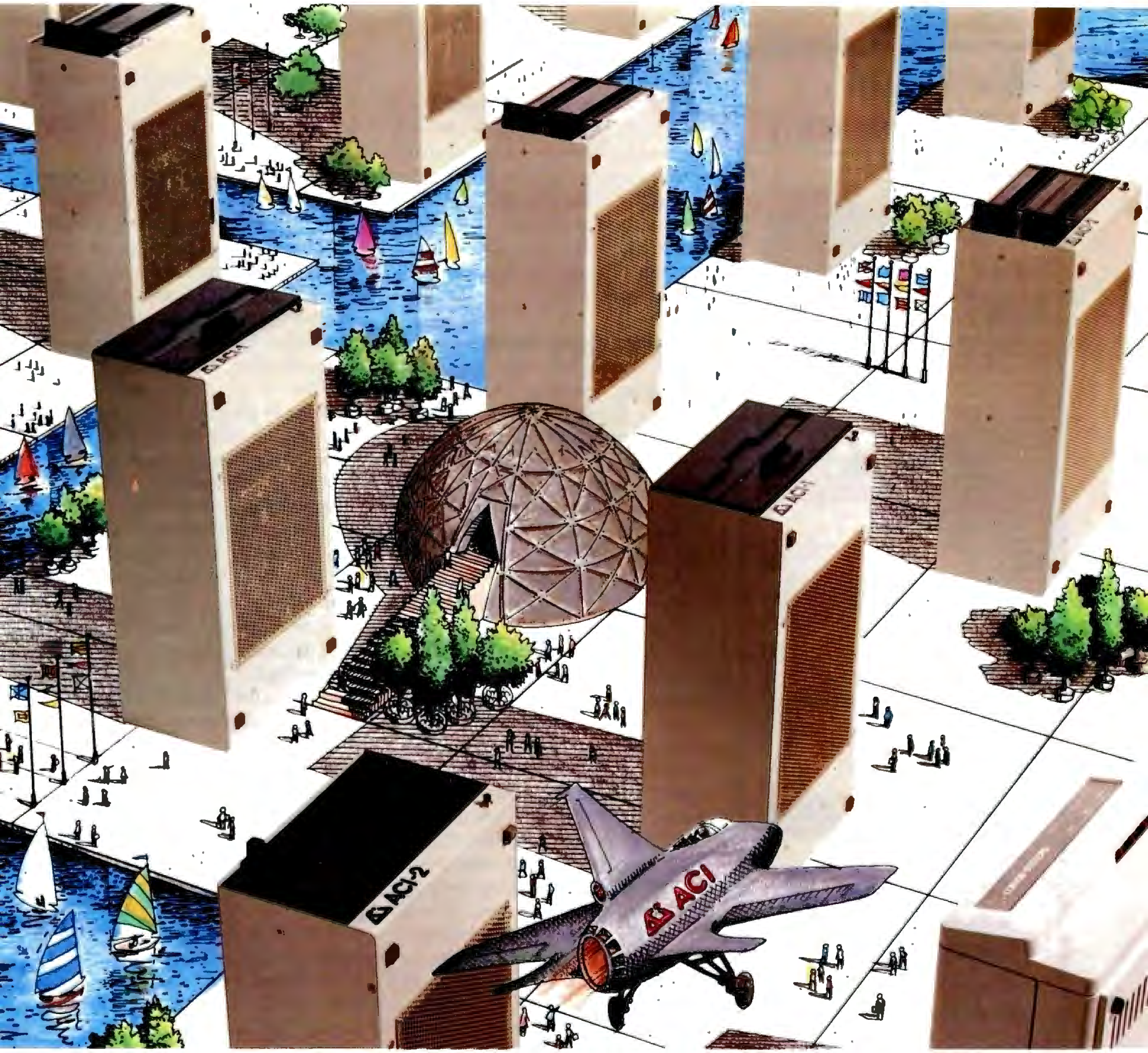
Listing 1 continued:

```
8090 PRINT @ 640,"IF YOU START WITH A PLANNED INTEGRATED NEIGHBORHOOD,"
8100 PRINT @ 704,"THEN BOTH TYPES OF PEOPLE ARE CONTENT AS LONG AS"
8110 PRINT @ 768,"THEY ARE NOT IN THE MINORITY"
8120 C$=INKEY$
8130 IF C$="" THEN 8120
8140 IF VAL(C$)<1 OR VAL(C$)>2 THEN 8120
8150 B=VAL(C$)
8160 IF B=1 THEN GOTO 9010
8170 CLS
8180 PRINT @ 512,"HOW MANY NEIGHBORS, OUT OF FOUR, DO THE X'S DEMAND TO BE"
8190 PRINT @ 576,"LIKE THEMSELVES"
8200 PRINT @ 640,"PRESS A NUMBER BETWEEN ZERO AND FOUR"
8210 C$=INKEY$
8220 IF C$="" THEN 8210
8230 IF VAL(C$)<0 OR VAL(C$)>4 THEN 8210
8240 PRINT @ 680, C$
8250 M=VAL(C$)
8260 CLS
8270 PRINT @ 512,"HOW MANY NEIGHBORS, OUT OF FOUR, DO THE O'S DEMAND TO BE"
8280 PRINT @ 576,"LIKE THEMSELVES"
8290 PRINT @ 640,"PRESS A NUMBER BETWEEN ZERO AND FOUR"
8300 C$=INKEY$
8310 IF C$="" THEN 8300
8320 IF VAL(C$)<0 OR VAL(C$)>4 THEN 8300
8330 PRINT @ 680, C$
8340 N=VAL(C$)
8350 CLS
8360 PRINT @ 512,"ENTER THE PROPORTION OF X'S IN THE RANDOM NEIGHBORHOOD,"
8370 PRINT @ 576,"1 IN ?"
8380 C$=INKEY$
8390 IF C$="" THEN 8380
8400 PRINT @ 583, C$
8410 C=VAL(C$)
8420 CLS
8430 PRINT @ 17,"SETTING UP A RANDOM NEIGHBORHOOD"
8440 FOR I=1 TO 14
8450 FOR J=1 TO 34
8460 A(I, J)=0
8470 NEXT J
8480 NEXT I
8490 FOR I=2 TO 13
8500 FOR J=2 TO 33
8510 X=RND(C)
8520 IF X=1 THEN A(I, J)=1 ELSE A(I, J)=2
8530 NEXT J
8540 NEXT I
8550 CLS
8560 GOSUB 10010
8570 PRINT @ 7,"PLEASE WAIT WHILE I COMPUTE THE INTEGRATION INDEX"
8580 GOSUB 7010
8590 Y=1
8600 PRINT @ 900,"ITERATION NO.";Y;" PERCENT ";CHR$(134);"=";INT((W/384)*100);"
INTEGRATION INDEX=";INT((L/1536)*100)
8610 IF D=1 THEN GOTO 8650
8620 FOR I=1 TO 4000
8630 NEXT I
8640 RETURN
8650 GOSUB 6010
8660 RETURN
9000 REM *** INTEGRATED NEIGHBORHOOD SUBROUTINE ***
9010 CLS
9020 PRINT @ 14,"SETTING UP AN INTEGRATED NEIGHBORHOOD"
9030 PRINT @ 78,"PERCENT ";CHR$(134);"= 50  INTEGRATION INDEX= 50"
9040 N=2
9050 M=2
9060 X=RND(2)
```

Listing 1 continued on page 190

Listing 1 continued:

```
9070 FOR I=1 TO 14
9080 FOR J=1 TO 34
9090 A(I, J)=0
9100 NEXT J
9110 NEXT I
9120 J=2
9130 I=2
9140 A(I, J)=X
9150 I=I+1
9160 IF I<=13 THEN 9140
9170 IF X=1 THEN X=2: GOTO 9190
9180 IF X=2 THEN X=1
9190 J=J+1
9200 IF J<=33 THEN 9130
9210 Y=1
9220 CLS
9230 GOSUB 10010
9240 PRINT @ 909,"RANDOM HOUSEHOLDERS WILL MOVE OUT"
9250 FOR I=2 TO 13
9260 FOR J=2 TO 33
9270 E=RND(6)
9280 IF A(I, J)=E THEN A(I, J)=0
9290 NEXT J
9300 NEXT I
9310 IF D=1 THEN GOSUB 6010
9320 CLS
9330 PRINT @ 15,"RANDOM HOUSEHOLDERS MOVING OUT"
9340 GOSUB 10010
9350 Y=1
9360 IF D=1 THEN GOSUB 6010
9370 RETURN
10000 REM *** PRINT SUBROUTINE ***
10010 K=128
10020 FOR I=2 TO 13
10030 FOR J=2 TO 33
10040 IF A(I, J)=1 THEN PRINT @ K, CHR$(134)
10050 IF A(I, J)=2 THEN PRINT @ K, CHR$(143)
10060 K=K+2
10070 NEXT J
10080 NEXT I
10090 RETURN
11000 REM *** STOPPING ROUTINE ***
11010 PRINT @ 901,"THE NEIGHBORHOOD IS STABLE, NO ONE WILL MOVE IN OR OUT"
11020 PRINT @ 965,"ITERATION NO.";Y;" PERCENT ";CHR$(134);"=";INT((W/(384-F))*10
0);" INTEGRATION INDEX=";INT((L/(((384-F)*4)-88))*100)
11030 END
12000 REM *** COPYRIGHT BLOCK ***
12010 PRINT CHR$(23)
12020 PRINT
12030 PRINT
12040 PRINT" * * * * * * * * * * * * * * "
12050 PRINT
12060 PRINT
12070 PRINT"   NEIGHBORHOOD SEGREGATION
12080 PRINT
12090 PRINT" * * * * * * * * * * * * * * "
12100 PRINT
12110 PRINT
12120 PRINT"A PROGRAM IN MICROSOFT BASIC BY
12130 PRINT"CARL MOODY AND EDWIN DETHLEFSEN"
12140 PRINT"   COLLEGE OF WILLIAM & MARY"
12150 PRINT
12160 PRINT"COPYRIGHT (C) 1981.<TOUCH A KEY>
12170 GOSUB 6020
12180 CLS
12190 RETURN
```



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Text continued from page 183:

the old residents and the stability of the neighborhood in general. Because the neighborhood develops before the students' eyes, they have immediate feedback on their predictions. This seems a productive use of class time, and it especially exemplifies the advantages of computer applications in the classroom.

Disturbing Developments

The second question in the introduction involves choosing between a planned, integrated neighborhood or a random neighborhood to begin the experiment. In the planned community option, both types of residents will prefer not to be in the minority, demanding that at least half of their neighbors must share their preferences. This choice reveals the most powerful and disturbing aspect of our model, namely that no matter how stable and perfectly integrated the neighborhood is to begin with, a relatively slight disturbance (in the current program, one-sixth of the residents are selected at random to move out and are replaced) can lead to such a dramatic restructuring of the community that the final, stable neighborhood is much more segregated than any of the individuals comprising the population really want it to be. (This observation leads us to suspect that even the best-planned, most stable, and best-integrated neighborhoods where everyone starts out happy with his or her immediate environment are difficult at best and may even be impossible to maintain.)

The second choice in the program, for experimenters who prefer to begin with an unplanned, random neighborhood, is to select the number of immediate neighbors (out of four) that the individual householder demands should share his view of life. One person might settle for one or even no neighbors similar to himself, while another might insist that *all* of his neighbors be of his own persuasion.

Here's where some disturbing developments can happen. The choice of dissimilar demands by the two types of neighbors must inevitably lead to the total elimination of the less gregarious type. That is, if Xs settle for two while Os demand three like neighbors, then after a number of iterations, there will be no place left that will satisfy an O. For example, suppose you have a music school dormitory that houses both trombonists and cellists and that the trombonists don't care who their neighbors are but the cellists can't practice in close proximity to a group of trombonists. (Schelling uses an example of snorklers and surfers. While an encounter between the two may be a minor annoyance to the surfer, it can be devastating to the snorkler.) Consequently, if there is an unlimited supply of trombone players (or surfers) beyond the neighborhood's borders, then the cellists and snorklers will eventually move away, *even though they have nothing personal or ideological against the people who are replacing them in the community.*

On the other hand, if neither group insists on being in the majority (for example, if the Xs want two neighbors like themselves and the Os will settle for only one) then neither group will be completely eliminated, although the more permissive type will dominate in numbers.

But there are even more possibilities. The program allows both types of individuals to demand majority status. For example, both types could demand three or even four similar neighbors. The community will eventually stabilize with neither group completely replacing the other, as long as both groups make equal demands concerning their neighbors' sympathies. Of course, if both groups insist that all neighbors be like themselves, the final "community" will be balkanized into several completely segregated ghettos, with a network of no-man's-land vacant lots separating the typological "clots" from contact with one another.

If the two types are not quite so demanding, requiring only three similar neighbors each, then a similar scene develops except that there are occasional bridges across the vacant lots where some households will have

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token contact across ethnic boundaries.

Our last example is of special demographic interest, wherein both types want at least half of their neighbors to be like themselves. If we start with a random neighborhood in which, say, the Xs are in a distinct minority, the final community, after all the dissatisfied folks have moved out and been replaced and all members are happy with their neighbors will be much more segregated than it would have been had we begun with an equal number of each type. This happens because the loss of an unhappy X has a proportionately larger effect on the remaining Xs than the loss of one of the more numerous Os. Furthermore, an O contemplating a move into the community will have more congenial places available to move into. Thus, as Os move in they encourage yet more Os to move in later, reinforcing the numerical superiority of their group.

How the Simulation Works

The actual neighborhood simulation operates as follows. If the user has chosen a random neighborhood, then the program calls the moving-out subroutine on lines 4000-4220. Here each householder counts the number of immediate neighbors that are either similar to himself or are vacant lots. (Note that special consideration must be given the top, bottom, and sides of the community. We assume that the community is bordered by vacant lots. To accomplish this we initially create a matrix of 14 by 34 zeros in lines 8440-8480 for the random neighborhood and lines 9070-9110 for the integrated neighborhood. We then populate it with Xs and Os, but only fill a submatrix that is 12 by 32. This retains a border of 0s around the 12 by 32 matrix, and the program interprets the 0s as vacant lots.) If there are too many dissimilar neighbors, the householder moves out, leaving a space. In this subroutine, we also keep track of the total number of similar neighbors and the total number of Xs. If no one moves out, the neighborhood is stable and the program ends.

If one or more householders moves out, then the moving-in routine on lines 130–255 is invoked. Here both types of individuals "inspect the property" and evaluate the neighborhood. If neither has enough similar neighbors, then no one moves in and the lot remains unoccupied. If both are satisfied with the neighborhood, then they essentially flip a coin to see who moves in. After all vacant spaces have been inspected and satisfied individuals have moved in, the program simply loops to alternate the moving-in and moving-out phases of the experiment. In the case of the planned, integrated neighborhood, the logic of the program is the same, but the first iteration starts with one-sixth of the population randomly moving out. The program then goes to the moving-in routine and proceeds as outlined above.

Some Aids to Understanding

Sometimes it helps to have more than a visual impression of the degree of segregation and of the proportion of ethnic types in the neighborhood, so we provide an *Integration Index* (I.I.) at each iteration. This is a numerical statement of the proportion of dissimilar neighbors surrounding the "average" individual. We might also think of it as a *mean contact level,* as it is a statement of the length of shared boundaries between type clusters. This index is computed during the moving-out subroutine (in the checking-neighbors subroutine in lines 3000–3060) when individual households are polled to see if they want to vacate. The number of similar neighbors (and vacant lots) is subtracted from four (the total number of relevant neighbors) in line 4110 to find the number of dissimilar types adjacent to each household. We also keep track of the number of vacant lots with the variable F. The total number of dissimilar neighbors is calculated for all (384 − F) households and expressed as a percentage of the total number of possible neighbors (ignoring the vacant lots in the neighborhood and on the


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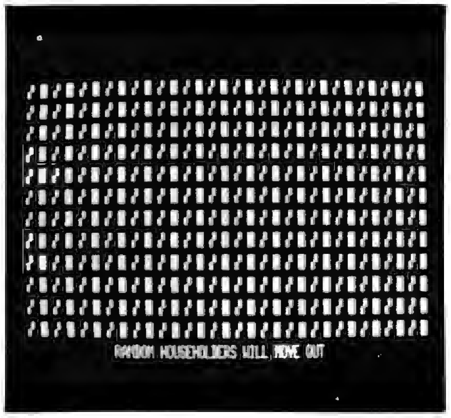

Photo 1a: *Representation of a planned, integrated neighborhood at the beginning of a run of the neighborhood-segregation program shown in listing 1. One class of people, the Os, are represented by rectangles. The other class, the Xs, are represented by chair-like shapes.*

Photo 1b: *The same neighborhood after one-sixth of the households, chosen at random, have moved out.*

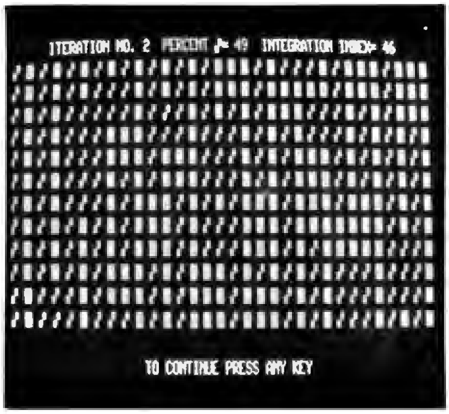

Photo 1c: *The emerging pattern of segregation. Households in each group require only that at least half of their neighbors be in their own group.*

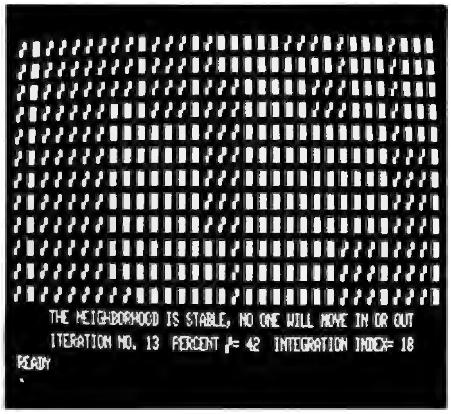

Photo 1d: *The final, stable neighborhood. The extreme segregation has come about despite the willingness of every household in each group to live alongside some neighbors from the other group.*

borders). By tracking the proportion of Xs and the Integration Index at each iteration, we can follow the progress of the neighborhood as it segregates itself.

Some Typical Runs

Photo 1a shows the planned integrated neighborhood that begins the simulation of this community. The Xs are represented on the screen as the chair-like shapes while the Os are represented as the rectangles. In photo 1b we have randomly moved approximately one-sixth of the members out, leaving 65 open slots. Of course, all these slots could be filled with exactly the right sort so as to restore the community to a stable balance, but the odds against this happening are astronomical and it doesn't happen here. Photo 1c shows that even by the second iteration a segregated pattern is developing, although the integration index is still very high (46). The final, stable neighborhood is shown in photo 1d. The squares are congregated into two distinct neighborhoods in the center of the community with two smaller congregations on the edges. The

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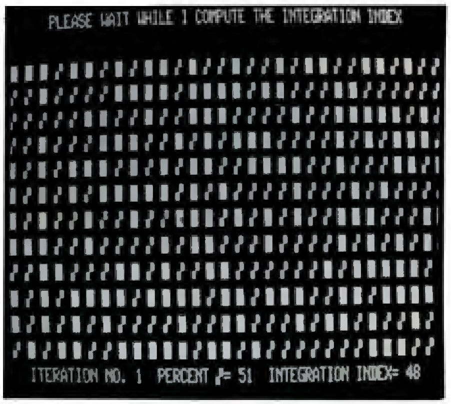

Photo 2a: *Representation of a random neighborhood at the beginning of a run of the neighborhood-segregation program. Although unplanned, the neighborhood has a high degree of integration.*

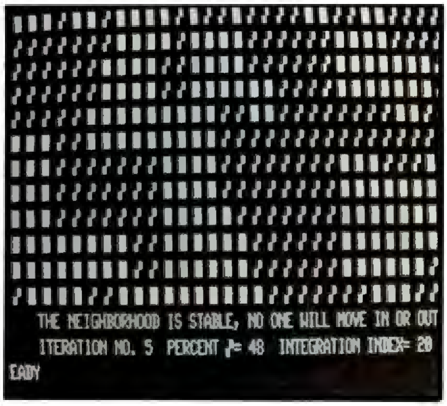

Photo 2b: *The final pattern of segregation that emerges in a program run in which each household in each group wants to have two neighbors from its own group.*

chairs are congregated primarily on the left-hand side, with a vertical strip in the middle and another on the right. If all anyone requires is two similar neighbors, then all vertical lines that are unaffected by the initial random disturbance will be permanent. This explains the vertical line of squares on the left-hand side and the overall vertical look of the final pattern.

Photo 2a shows an initial random neighborhood. It is unplanned, but relatively highly integrated (the integration index is 48). However, it is not stable, and unhappy householders will move out. The final, stable neighborhood is shown in photo 2b. The final neighborhood is highly segregated, with an integration index of 20 (similar to the result achieved with an initially integrated neighborhood). Because there is no necessary vertical pattern in the initial neighborhood, there is less of a corresponding vertical pattern in the resulting segregated neighborhood, although the requirement that only two neighbors be similar to oneself tends to stabilize the final patterns around vertical lines of similar types. The existence of relatively isolated individuals around the edges of the community can be explained by the fact that the community is bordered by vacant lots that are considered "friendly" by whoever locates next to them.

The final neighborhood, corresponding to a simulation in which both groups demand three neighbors be like themselves, is shown in photo 3. There is a very high level of segregation (the integration index is

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OR STEP <= <> >= $ ( ) "
Q W E R T Y U I O P
SIN COS TAN INT RND STR$ CHR$ CODE PEEK TAB
NEW SAVE DIM FOR GOTO GOSUB LOAD LIST LET
STOP LPRINT SLOW FAST LLIST ** - + = FUNCTION
A S D F G H J K L ENTER
ARCSIN ARCCOS ARCTAN SGN ABS SQR VAL LEN USR
COPY CLEAR CONT CLS SCROLL NEXT PAUSE
SHIFT : ; ? / * < > , £
Z X C V B N M . SPACE
LN EXP AT IN KEY$ NOT π

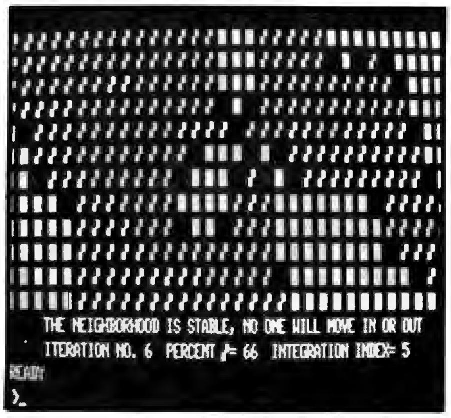

Photo 3: *The final pattern of extreme segregation when each household in each group wants to have three neighbors from its own group.*

only 5) and several lots will remain vacant between the isolated groups.

Photo 4a shows an initial random neighborhood with the Xs in a distinct minority (34 percent in this case). The initial integration index is 41, indicating a high level of dispersion of the minority group. However, the neighborhood is very unstable, even though both groups merely demand that they not be in a minority with respect to their immediate neighbors. After only five interactions the resulting stable neighborhood will be highly segregated, as illustrated in photo 4b, with the population of Xs severely reduced (to 15 percent).

These are only a few illustrations of the patterns that can develop according to the various conditions put on the initial neighborhood.

Alternative Possibilities

Like good neighbors, we disagree on what are the most important aspects of using this program. The economist is mainly interested in what is ultimately going to happen to the community, while the anthropologist is more interested in the little things that happen along the way, viewing the model as a broad simulation. For the latter, it would be nice to allow some randomness in the subroutines. In this way a potential householder could make a mistake and move into a house in which he will be unhappy, perhaps because he was misled by the real estate agent. If these sorts of mistakes are not systematic, the final outcome will indeed be unaffected. However, if the user is interested in examining this phenomenon, we can add some random effects into the moving-in subroutine by adding a line such as:

```
5015 P=RND(500):IF P=1 THEN
     A(I,J)=RND(2):RETURN
```

This assigns one type or the other randomly to somewhat less than one vacant lot per iteration.

Similarly, if we add a line such as:

```
4125 P=RND(500):IF P=1 THEN
     A(I,J)=0:RETURN
```

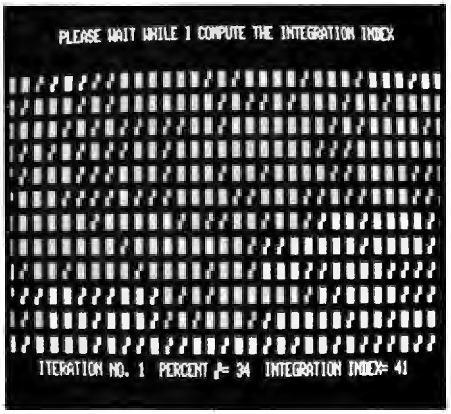

Photo 4a: *An initial random neighborhood in which the Xs are a minority of 34 percent. Despite the minority status of the Xs, the neighborhood is well integrated.*

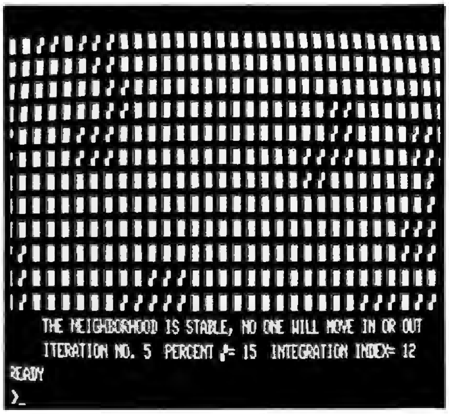

Photo 4b: *The stable, highly segregated neighborhood that evolves from that shown in photo 4a when all the households in both groups just want not to be in a minority with respect to their immediate neighbors.*

Case	M = number of like neighbors required by Xs	N = number of like neighbors required by Os	Initial percent X	Initial distribution	Integration Index Max	Min	Ave	Percent X Max	Min	Ave
1	2	2	50	integrated	31	13	19	69	32	51
2	2	2	50	random	25	15	20	76	35	50
3	1	2	50	random	29	16	22	80	60	69
4	2	3	50	random	0	0	0	100	100	100
5	3	3	50	random	8	4	6	73	27	49
6	4	4	50	random	0	0	0	71	27	51
7	1	1	50	random	45	36	40	58	43	51
8	2	2	33	random	20	3	10	27	5	13

Table 1: *Experimental results of the neighborhood-segregation program shown in listing 1. The table gives the results for 50 trial runs for each of 8 different cases of initial assumptions about a neighborhood made up of 2 groups, the Xs and the Os. The integration index (i.e., proportion of dissimilar neighbors surrounding the average household) and the percent of Xs describe the heterogeneity of the neighborhoods resulting from the runs for each case. Only the seventh case, in which both the group X households and the group O households required just one neighbor belonging to their own group, shows impressive integration.*

to the moving-out routine, then approximately 1/500 of all movers-out will be doing it for reasons other than dissatisfaction with their neighbors. This creates a more realistic situation at the expense of a higher number of iterations.

Experimental Findings

Table 1 presents results from trials of 50 runs of the program under 8 different sets of conditions. In the table, we record the preferences of the two types of individuals with respect to the number of like neighbors. Xs' demands are in column (M), and the Os' demands in column (N). Also tabulated is the proportion of Xs in the initial neighborhood and whether the initial neighborhood is integrated or random. The maximum, minimum, and average Integration Index (I.I.) is tabulated for final neighborhoods from the 50 independent trials, along with corresponding maximum, minimum, and mean percentages of X in the same final neighborhoods.

The first case reported in the table is the planned, integrated neighborhood. The final I.I. averages 19 percent, even though both groups should theoretically be content with 50 percent. (How would *you* explain this result?) The final neighborhood shows an average 51 percent X, which demonstrates that although like has clustered with like, neither type dominates.

The second case is identical to the first except that it begins with a randomly organized neighborhood instead of our perfectly planned and integrated neighborhood. Starting from a random situation seems to have little effect on the final outcome, but it allows stability to be reached with fewer iterations.

In the third case, the Xs demand only one like neighbor while the Os' are slightly less permissive, demanding two. The final, stable neighborhood shows an integration index of 22, hardly different from the

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preceding cases, but the 69 percent proportion of Xs clearly shows the effects of their greater permissiveness. It earns them a significant majority.

In the fourth case, the Os require that at least three of their neighbors be like themselves and, like the cellists in competition with trombone players, the Os are inevitably slowly driven out. In the fifth case, both types demand a majority of like neighbors. The average I.I. is 6 percent, and it is a toss-up which group will dominate the final neighborhood. The sixth case is simply an extreme version of the fifth one, where each type demands exclusiveness. The integration index is always 0, and either group could dominate in the end, but there will always be a no-man's-land of vacant lots between completely segregated ghettos.

In the seventh case, both groups are gregarious, demanding only one similar neighbor. This gives us an average I.I. of 40, which is close to the maximum of 50, but to get even this close to the maximum each person must be willing to tolerate a substantial majority of the other group around him. If this model has any relevance to actual neighborhood formation, then our results could be particularly depressing to people of goodwill who wish to encourage community integration.

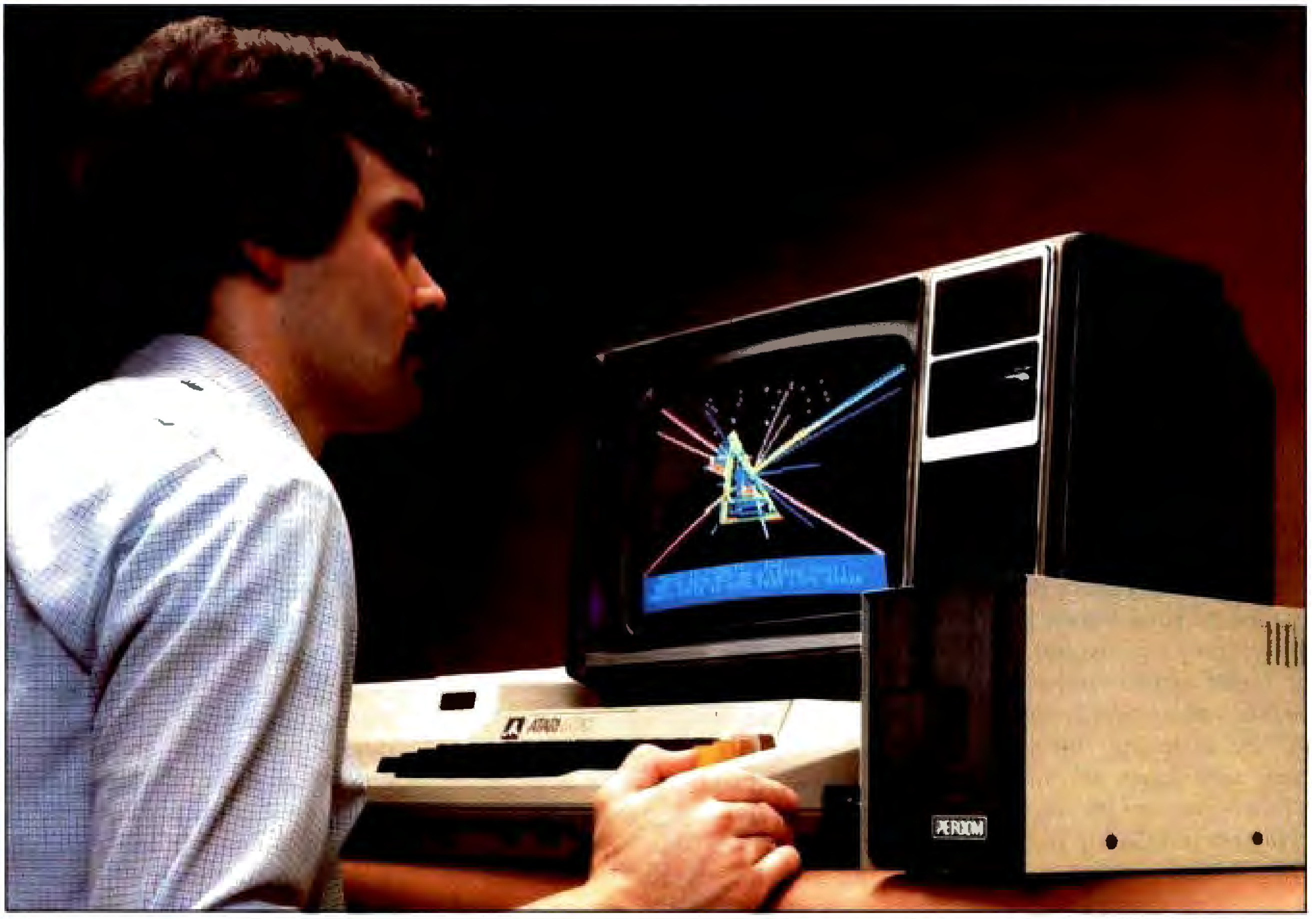
There are many probabilistic as well as systemic factors in the evolution of any organization as complex as a human community.

The last experiment we have recorded assumes that each group wants at least two neighbors like themselves, but the Xs begin in a clear minority (33 percent). We end up with an average I.I. of 10, with the final proportion of Xs dropping to 13 percent, but actually sinking as low as 5 percent in one of the trials!

Conclusion

Although we both enjoyed a challenging opportunity to enhance our BASIC programming skills (that's how this project began), we have particularly come to appreciate the kinds of intellectual challenges and insights that can be made available with the help of a microcomputer. Few of us would have had the time or patience to fiddle through the thousands of coin manipulations necessary to make ourselves aware not only that maintaining an integrated community requires considerably more than goodwill, but that there are many probabilistic as well as systemic factors in the evolution of any organization of interacting parts, especially when that organization is anything as complex as a human community.

We hope that Neighborhood Segregation will stimulate discussion and creative reflection by those who use it.■



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Measuring Attitudes with a PET

A BASIC Program That Finds Out How People Feel

David R. Heise
Department of Sociology
Indiana University
Bloomington, IN 47405

Computers don't have feelings yet, but they can help us express and analyze our own feelings or attitudes toward everything from gun control legislation to Kiwi Kandy Bars. Until recently, only the largest organizations could afford sophisticated attitudinal assessment techniques. Now, by assigning these time-consuming techniques to your microcomputer, you can join the minors of the Nielsen and Gallup leagues.

The BASIC program presented here transforms your PET microcomputer into an attitude-measuring instrument. It gives instructions, poses questions, registers and translates responses into numerical values, calculates averages, and presents results in chart form. In fact, the program's use of advanced measurement principles provides better technology than that applied by most businesses and political organizations.

Two operational modes are available in the program: a teaching mode, developed to instruct college students in attitude theory and measurement, and a field mode for practical applications. The ability to explain itself combined with the PET's portability and novelty makes it easy to tap public opinion on a street corner, in a theater lobby, or in your own store.

About the Author

David Heise is a sociology professor at Indiana University. His books include Causal Analysis *and* Understanding Events. *He has written commercial microcomputer programs for word processing and statistical analysis.*

Attitude Theory and Measurement

Attitudes form the bedrock of our expectations and intentions. When properly measured and analyzed, attitudes become fairly accurate indicators of how we perceive the world and what actions we would probably take in a given situation.

Behaviors are once-removed from attitudes. What you expect to happen may not come to pass, thereby denying you the opportunity to act on your intentions. On the other hand, the opportunity may present itself, but your intended behavior may be suppressed or interrupted. Still, attitude measurements provide information that suggests what *might* occur.

Social psychologists define one's attitude toward something as the feeling or "affective response" associated with it. In addition to the good-bad (evaluative) feelings examined by early researchers, affective responses consist of at least two other components. The *potency*, or power of a person or object, and the *activity* level, or liveliness associated with same, influence our attitudes toward that person or object.

Research during the last quarter-century has established that evaluation, potency, and activity (EPA) are basic dimensions of human affect, and that any kind of stimulus produces reactions along these dimensions. Our responses, however, are more subtle than just choosing between opposites such as powerful and weak or lively and inactive. There exist gradations or shadings of response. For example, you might feel that an eight-hour workday is slightly good but that a three-day weekend is extremely good.

Surveys usually assess this aspect of attitude by providing response categories such as "approve" and "strongly approve." Greater accuracy could be obtained by presenting a *continuous* scale (similar to a thermometer's continuum). Those responding could make distinctions as fine as they wished merely by checking a point on a line. The considerable expense of coding spatial data into numerical form prohibits this approach in many applications.

Attitude assessment is challenging because of the myriad trivial factors that can bias opinion. Response to a question or stimulus might be influenced by the previous question, by the judgment made last, or even by the way a scale is oriented (e.g., bad-good versus good-bad). *Repeated measures*, or presenting the questions more than once in random order, can be averaged together to allow the biases of one measure or scale to cancel those of another. While this is the preferred research method, the time and expense involved in making several different printed, randomized forms has limited its application.

The Attitudes Program

Microcomputers now make the use of randomized repeated measures economically feasible. The attitude measurement program (see listing 1, page 216) records respondents' reactions to questions or stimuli in terms of the EPA dimensions by means of a

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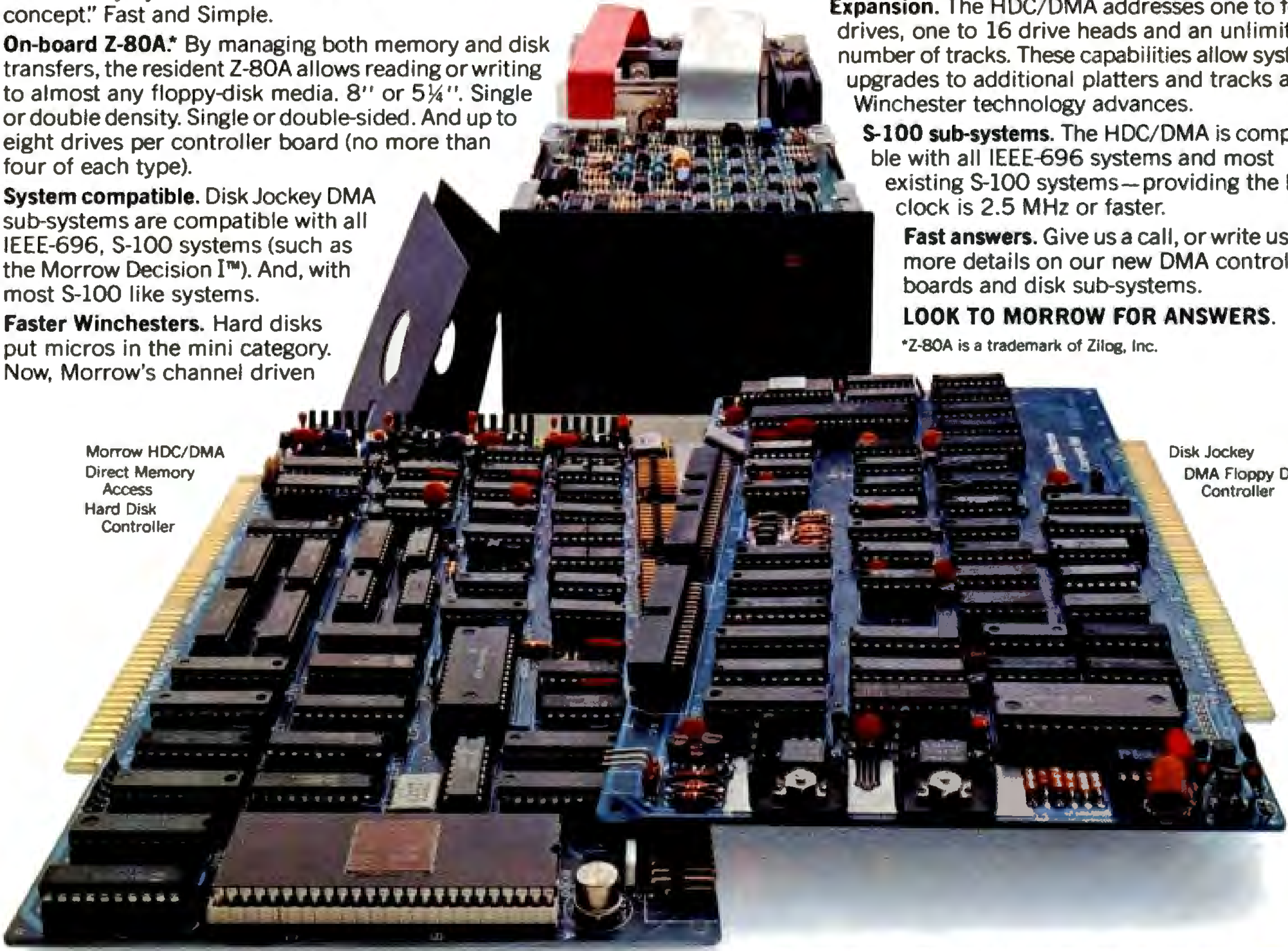

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graphic rating scale. To register a reaction, the respondent controls an animated check mark. The program uses the PET's random-number generator to vary the order of stimuli, the order of the EPA scales' presentation, and the orientation of those scales. Respondents rate each stimulus more than once so errors can be reduced through averaging.

The operator loads and runs the program before turning it over to respondents. In its teaching mode, the program collects data from the respondent and also shows him or her the results. In its field mode, the program asks the operator to start a data tape before respondents begin. Then the program collects data from each respondent, stores it on the tape, and automatically sets up for the next respondent. Results of field operations are obtained later, when a special routine reads the data tape.

The first display a respondent sees tells how to enter his or her name. The program "personalizes" its inquiries by embedding each respondent's name in the instructions. After entry of a name, the PET clears the screen and introduces itself as a microcomputer that is "going to help you express some attitudes." Then the program asks the respondent whether or not he or she has used the program before; if the answer is no, the program provides instructions:

"You'll say how you feel about some different things. I'll flash words at the top of the screen. Press R when you're ready, and I'll show you how I do it."

The screen clears and "A MICROCOMPUTER" appears at the top of the screen in reversed lettering. The instructions continue on the screen below: "You show how you feel about it on a scale like this." The evaluation scale is constructed on the bottom half of the screen. New instructions overwrite the last ones: "A check mark will appear above the line, and you move it back and forth with the < key or the > key. You press RETURN when the check is where you want it. Go ahead and try it. Rate ME."

The check mark appears, as shown in photo 1, and moves left or right continuously as long as the respondent presses the < key or the > key. The computer gets the respondent's first rating, then clears the screen. If the rating was on the good side, the PET prints, "Gee, (name). That's good of you." If the rating was neutral or bad, it prints, "Gosh. But (name). You hardly know me." In either case, the program pauses and then prints "Well, you've got the idea." The screen clears and prints "You rate each thing on three different scales."

In the field mode, the instructions end here and presentation of stimuli begins. Stimuli are defined beforehand in DATA statements. A stimulus may be a word, phrase, or sentence fewer than 37 characters long. In the teaching mode, the instructions continue: "We'll go through everything twice. After you've finished, I'll convert your ratings to numbers, calculate averages, and present the results in charts.

"You are to provide the words for this assignment. So let's do that now. How many things are you going to rate?" The PET drops into an error routine if the number is more than 20; otherwise it says, "Fine, now what are the words?" and the respondent enters the stimuli.

At the beginning of the rating process, the PET constructs the graphic rating scale at the bottom of the screen; this remains until all ratings are done. The scale is anchored by a series of adverbs—*slightly, quite, extremely, infinitely*—printed vertically beneath various points of the scale. The middle position is labeled "*neither.*" Centered and highlighted stimuli are presented at the top of the screen. Each stimulus is erased before another is presented. The PET goes through the stimuli twice, randomizing order of presentation each time. Dimensions change by replacing the adjectives at either end of the scale

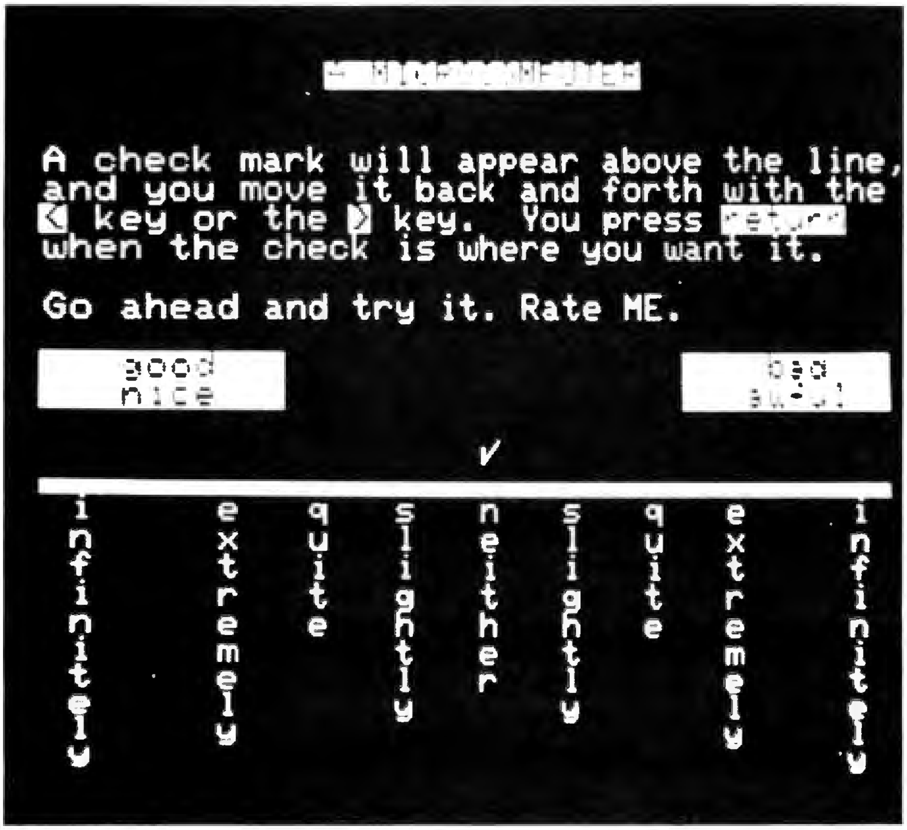

Photo 1: *A screen display from the attitude-measurement program in listing 1. The stimulus is the phrase "A MICROCOMPUTER." The response is measured in the good-to-bad or nice-to-awful dimension. The respondent uses the < or > keys to move the check mark to the desired rating.*

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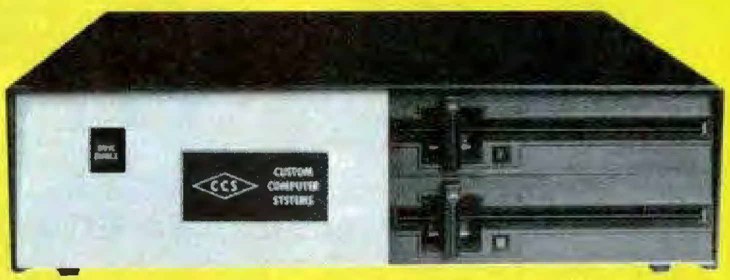

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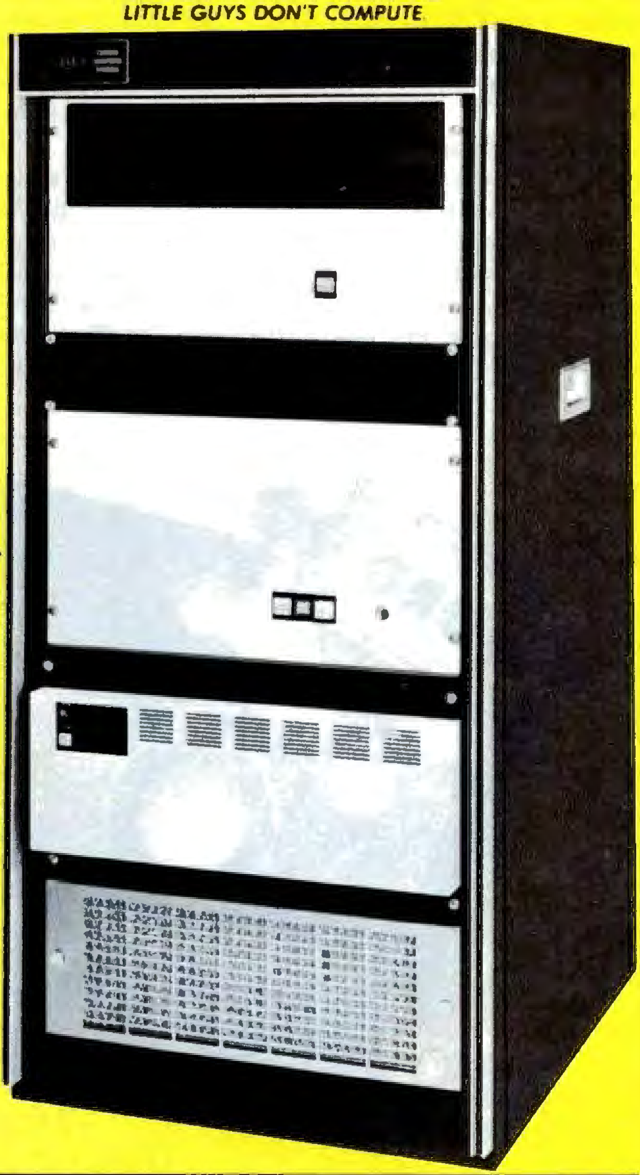

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while the stimulus remains constant. The order of the EPA elements is randomized, as is the placement of given adjectives on the left or right side of the screen.

As the respondent enters each rating, the spatial position of the check mark is converted to a number and stored in an array. If a respondent rates a stimulus as neutral on all three dimensions, the PET prints, "(Name), you rated this one at the middle all three times. Let's do it again to be sure about that." This procedure guards against a respondent's pressing RETURN without moving the check. The ratings, whatever they are, are accepted the second time.

In the teaching mode, the screen clears when all of the ratings are completed, then displays: "OK. You've rated each word twice on the three scales. Now I'll show you the average profiles. Then I'll show you graphs of the results. Press C to continue." On receiving the continue signal, the PET constructs a table with stimuli (truncated to 12 characters) listed on the left side of the screen and preceded by an index letter. The EPA ratings appear in three columns. The numbers are mean values, calculated across the different presentations. The numbers may range from −4.75 to +4.75. Negative means *bad, powerless,* or *quiet*; positive is *good, powerful,* or *lively*; zero means *neither*. (Optionally, the program can print this table on paper.)

The respondent gives another continue signal when finished viewing the EPA profiles. The program then constructs a graph showing the distribution of stimuli (each represented by its index letter) on the evaluation and activity dimensions. Plus or minus values on the potency dimension are indicated by capitals or lowercase index letters. Another continue signal produces a graph on the activity and potency axes; a third continue signal produces a potency-evaluation graph. A final continue signal produces the message "OK, (name), that's all. Hope you enjoyed it." This message stays on the screen awhile, then the program returns to the beginning, ready for another respondent.

In the field mode, the end of the ratings can initiate presentation of as many as ten background questions entered into the program beforehand. This part of the session might go as follows: "Now, (name), a few questions about you. Are you 1 Male or 2 Female?" If no background questions are included or when all background questions have been answered, the program gives the "that's all" message, saves all of the respondent's data on tape, and readies itself for another respondent.

Field-mode data collection is terminated by entering END instead of a respondent's name. This closes the data file and produces a message indicating the number of respondents who used the program. Since it's needed to run analyses, the number should be written on the data tape.

To analyze a data tape, rewind the tape and restart the program by

Text continued on page 236

Listing 1: *A BASIC attitude-measuring program that runs on a Commodore PET. An executive routine at lines 220-360 defines the program's structure. The program presents stimuli and assesses the respondent's attitudes toward them in three dimensions set by data statements beginning at line 520. The user can change the stimuli presented by using a DATA statement like the one at line 2450. At line 4530, a routine asks the respondent's gender; the routine can be expanded to gather more background information.*

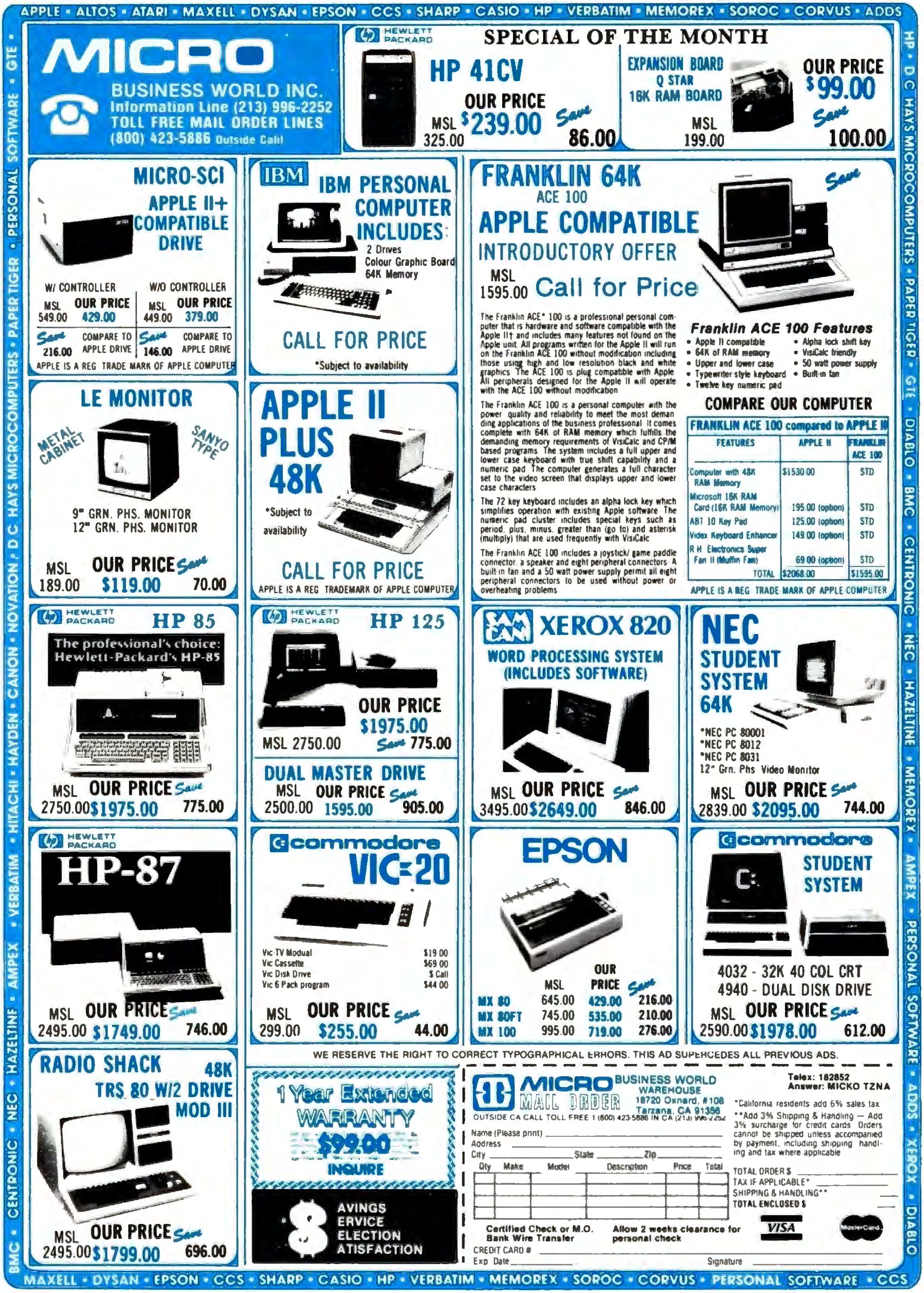
```
100 REM  *** ATTITUDES PROGRAM FOR 8K OR MORE ***
110 :
120 REM  WHEN USING PROGRAM IN THE FIELD, SET TEACHING=0
130 TEACHING=-1
140 IF NOT TEACHING THEN INPUT "<s>NAME FOR DATA FILE";NM$:OPEN 1,1,1,NM$
150 :
160 REM  TO PRINT PROFILES ON PAPER, SET PAPER=-1 AND TURN PRINTER ON
170 PAPER=0
180 IF TEACHING AND PAPER THEN OPEN 4,4
190 REM  SET NUMBER OF REPLICATIONS.
200 NR=2
210 :
220 REM*** EXECUTIVE PROGRAM
230 GOSUB 390                      :REM  SET ARRAYS AND STRING CONSTANTS.
240 IF NOT TEACHING THEN GOSUB 2340:REM  DEFINE STIMULI IN PROGRAM.
250 GOSUB 3760                     :REM  GIVE INTRODUCTION AND INSTRUCTIONS.
260 IF TEACHING THEN GOSUB 2510    :REM  LET RESPONDENT DEFINE STIMULI.
270 GOSUB 1030                     :REM  DRAW RATING SCALE.
280 FOR T=0 TO NR-1                :REM  GET NR SETS OF RATINGS
290 FOR LI=0 TO LL-1               :REM  FOR EACH STIMULUS
300 GOSUB 1460                     :REM  BY PRESENTING STIMULUS
310 GOSUB 1980                     :REM  THEN GETTING EPA RATINGS AND STORING.
320 NEXT LI,T
330 GOSUB 2850                     :REM  DISPLAY AVERAGES IN TABLE AND GRAPHS.
340 GOSUB 4560                     :REM  SIGN OFF.
350 IF TEACHING THEN CLR:GOTO 130  :REM  SET UP FOR NEXT RESPONDENT.
360 GOTO 250
370 :
380 REM*** DEFINE  UTILITY ARRAYS AND STRINGS
390 DIM Q%(2),DA%(2),BB$(3),AV$(4),AJ$(2,2,1),DM$(2)
400 REM  STRINGS OF BLANKS
410 FOR I=1 TO 39:BB$(3)=BB$(3)+"[ ]":NEXT I
420 BB$(0)=LEFT$(BB$(3),19)
430 BB$(1)="[ ][ ][ ][ ][ ]":BB$(2)="[ ][ ][ ]"
440 REM  SCALE ADVERBS
450 FOR I=0 TO 4: READ AV$(I):NEXT I
460 DATA "INFINITELY","EXTREMELY[ ]","QUITE[ ][ ][ ][ ][ ]"
470 DATA "SLIGHTLY[ ][ ]","NEITHER[ ][ ][ ]"
480 REM  SCALE ADJECTIVES
490 FOR I=0 TO 2:FOR J=0 TO 2:FOR K=0 TO 1
500 READ AJ$(I,J,K)

READY.

510 NEXT K,J,I
520 DATA "[ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]","[ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]"
530 DATA "[ ][ ][ ]GOOD[ ][ ][ ]","[ ][ ][ ][ ]BAD[ ][ ][ ]"
540 DATA "[ ][ ][ ]NICE[ ][ ][ ]","[ ][ ][ ]AWFUL[ ][ ]"
550 DATA "[ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]","[ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]"
560 DATA "[ ][ ][ ]BIG[ ][ ][ ][ ]","[ ][ ]LITTLE[ ][ ]"
570 DATA "[ ]POWERFUL[ ]","[ ]POWERLESS"
580 DATA "[ ][ ][ ]FAST[ ][ ][ ]","[ ][ ][ ]SLOW[ ][ ][ ]"
590 DATA "[ ][ ]YOUNG[ ][ ][ ]","[ ][ ][ ][ ]OLD[ ][ ][ ]"
600 DATA "[ ][ ]NOISY[ ][ ][ ]","[ ][ ][ ]QUIET[ ][ ]"
```

Listing 1 continued on page 218

Listing 1 continued:

```
610 REM  NAMES OF GRAPH AXES
620 DM$(0)="EVAL.[ ]":DM$(1)="POTEN.":DM$(2)="ACTIV."
630 REM  CURSOR DOWN 11 ROWS
640 CU$="<Q><Q><Q><Q><Q><Q><Q><Q><Q><Q><Q>"
650 REM  SEED THE RND FUNCTION
660 I=RND(-TI)
670 RETURN
680 :
690 REM*** INPUT WORDS, GUARDING AGAINST BREAKOUT
700 REM RESTORE STOP KEY IN CASE PROGRAMMER BREAKS OUT BY ENTERING SPACE
710 REM  (OLD ROM: POKE 537,136; OS 4.0: POKE 144,88)
720 POKE 144,46
730 REM  FIND CURSOR POSITION
740 REM  (A=226 FOR OLD ROM)
750 A=198:X=PEEK(A)
760 REM  GET INPUT STRING
770 INPUT "<]><]>[&]<}><}><}>";A$
780 REM  IGNORE IF USER PRESSES RETURN WITHOUT PRIOR KEYSTROKE
790 IF A$="[&]" THEN PRINT"<q>";:POKE A,X:GOTO 770
800 REM  DISABLE STOP KEY
810 REM  (OLD ROM: POKE 537,133; OS 4.0: POKE 144,85)
820 POKE 144,49
830 RETURN
840 :
850 REM*** CAPITALIZE FIRST LETTERS OF WORDS
860 C$="":DI=128
870 REM  SEARCH STRING FOR SPACES
880 FOR K=1 TO LEN(A$)
890 B$=MID$(A$,K,1)
900 REM    FOR OLD ROM ADD THIS STATEMENT
910 REM    B$=CHR$(128+ASC(B$)):DI=-128
920 REM  CAPITAL FOR FIRST WORD
930 IF K=1 THEN K=0:B$=" "
940 REM  PUT CAPITALS AFTER SPACES
950 IF B$=" " THEN K=K+1:B$=CHR$(DI+ASC(MID$(A$,K,1))):IF K>1 THEN C$=C$+" "
960 REM  REBUILD STRING
970 C$=C$+B$
980 NEXT K
990 A$=C$
1000 RETURN
1010 :
1020 REM*** DRAW THE SCALE
1030 PRINT "<S><Q><Q><Q>"CU$;
1040 REM  DRAW A LINE
1050 FOR I=1 TO 39:PRINT CHR$(162);:NEXT I:PRINT
1060 REM  PRINT THE ADVERBS VERTICALLY
1070 FOR I=1 TO 10
1080 REM  FIRST DO THE LEFT-SIDE ADVERBS AND MIDDLE
1090 PRINT "[ ]";
1100 FOR J=0 TO 4
1110 REM  USE LARGER GAP AFTER 'INFINITELY'
1120 K=2:IF J=0 THEN K=1
1130 REM  PRINT ONE LETTER FROM EACH ADVERB PER ROW
1140 PRINT MID$(AV$(J),I,1)BB$(K);
1150 NEXT J
1160 REM  BACKSPACE AND DO THE RIGHT-SIDE ADVERBS
1170 PRINT "<}><}><}>";
1180 FOR J=3 TO 0 STEP -1
```

Listing 1 continued on page 220



Circle 244 on inquiry card.

Listing 1 continued:

```
1190 K=2:IF J=0 THEN K=1
1200 PRINT BB$(K)MID$(AV$(J),I,1);
1210 NEXT J
1220 REM  GO ON TO NEXT ROW
1230 IF I<10 THEN PRINT
1240 NEXT I
1250 REM  RETURN CURSOR TO HOME
1260 PRINT "<S>";
1270 RETURN
1280 :
1290 REM*** DISPLAY SCALE ADJECTIVES WITH HIGHLIGHTING
1300 REM  GO DOWN TO POSITION
1310 PRINT "<Q><Q><Q><Q><Q><Q><Q><Q><Q>";
1320 REM  DISPLAY THREE LINES OF ADJECTIVES
1330 FOR J=0 TO 2
1340 REM  SET REVERSE VARIABLES, ON AND OFF
1350 A$="<R>":B$="<r>"
1360 REM  DO NOT HIGHLIGHT IF ERASING A LINE
1370 IF AJ$(I,J,0)="[ ][ ][ ][ ][ ][ ][ ][ ][ ]" THEN A$="":B$=""
1380 REM  PRINT A ROW
1390 PRINT A$;AJ$(I,J,DI);B$;BB$(0);A$;AJ$(I,J,1-DI)
1400 NEXT J
1410 PRINT "<S>";
1420 RETURN
1430 :
1440 REM*** STIMULUS PRESENTATION
1450 REM  ERASE OLD STIMULUS
1460 PRINT BB$(3)"<S>";
1470 REM  SELECT STIMULUS RANDOMLY
1480 FOR K=1 TO 2000:L=INT(LL*RND(1))
1490 IF R%(L,0,T)=0 THEN K=2000:NEXT K:GOTO 1540
1500 NEXT K
1510 REM  EXCESSIVE DELAY: SELECT STIMULUS SEQUENTIALLY
1520 FOR K=0 TO LL-1:L=K:IF R%(L,0,T)>0 THEN NEXT K
1530 K=LL-1:NEXT K
1540 A$=WD$(L)
1550 REM  COMPUTE SPACES FOR CENTERING
1560 K=INT((40-LEN(A$))/2)
1570 REM  PRINT THE STIMULUS, HIGHLIGHTED
1580 PRINT MID$(BB$(3),1,K)"<R>"A$"<r><S>";
1590 RETURN
1600 :
1610 REM*** OBTAIN JUDGEMENT
1620 REM  DISPLAY CHECKMARK ABOVE SCALE
1630 PRINT "<Q><Q>";CU$;MID$(BB$(3),1,19)"[:]";
1640 REM  GET KEYBOARD INPUT
1650 GET MV$
1660 IF MV$=CHR$(13) THEN 1840 :REM MOVING DONE
1670 IF MV$="<" THEN A$="<}>[ ]<}><}>[:]":A=33288:GOSUB 1720:REM MOVE LEFT
1680 IF MV$=">" THEN A$="<}>[ ][:]":A=33326:GOSUB 1720:REM MOVE RIGHT
1690 GOTO 1650
1700 REM  MOVE THE CHECKMARK
1710 REM  STOP WHEN CHECK IS AT SIDE OF SCREEN
1720 IF PEEK(A)=122 THEN RETURN
1730 REM  ERASE OLD CHECK AND PRINT NEW CHECK
1740 PRINT A$;
1750 REM  'LIFT' KEY ARTIFICIALLY FOR AUTO REPEAT
```

Listing 1 continued on page 222

Listing 1 continued:

```
1760 REM  (FOR OLD ROM USE  POKE 515,255 )
1770 POKE 151,255
1780 REM  SLOW DOWN
1790 FOR A=1 TO 20:NEXT A
1800 RETURN
1810 :
1820 REM*** DEFINE SCALE VALUE AND RECORD
1830 REM  MOVE ACROSS SCALE
1840 FOR I=1 TO 39
1850 REM  SEARCH FOR CHECKMARK
1860 A=PEEK(33287+I)+64
1870 IF A<>ASC("[:]") THEN NEXT I
1880 REM  POSITION = VALUE
1890 VL=I
1900 REM  CLOSE LOOP
1910 I=39:NEXT I
1920 REM  ERASE THE CHECK
1930 PRINT "<}>[ ]<S>";
1940 RETURN
1950 :
1960 REM*** PRESENT EPA, AND SAVE DATA
1970 REM  SET FLAG FOR MOTIVATION TEST.
1980 K=0
1990 REM  RANDOMIZE ORDER OF PRESENTATION OF DIMENSIONS
2000 Q%(0)=INT(1+10*RND(1)/4)-1
2010 Q%(1)=INT(1+10*RND(1)/4)-1
2020 IF Q%(1)=Q%(0) THEN 2010
2030 Q%(2)=3-Q%(0)-Q%(1)
2040 REM  GO THROUGH THE THREE DIMENSIONS
2050 FOR N=0 TO 2
2060 REM  RANDOMIZE DIRECTION OF SCALE
2070 DI=INT(RND(1)+.5)
2080 REM  DISPLAY THE SCALE
2090 I=Q%(N):GOSUB 1310
2100 REM  GET THE RESPONSE
2110 GOSUB 1630
2120 REM  UNRANDOMIZE THE DATA AND STORE
2130 R%(L,Q%(N),T)=ABS(VL-DI*40)
2140 NEXT N
2150 REM  MOTIVATION CHECK ON WHETHER RATER IS JUST PRESSING RETURN
2160 IF K=1 OR R%(L,0,T)<>20 OR R%(L,1,T)<>20 OR R%(L,2,T)<>20 THEN RETURN
```

Listing 1 continued on page 224

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Circle 424 on inquiry card.

Listing 1 continued:

```
2170 PRINT "<S><Q><Q><Q><Q>"NM$", YOU RATED THIS ONE
2180 PRINT "AT THE MIDDLE ALL THREE TIMES.  [L]ET'S
2190 PRINT "DO IT AGAIN TO BE SURE ABOUT THAT.
2200 REM  PUNISHING DELAY
2210 FOR I=1 TO 5000:NEXT I
2220 REM  ERASE MESSAGE
2230 PRINT "<S><Q><Q><Q><Q>"BB$(3)
2240 PRINT BB$(3)
2250 PRINT BB$(3)"<S>";
2260 REM  COUNT HOW OFTEN THIS HAPPENS
2270 REM  (THIS IS SAVED ON TAPE WITH BACKGROUND QUESTIONS)
2280 BA%(0)=BA%(0)+1
2290 REM  RESET FLAG SO AS TO DO OVER ONE TIME
2300 K=1:GOTO 2000
2310 :
2320 REM*** DEFINITION OF STIMULI BY PROGRAMMER
2330 REM  NUMBER OF STIMULI
2340 LL=2
2350 REM  NUMBER OF BACKGROUND QUESTIONS IN THE SIGN-OFF SUBROUTINE
2360 NB=0
2370 REM  SAVE NUMBER OF STIMULI, REPLICATIONS, AND QUESTIONS ON TAPE
2380 PRINT#1,LL;CHR$(13);NR;CHR$(13);NB;CHR$(13);
2390 REM  SET UP DATA ARRAYS
2400 DIM WD$(LL-1),R%(LL-1,2,NR-1)
2410 REM  READ IN THE STIMULI; CONVERT TO CAPS/LC
2420 FOR I=0 TO LL-1:READ A$:GOSUB 860:WD$(I)=A$:NEXT I
2430 REM  DEFINITIONS OF STIMULI
2440 REM  EXAMPLE DEFINITIONS:
2450 DATA "MAKING LOVE","SOCIOLOGISTS"
2460 REM  ADD MORE DATA STATEMENTS IF NEEDED
2470 RETURN
2480 :
2490 REM*** DEFINITION OF STIMULI BY RESPONDENT
2500 REM  GET NUMBER OF STIMULI
2510 PRINT "<Q>[Y]OU ARE TO PROVIDE THE WORDS FOR THIS
2520 PRINT "ASSIGNMENT. [S]O LET'S DO THAT NOW.
2530 PRINT "<Q>[H]OW MANY THINGS ARE YOU GOING
2540 PRINT "TO RATE";
2550 GOSUB 720:LL=VAL(A$):REM INPUT
2560 IF LL<21 THEN 2640
2570 REM  USER WANTS TOO MANY
2580 PRINT "<Q>[S]ORRY,[ ]"NM$",[ ][I] CAN ONLY HANDLE
2590 PRINT "20 AT A TIME. [H]OW MANY DO YOU WANT TO
2600 INPUT "DO ON THIS RUN";LL
2610 IF LL<21 THEN 2640
2620 PRINT "<Q>[P]LEASE! [N]O MORE THAN":GOTO 2590
2630 REM  SET UP DATA ARRAYS
2640 DIM WD$(LL-1),R%(LL-1,2,NR-1)
2650 REM GO INTO CAPS MODE
2660 POKE 59468,12
2670 REM  GET THE STIMULI
2680 PRINT "<s><Q>FINE. NOW WHAT ARE THE WORDS?<Q><Q>
2690 FOR I=1 TO LL
2700 PRINT "<Q>"I;:GOSUB 720
2710 REM  CONVERT STIMULUS TO CAPS AND LOWER CASE
2720 GOSUB 860:WD$(I-1)=A$
2730 NEXT I
2740 REM RETURN TO CAPS AND LOWER CASE OPERATIONS
```

Listing 1 continued on page 226

Listing 1 continued:

```
2750 POKE 59468,14
2760 REM  ALERT USER, THEN CLEAR SCREEN
2770 PRINT"<s>"
2780 PRINT"<S><Q><Q><Q><Q>[O][K]. [H]ERE WE GO."
2790 FOR I=1 TO 1000:NEXT I
2800 PRINT"<s>";
2810 RETURN
2820 :
2830 REM*** DISPLAY RESULTS
2840 REM  OR SAVE RATINGS ON TAPE
2850 IF NOT TEACHING THEN FOR K=0 TO NR-1:FOR I=0 TO LL-1:FOR J=0 TO 2
2860 IF NOT TEACHING THEN PRINT#1,R$(I,J,K);CHR$(13);:NEXT J,I,K
2870 IF NOT TEACHING THEN RETURN
2880 PRINT "<s>[O][K]. [Y]OU'VE RATED EACH WORD TWICE ON THE
2890 PRINT "THREE SCALES.
2900 PRINT "<Q>[N]OW, [I]'LL SHOW YOU THE AVERAGE
2910 PRINT "PROFILES. [T]HEN [I]'LL SHOW YOU GRAPHS OF
2920 PRINT "THE RESULTS.";CU$
2930 REM  WAIT FOR USER TO RESPOND
2940 GOSUB 3670
2950 REM  PRESENT PROFILES
2960 REM  PRINT HEADERS
2970 PRINT TAB(16)"<R>"DM$(0)SPC(2)DM$(1)SPC(2)DM$(2)
2980 PRINT TAB(16)"<R>+[ ][ ]=[ ][ ]"SPC(2)"+[ ][ ]=[ ][ ]"SPC(2)"+[ ][ ]=[ ][ ]"
2990 PRINT TAB(16)"<R>[G]OOD[ ][ ]"SPC(2)"[S]TRONG"SPC(2)"[F]AST[ ][ ]<Q>"
3000 IF PAPER THEN CMD 4
```

Listing 1 continued on page 228

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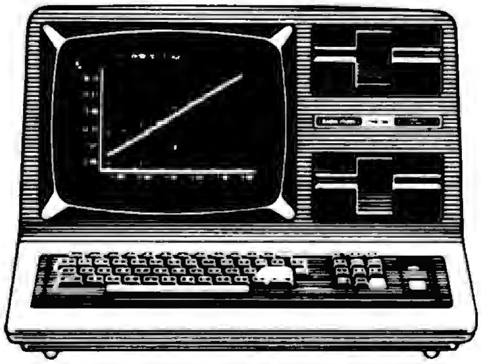

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Circle 22 on inquiry card.

Listing 1 continued:

```
3010 REM  FOR ALL WORDS
3020 FOR I=0 TO LL-1
3030 REM  TRUNCATE WORDS TO 12 CHARACTERS
3040 IF LEN(WD$(I))>12 THEN WD$(I)=LEFT$(WD$(I),12)
3050 REM  PRESENT INDEX LETTER, WORD AND SPACE OVER TO E COLUMN
3060 PRINT CHR$(I+65);"[ ]";WD$(I)SPC(13-LEN(WD$(I)));
3070 REM  FOR E, P, AND A
3080 FOR J=0 TO 2
3090 REM  COMPUTE SUMMED RATING
3100 IF NR>1 THEN FOR K=1 TO NR-1:R%(I,J,0)=R%(I,J,0)+R%(I,J,K):NEXT K
3110 REM  COMPUTE AVERAGE, SCALED INTO RANGE: + OR -4.75
3120 A=-(R%(I,J,0)-20*NR)/(4*NR)
3130 REM  CONVERT TO STRING
3140 A$=STR$(A)
3150 REM  ADD A SPACE IN FRONT OF FRACTIONS
3160 IF ABS(A)<1 THEN A$=" "+A$
3170 REM  ADD SPACES TO NEXT COLUMN AND PRINT
3180 A$=LEFT$(A$+BB$(0),8)
3190 PRINT A$;
3200 NEXT J:PRINT
3210 REM  DO NEXT WORD
3220 NEXT I:PRINT
3230 IF PAPER THEN PRINT#4
3240 REM  WAIT FOR USER RESPONSE
3250 GOSUB 3670
3260 REM  MAKE GRAPHS
3270 REM  DEFINE HORIZONTAL, VERTICAL, AND LATENT AXES
3280 HA=0:VA=2:LA=1
3290 REM  MAKE A GRID
3300 PRINT:PRINT:FOR I=1 TO 19
3310 PRINT TAB(6);:FOR J=1 TO 27:PRINT "[[]";:NEXT J:PRINT
3320 NEXT I
3330 REM  LABEL THE VERTICAL AXIS
3340 PRINT "<S><Q>"SPC(16);DM$(VA)
3350 REM  EMPHASIZE THE VERTICAL AXIS
3360 FOR I=1 TO 19:PRINT TAB(19)"[]]":NEXT I
3370 REM  MOVE TO HORIZONTAL AXIS
3380 PRINT "<S>"CU$;SPC(6);
3390 REM  EMPHASIZE IT
3400 FOR I=1 TO 27:PRINT "[@]";:NEXT I
3410 REM  LABEL IT
3420 PRINT DM$(HA)
3430 REM  ADD NUMERICAL LABELS TO VERTICAL AXIS
3440 PRINT "<S><Q>
3450 FOR I=-4 TO 4:PRINT "<Q>"TAB(19)"<R>"CHR$(48+ABS(I)):NEXT I
3460 REM  ADD NUMERICAL LABELS TO HORIZONTAL AXIS
3470 PRINT "<S>"CU$;SPC(5);
3480 FOR I=-4 TO 4:PRINT "<]><]><R>"CHR$(48+ABS(I));:NEXT I
3490 REM  FOR EACH STIMULUS
3500 FOR I=0 TO LL-1
3510 REM  BEGIN AT UPPER LEFT
3520 PRINT "<S><Q>";
3530 REM  GO DOWN PROPORTIONAL TO VALUE ON VERTICAL AXIS
3540 FOR J=1 TO INT((1+(2*R%(I,VA,0)/NR))/4):PRINT "<Q>";:NEXT J
3550 REM  GO OVER PROPORTIONAL TO VALUE ON HORIZONTAL AXIS
3560 PRINT TAB(5);
3570 FOR J=1 TO INT((80.92-(2*R%(I,HA,0)/NR))/2.92):PRINT "<]>";:NEXT J
```

Listing 1 continued on page 230

Listing 1 continued:

```
3580 REM  SELECT CAPS/LC TO FIT PLUS-MINUS VALUE ON LATENT AXIS
3590 A$=CHR$(I+65):IF (-(2*R%(I,LA,0)/NR)+40)>0 THEN A$=CHR$(I+193)
3600 REM  PRINT MARKER
3610 PRINT "<R>"A$
3620 NEXT I
3630 REM  DISPLAY KEY (INTERCHANGE 'PLUS' & 'MINUS' FOR OLD ROM)
3640 PRINT"<S>";CU$;CU$;"<q>";
3650 PRINT SPC(4)"<R>[X]<r> = PLUS "DM$(LA)"[ ][ ][ ]<R>X<r> = MINUS "DM$(LA):PRINT
3660 REM  WAIT FOR USER TO RESPOND
3670 PRINT "<]><]><]><]><]><]><]><]><]>[P]RESS <R>[C]<r> TO CONTINUE.";
3680 GET A$:IF A$<>"C" THEN 3680
3690 PRINT "<s>";
3700 REM  CHANGE AXES, IF GRAPHING
3710 A=HA:HA=VA:VA=LA:LA=A:IF HA THEN 3300
3720 RETURN
3730 :
3740 REM*** INTRODUCTION AND INSTRUCTIONS
3750 REM  DISABLE STOP KEY (OLD ROM: POKE 537,136; OS 4.0: POKE 144,88)
3760 POKE 144,49
3770 REM  GET PERSON'S NAME IN ALL CAPS MODE
3780 POKE 59468,12
3790 PRINT "<s>PLEASE TYPE OUT YOUR FIRST NAME
3800 PRINT "<Q>AND THEN PRESS THE <R>RETURN<r> KEY.";CU$
3810 PRINT "[ ][ ][ ][ ]YOUR FIRST NAME";:GOSUB 720
3820 REM  STOP PROGRAM IF 'END' WAS ENTERED
3830 IF A$<>"END" THEN 3880
3840 REM  SAVE STIMULI AND CLOSE TAPE FILE
3850 FOR I=0 TO LL-1:PRINT#1,CHR$(34);WD$(I);CHR$(34);CHR$(13);:NEXT I:CLOSE 1
3860 PRINT "<s><R>NUMBER OF RESPONDENTS =";NN:END
3870 REM  COUNT RESPONDENTS
3880 NN=NN+1
3890 REM  CONVERT NAME TO CAPS AND LOWER CASE
3900 GOSUB 860:NM$=A$
3910 REM  CONVERT OPERATIONS TO CAPS AND LOWER CASE
3920 POKE 59468,14
3930 PRINT "<s>[A]S YOU SEE, [I]'M A MICROCOMPUTER.
3940 PRINT "[I]'M GOING TO HELP YOU EXPRESS SOME
3950 PRINT "ATTITUDES. [I] HOPE YOU ENJOY IT.
3960 PRINT "<Q>[T]ELL ME, "NM$", HAVE YOU DONE THIS
3970 PRINT "WITH ME BEFORE?"
3980 PRINT CU$"<]><]>([T]YPE <R>[Y]<r> FOR [Y]ES, <R>[N]<r> FOR [N]O.)
3990 GET A$:IF A$<>"Y" AND A$<>"N" THEN 3990
4000 IF A$="Y" THEN PRINT"<s><Q>[O][K]. [I]'LL SKIP THE INTRODUCTION THEN.":GOTC 2790
4010 REM  INSTRUCTIONS FOR NEW USERS
4020 PRINT "<s>[Y]OU'LL SAY HOW YOU FEEL ABOUT SOME
4030 PRINT "DIFFERENT THINGS. [I]'LL FLASH
4040 PRINT "WORDS AT THE TOP OF THE SCREEN.
4050 PRINT "<Q><Q><Q><Q>([P]RESS <R>[R]<r> WHEN YOU'RE READY, AND
4060 PRINT "[I]'LL SHOW YOU HOW [I] DO IT.)
4070 GET A$:IF A$<>"R" THEN 4070
4080 REM  CLEAR SCREEN AND MAKE EXAMPLE STIMULUS
4090 PRINT "<s>";:A$="[A] [M][I][C][R][O][C][O][M][P][U][T][E][R]"
4100 REM  DISPLAY STIMULUS
4110 GOSUB 1560
4120 REM  TIME DELAY
4130 FOR I=1 TO 1000:NEXT I
4140 REM  CONTINUE INSTRUCTIONS
4150 PRINT "<Q><Q><Q>[Y]OU SHOW HOW YOU FEEL ABOUT IT ON A
```

Listing 1 continued on page 234

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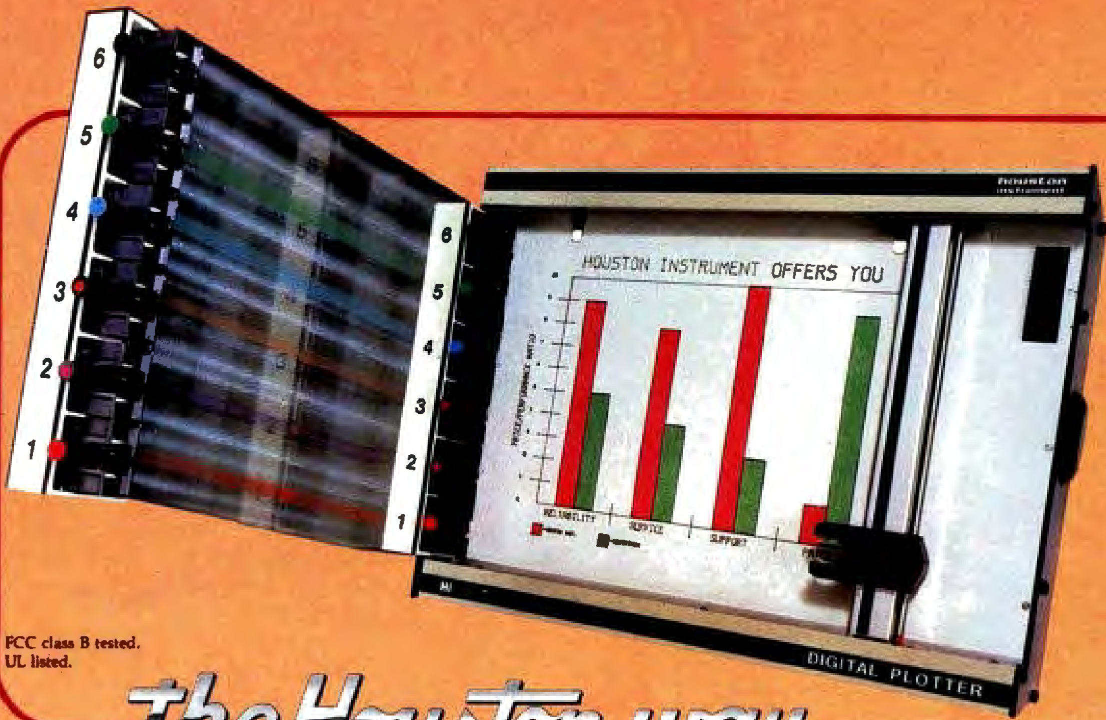

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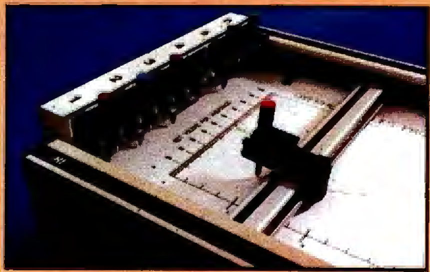

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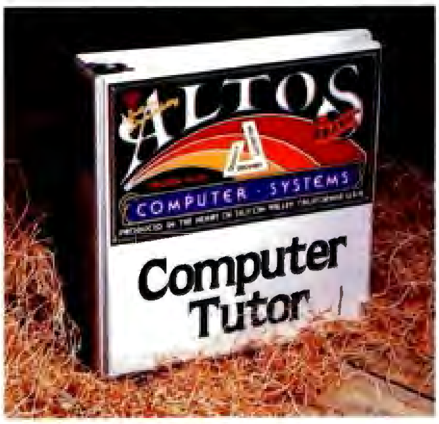

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Circle 20 on inquiry card.

Listing 1 continued:

```
4160 PRINT "SCALE LIKE THIS.<S>";
4170 REM  DISPLAY EVALUATION ADJECTIVES
4180 I=0:DI=0:GOSUB 1310
4190 REM  DISPLAY SCALE
4200 GOSUB 1030
4210 REM  TIME DELAY
4220 FOR I=1 TO 1200:NEXT I
4230 REM  OVERWRITE LAST INSTRUCTIONS WITH NEW
4240 PRINT "<Q><Q><Q>[A] CHECK MARK WILL APPEAR ABOVE THE LINE,";
4250 PRINT "AND YOU MOVE IT BACK AND FORTH WITH THE ";
4260 PRINT "<R><<r> KEY OR THE <R>><r> KEY.  [Y]OU PRESS <R>RETURN<r>
4270 PRINT "WHEN THE CHECK IS WHERE YOU WANT IT.
4280 PRINT "<Q>[G]O AHEAD AND TRY IT. [R]ATE [M][E].<S>";
4290 REM  OBTAIN JUDGEMENT
4300 GOSUB 1630
4310 REM  RESPONSE FOR GOOD JUDGEMENT
4320 IF VL<19 THEN PRINT "<s>[G]EE, "NM$".":PRINT "[T]HAT'S GOOD OF YOU!":GOTO 4360
4330 REM  RESPONSE FOR BAD JUDGEMENT
4340 PRINT "<s>[G]OSH. [B]UT "NM$".":PRINT "[Y]OU HARDLY KNOW ME!"
4350 REM  TIME DELAY
4360 FOR I=1 TO 1000:NEXT I
4370 PRINT "<Q><Q>[W]ELL, YOU'VE GOT THE IDEA.
4380 REM  TIME DELAY
4390 FOR I=1 TO 1800:NEXT I
4400 REM  FINISH INSTRUCTIONS
4410 PRINT "<s>[Y]OU RATE EACH THING ON THREE
```

Listing 1 continued on page 236

Listing 1 continued:

```
4420 PRINT "DIFFERENT SCALES.<O>
4430 FOR I=1 TO 1500:NEXT I
4440 IF NOT TEACHING THEN 2780
4450 PRINT "[W]E'LL GO THROUGH EVERYTHING TWICE.
4460 PRINT "[A]FTER YOU'VE FINISHED, [I]'LL
4470 PRINT "CONVERT YOUR RATINGS TO NUMBERS,
4480 PRINT "CALCULATE AVERAGES, AND PRESENT THE
4490 PRINT "RESULTS IN CHARTS.
4500 RETURN
4510 :
4520 REM*** CLOSING
4530 REM  FOR BACKGROUND DATA, INCLUDE LINES LIKE THESE
4540 REM  PRINT "<s>[N]OW, "NM$", A FEW QUESTIONS ABOUT YOU.":IB=0
4550 REM  IB=IB+1:INPUT "[A]RE YOU <R>1<r> MALE OR <R>2<r> FEMALE";A$:BA%(IB)=VAL(A$)
4560 PRINT "<s>[O][K], "NM$", THAT'S ALL.":PRINT "[H]OPE YOU ENJOYED IT!
4570 REM  SAVE BACKGROUND DATA ON TAPE
4580 IF NOT TEACHING THEN FOR I=0 TO IB:PRINT#1,BA%(I);CHR$(13);:BA%(I)=0:NEXTI
4590 REM  CLEAR DATA
4600 FOR I=0 TO LL-1:FOR J=0 TO 2:FOR K=0 TO NR-1:R%(I,J,K)=0:NEXT K,J,I
4610 FOR I=1 TO 5000:NEXT I
4620 RETURN
4630 :
4640 :
4690 REM*** ENTRY TO READ AND ANALYZE SAVED DATA
4700 OPEN 1,1
4710 INPUT "<s>NUMBER OF RESPONDENTS";I2
4720 INPUT#1,LL,I1,IB
4730 NR=I1*I2
4740 INPUT "ENTER -1 FOR HARD COPY, 0 FOR NONE";PA
4750 OPEN 4,4
4760 GOSUB 390
4770 DIM R%(LL-1,2,NR-1),WD$(LL-1)
4780 FOR H=0 TO I2-1
4790 FOR K=0 TO I1-1
4800 FOR I=0 TO LL-1
4810 FOR J=0 TO 2
4820 INPUT#1,R%(I,J,H*I1+K)
4830 NEXT J,I,K
4840 FOR I=0 TO IB
4850 INPUT#1,BA%(I)
4860 NEXT I,H
4870 FOR I=0 TO LL-1
4880 INPUT#1,WD$(I)
4890 NEXT I
4900 CLOSE 1
4910 POKE 59468,14
4920 PRINT "<s>";
4930 GOSUB 2970
4940 CLOSE 4
4950 END
```

Text continued from page 214:
entering RUN 4700. You will be asked to enter the number of respondents and to indicate where you want the EPA profiles printed, on paper or on screen. The program searches the tape for the first file, opens it, and reads the recorded data. Then the program presents results, as described above. The multiple respondents are treated as additional replications (presentations of the stimuli) when mean values are calculated. The program does not analyze background questions, but the variables are available in the data file for analysis by other statistical programs.

Options in the Attitudes Program

The mode of operation is set in line 130. Use TEACHING = −1 for the

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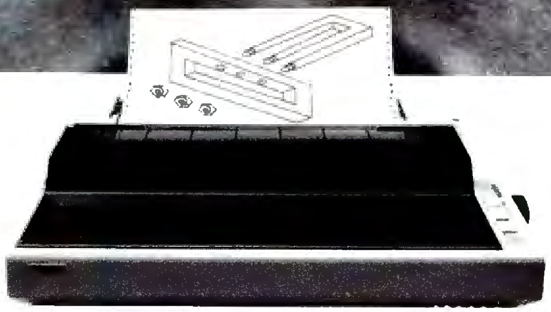

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teaching mode and TEACHING=0 for the field mode. (To get a hard copy of the profiles table while in the teaching mode, change line 170 to PAPER=−1 and keep the printer turned on throughout the session.)

The program obtains two complete sets of ratings from each respondent. You can change this to one set or to more than two by changing the value of NR in line 200. You also should change the word "twice" in the instructions if operating in the teaching mode (lines 2880 and 4550).

In the field mode, stimuli are entered using DATA statements, as illustrated at line 2450. Type the words without using the shift key because the program provides caps and lowercase. (To disable the capitalization feature, remove GOSUB 860 in line 2420.) You also must specify the number of stimuli as the value of LL in line 2340. No definite limit on the number of stimuli exists in the field mode operation, but 50 would strain the patience of most respondents.

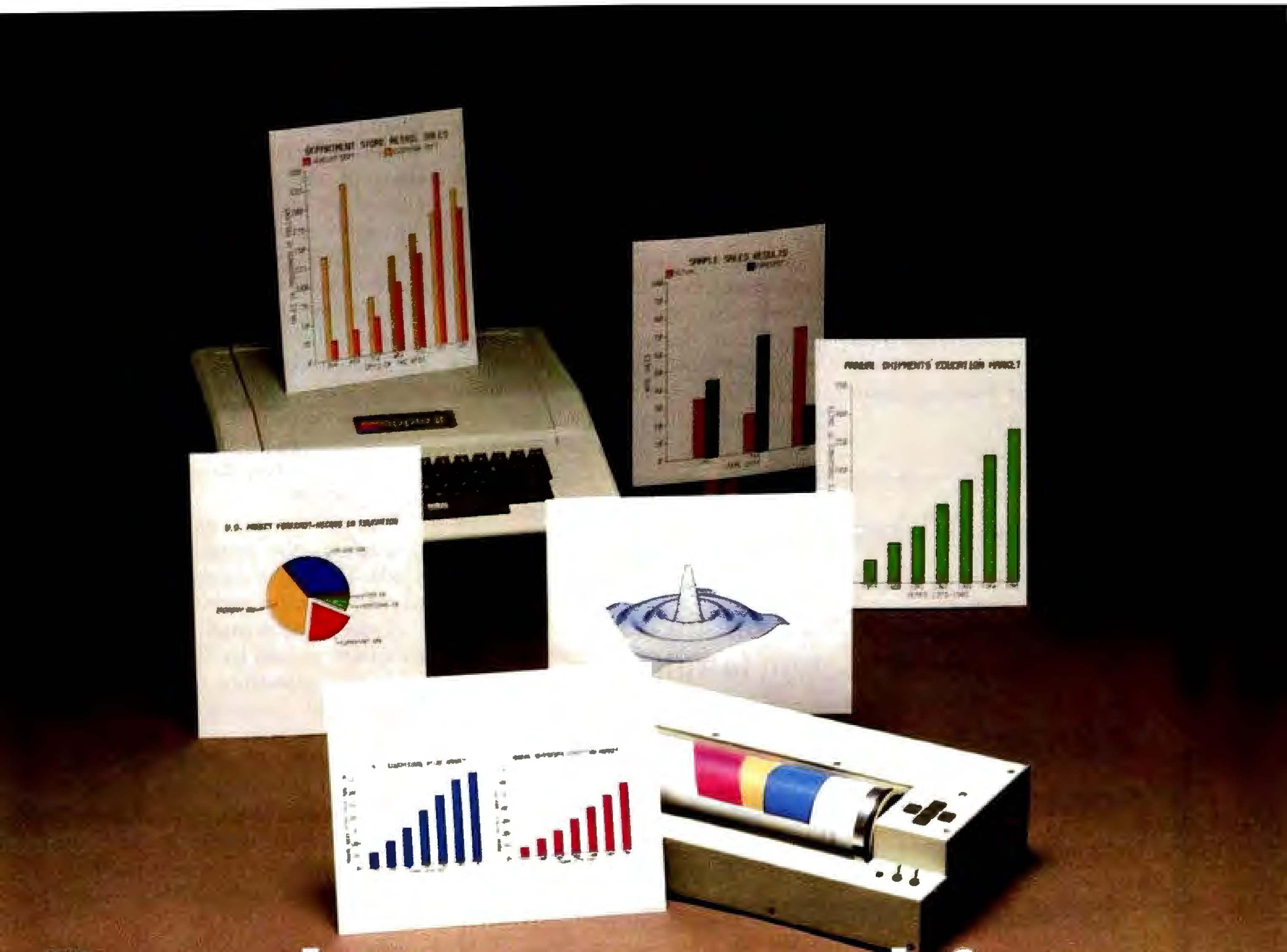
Background questions are entered via program lines, as illustrated in lines 4540-4550 (you wouldn't include the REM at the beginning of the lines). You'll have to experiment to get a neat format; be sure to test the altered program before using it. IB=IB+1 must precede each question. Also, you must set NB in line 2360 equal to the total number of background questions.

The data file written to tape begins by defining the number of stimuli (LL), the number of replications (NR), and the number of background questions (NB). Data are then written with the structure shown in table 1a. Each number or word in the file is followed by a "return"—CHR$(13). EPA values are written as integers 1 to 39; to transform these to plus-minus scores, subtract 20 and divide by 4. As an example, suppose two respondents rated the stimuli "Making Love" and "Sociologists" with two replications and no background questions. The file might look like the left part of table 1b, where "\" stands for CHR$(13).

Scale adjectives used to define the dimensions are based on previous research and are appropriate for most applications. You can, however, change the adjectives by altering the DATA statements in lines 520-600. Each entry, enclosed in quotes, must be spaced out to ten characters. A dimension is defined by three pairs of elements which are either adjectives or blanks.

Example of a Field Application

Senator Jones is running against Mayor Smith for election to the state legislature. Jones decides to see how he's doing and has a worker take a PET to a shopping mall. The attitudes program is set up to operate in the field mode with one presentation (NR=1) of the stimuli "Candidate Alfred B. Jones" and "Candidate Thomas A. Smith." Thirty-five adults use the program. When the data tape is analyzed, mean profiles are as follows:



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Jones 3.0 1.0 1.0
Smith 2.1 3.2 0.5

People usually vote for the candidate seen as the most good and powerful. Jones is fine on goodness, but he needs to improve the image of his potency by stressing his military record, political victories, and religious faith. Smith, if he had the results, would see that he should work on his perceived goodness by joking, kissing babies, and shaking hands cheerfully.

Program Notes

The program is constructed for 40-column Commodore machines. Since it is written in BASIC, the program could be adapted for other computers.

Special symbols used in the listing are defined in table 2. Listing 2 shows all variables and the lines at which they occur. Leave out remarks when entering the program unless you have a 32K machine; documentation more than doubles the program's size.

Contrary to the company's claims, Commodore BASIC is not the same on all machines, and different versions of the program have to be created for old and new ROMs. The difficulty: capital and lowercase letters reverse between old and new ROM sets. The program's PEEKs and POKEs have to be adjusted for different ROM sets, as indicated in remarks preceding the relevant lines.

The overall structure of the program is shown in the executive routine, lines 220-360, and the routine to analyze data on tape is in lines 4690-4950.

Timing loops are scattered throughout the program (e.g., line 4130). These give the respondent time to read messages and instructions.

A special input routine with a shaded cursor is used by the program to prevent respondents from breaking out of the program by pressing RETURN without prior keystrokes (lines 690-830). The STOP key is disabled most of the time (line 3760) but can be restored to normal functioning during the input routine (in case you wish to break for programming purposes) by pressing SPACE, then RETURN.

The routine in lines 850-1000 capitalizes the first letter in a string as well as letters appearing after spaces; it turns all other letters into lowercase.

Lines 1020-1270 contain the routine for drawing the graphic rating scale, which prints adverbial anchors vertically below the scale. The choice and positioning of adverbs along the scale is based on previous research. The routine for putting adjectives on the scale (lines 1290-1420) overwrites the adjectives there previously. When fewer than three pairs of adjectives are being displayed, blank elements are used to erase previous lines.

Stimulus presentation (lines 1440-1590) first involves erasing the old stimulus. A new stimulus is then chosen as follows. A stimulus number is generated randomly; if it has already been rated on this round, another stimulus number is selected randomly. The process is repeated until an unrated stimulus is found. If this does not occur within 2000 tries,

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Listing 2: *The variables in the attitude-measurement program and the lines on which each variable occurs.*

```
       LIST OF VARIABLES IN PROGRAM: "ATTITUDES"

A      750 750 790 1670 1680 1720 1790 1790 1860 1870 3120 3140 3160 3710
       3710
A$     770 790 880 890 950 990 1350 1370 1390 1390 1540 1560 1580 1670 1680
       1740 2420 2420 2550 2720 3140 3160 3160 3180 3180 3190 3590 3590 3610
       3680 3680 3830 3900 3990 3990 3990 4000 4070 4070 4090
AJ$()  390 500 1370 1390 1390
AV$()  390 450 1140 1200
B$     890 930 950 950 970 1350 1370 1390
BA%()  2280 2280 4580 4580 4850
BB$()  390 410 410 420 420 430 430 1140 1200 1390 1460 1580 1630 2230 2240
       2250 3180
C$     860 950 950 970 970 990
CU$    640 1030 1630 2920 3380 3470 3640 3640 3800 3980
DA%()  390
DI     860 950 1390 1390 2070 2130 4180
DM$()  390 620 620 620 2970 2970 2970 3340 3420 3650 3650
H      4780 4820 4860
HA     3280 3420 3570 3710 3710 3710
I      410 410 450 450 450 490 500 510 660 1050 1050 1070 1140 1200 1230
       1240 1370 1390 1390 1840 1860 1870 1890 1910 1910 2090 2210 2210 2420
       2420 2420 2690 2700 2720 2730 2790 2790 2850 2860 2860 3020 3040 3040
       3040 3060 3060 3060 3100 3100 3100 3120 3220
       3300 3320 3360 3360 3400 3400 3450 3450 3450 3480 3480 3480 3500
       3540 3570 3590 3590 3590 3620 3850 3850 3850 4130 4130 4180 4220 4220
       4360 4360 4390 4390 4430 4430 4580 4580 4580 4580 4600 4600 4600 4610
       4610 4800 4820 4830 4840 4850 4860 4870 4880
       4890
I1     4720 4730 4790 4820
I2     4710 4730 4780
IB     4580 4720 4840
J      490 500 510 1100 1120 1140 1150 1180 1190 1200 1210 1330 1370 1390
       1390 1400 2850 2860 2860 3080 3100 3100 3100 3120 3200 3310 3310 3540
       3540 3570 3570 4600 4600 4600 4810 4820 4830
```

Listing 2 continued on page 244

Listing 2 continued:

```
K       490 500 510 880 890 930 930 950 950 950 950 980 1120 1120 1140 1190
        1190 1200 1480 1490 1490 1500 1520 1520 1520 1530 1530 1560 1580 1980
        2160 2300 2850 2860 2860 3100 3100 3100 4600 4600 4600 4790 4820 4830
L       1480 1490 1520 1520 1540 2130 2160 2160 2160
LA      3280 3590 3650 3650 3710 3710
LI      290 320
TI      660
VA      3280 3340 3540 3710 3710
VL      1890 2130 4320
WD$()   1540 2400 2420 2640 2720 3040 3040 3040 3060 3060 3850 4770 4880
X       750 790
LL      290 1480 1520 1530 2340 2380 2400 2400 2420 2550 2560 2600 2610 2640
        2640 2690 2850 3020 3500 3850 4600 4720 4770 4770 4800 4870
MV$     1650 1660 1670 1680
N       2050 2090 2130 2140
NB      2360 2380
NM$     140 140 2170 2580 3900 3960 4320 4340 4560
NN      3860 3880 3880
NR      200 280 2380 2400 2640 2850 3100 3100 3120 3120 3540 3570 3590 4600
        4730 4770
PA      170 180 3000 3230 4740
Q%()    390 2000 2010 2020 2020 2030 2030 2030 2090 2130
R%()    1490 1520 2130 2160 2160 2160 2400 2640 2860 3100 3100 3100 3120
        3540 3570 3590 4600 4770 4820
T       280 320 1490 1520 2130 2160 2160 2160
TE      130 140 180 240 260 350 2850 2860 2870 4440 4580
```

the program searches through the stimuli sequentially, taking the first unrated stimulus it finds. Once found, the stimulus is centered and highlighted at the top of the screen. (Highlighting can be removed by deleting the REVERSE character in line 1580.)

The routine for getting a respondent's judgment (lines 1610-1940) prints a check mark at the center of the graphic rating scale and moves it left or right, depending on whether the respondent presses the < or > keys. Auto repetition is obtained by using a POKE that makes the PET act as if the key were released. The routine PEEKs at the screen to see if

Parameters LL, NR, NB
Respondents 1 to NN
  Attitude data
    Replications 1 to NR
      Stimuli 1 to LL
        Dimensions E, P, A
  Background data
    Frequency of 3 neither-ratings
    Optionally, answers for questions 1 to NB
List of stimuli 1 to LL

Table 1a: *The structure of a data file written to tape by the attitude-measurement program shown in listing 1. LL defines the number of stimuli, NR the number of replications (the number of times the stimuli are presented to respondents), and NB the number of background questions. NN is the number of respondents. Respondents rate each stimulus in three dimensions for each replication. The program reports the frequency of rating a stimulus "neither" in all three dimensions, a sign that the respondent is repeatedly hitting RETURN without really reflecting on his or her attitudes.*

```
                2\ 2\ 0\
31\ 35\ 35\  20\ 20\ 21\
33\ 32\ 34\  18\ 22\ 19\
                      0\
38\ 39\ 33\  23\ 27\ 15\
36\ 36\ 35\  20\ 25\ 13\
                      0\
           "Making Love"\
            "Sociologists"\
```

Table 1b: *A sample set of data from the attitude-measurement program. Organized according to the structure shown in table 1a, these data were gathered in response to two stimuli, presented to two respondents, and replicated twice. Respondents rated stimuli in each of three dimensions. There were no background questions and no triple "neither-ratings." The "\" represents a carriage return [CHR$(13)].*

<S>	Cursor home
<s>	Clear screen
<Q>	Cursor down
<q>	Cursor up
<]>	Cursor right
<}>	Cursor left
<R>	Reverse on
<r>	Reverse off
A-Z	Lowercase letters
[A]-[Z]	Capitals
[ ]	Space
[:]	Check mark
[I]	Cross
[I]	Vertical line
[@]	Horizontal line
[&]	Shaded square

Table 2: *Definitions of the special symbols used in the attitude-measurement program shown in listing 1.*

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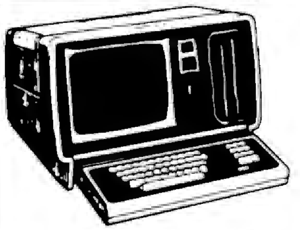

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the check is at the extreme left or right and stops movement if so. When the respondent presses RETURN, the program PEEKs across the screen until it finds the check, then records its position and erases the mark.

Lines 1960-2300 present the EPA scales and store numerical judgments in arrays. Order of presentation is randomized by choosing the first scale randomly, the second randomly as long as it is not equal to the first choice, and the third as the scale that hasn't been done yet. Orientation of the scale is determined by a random number that defines which adjectives are printed on the left. The value returned by the judgment routine is stored in a data array, taking into account the various randomizations. This routine also monitors answers to make sure the respondent is not just hitting RETURN without moving the check.

The section that displays results (lines 2830-3720) saves data on tape and returns if operating in the field mode. Results appear when in the teaching mode and when the routine is called from the tape-read subprogram. The instructions (lines 3740-4500) have been described in detail. You can, of course, change them to suit yourself.

Background questions, if any, are presented in the closing routine. The routine then saves the answers on tape, clears the data matrix, and returns.

The routine for analyzing recorded data (lines 4690-4950) begins by opening the tape file. The number of respondents is input manually, but other parameters of the analysis are read off the tape. Signal if you want the mean values printed on paper. A printer file is opened for device 4 (even if you signal that you don't want hard copy). Dimensions are set for arrays. The number of replications is calculated as the original number of replications times the number of respondents. Data are read, and results are presented using the usual Results subroutine.

Conclusion

Now that you have at your disposal a sophisticated tool for measuring attitudes, you may find more applications than you thought possible. Forecasting programs for microcomputers have given small businesses financial-planning tools once reserved for giant corporations. Attitude-assessment programs can provide similar help in devising marketing strategies, product lines, and service goals. You no longer have to stand on a giant's shoulders to enjoy a better view.■

Further Readings

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Microcomputers in Cultural Anthropology

APL Programs for Qualitative Analysis

Microcomputers aid in the study of Navajo and other cultures.

Oswald Werner
Professor of Anthropology and Linguistics
Northwestern University
Evanston, IL 60201

Several years ago, a fire at the Center for Advanced Study in the Behavioral Sciences at Stanford University destroyed the life's work of a well-known anthropologist. Thousands of pages of field notes were lost to flames and the water used to put them out. Loss of data is a recurring nightmare for most of my colleagues. Equally important is the question of how to manage all this data. A few professional cultural anthropologists, like myself, believe microcomputers can help.

In this article, I'll talk about the management of qualitative data, mainly texts. A text is any thought or idea reduced to writing.

The Nature of Data in Cultural Anthropology

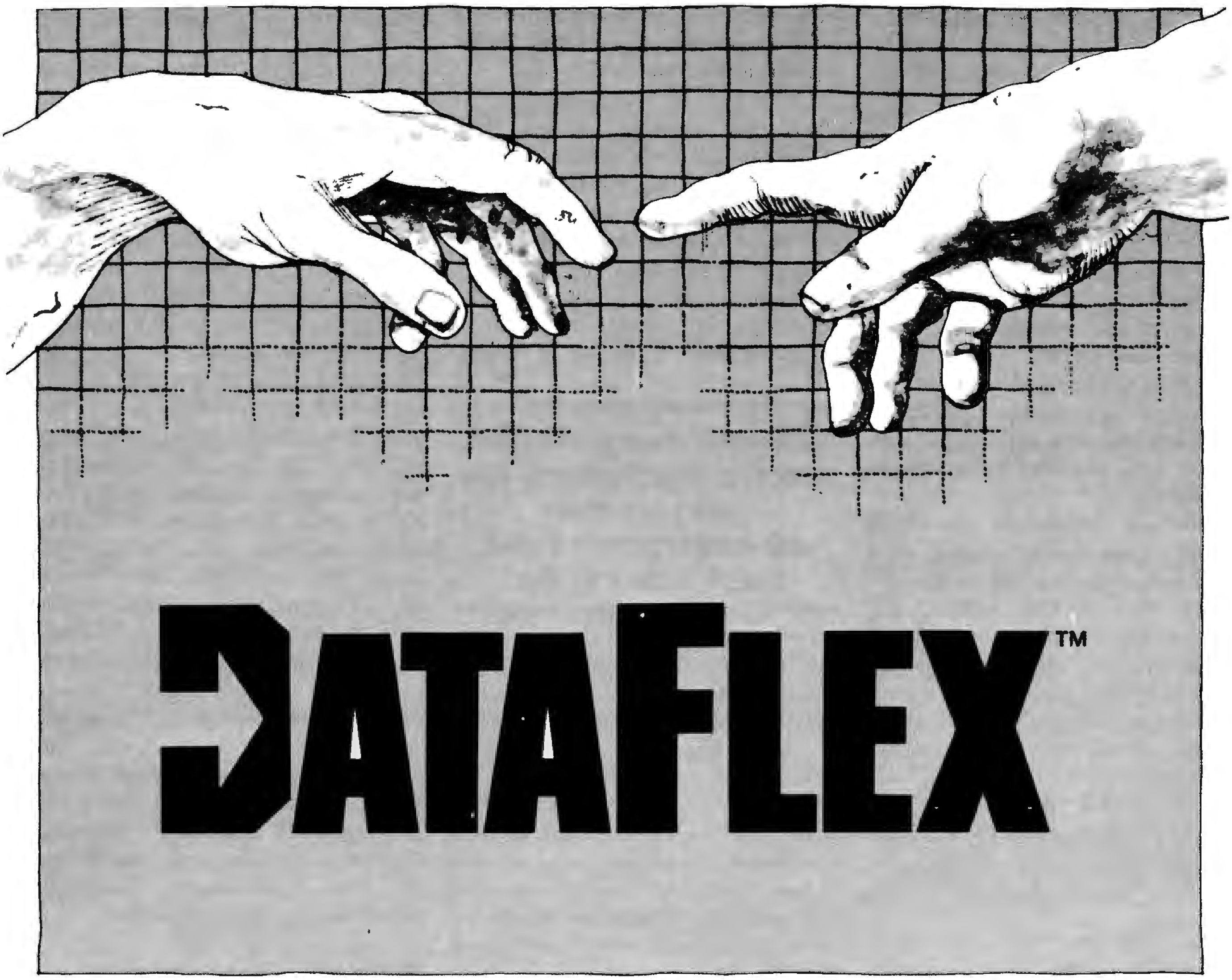
Anthropologists' data comes in different forms. Numerical data is relatively easy to manage. Statistics is a way of summarizing large bodies of numerical information. The major crunch cultural anthropologists face is the tremendously rapid growth of texts or qualitative data, one of the hallmarks of our profession.

For example, a simple 45-minute interview results in texts of 5000-7000 words. It does not take many interviews to collect a database of several hundred thousand words. Anne Chambers and Ralph Bolton, two cultural anthropologists from California, estimate that the databases of anthropologists returning from field trips of one year to 18 months range from several hundred pages to a maximum of about 8000 pages (2 million words). The average is about 1000 pages, or 500,000 words. For those of us who teach anthropologists to work in the field, the low end of this figure is shocking. A hypothetical database of 50,000 words (roughly 200 double-spaced pages) is relatively easy to manage. The thorough field worker's problems increase as the data grows beyond a few hundred pages into thousands.

The size of the database obviously depends on the problem chosen as the focus of the study. For example, a linguistic problem, such as the grammatical description of an unknown but exotic language, may require a database closer to the lower limit. On the other hand, the description of the culture of a small tribe, a peasant village, a city neighborhood, a patient-care unit in a hospital, or a small industrial company, requires extensive interviews and other documents. This problem of volume is typical of the branch of cultural anthropology called ethnography (the Greek source means "the description of a folk").

Ethnographers, as the anthropologists (and some sociologists) doing ethnographies are called, are comparable to systems engineers. These engineers try to determine, for example, the paper flow in a bureaucracy and then try to make it more efficient. Describing the flow of paper through an organization is an ethnographic task. You can think of ethnographers as systems engineers who describe how groups of people function. The "flows" that ethnographers study involve such items as women (wives), goods (gifts), ideas (religion), etc.

Until recently, ethnographers rarely wanted to improve efficiency. Today, many anthropologists/ethnographers work with agricultural innovations in the Third World, health-care utilization and program evalua-



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tion, or in other areas where their work benefits humanity. The initial aspect of applied anthropological work, before concrete recommendations are offered, is always ethnographic, or descriptive.

Ethnographic field work is viewed as qualitative social science. Surveys with questionnaires are quantitative social science. Questionnaires are usually short—100 questions are considered the upper limit. They can be administered to 1000 people or more. Ethnographies, based on intensive interviews, are usually limited to no more than 100 people. It is clear that these two approaches, qualitative (deep but narrow) and quantitative (broad but shallow), complement each other.

Texts are important for other reasons. Quantitative studies of a society must be viewed as literally looking in from the outside. The power of the qualitative approach is that it tries to capture the internal view: how the "natives" themselves see their life and how they talk about it. This approach is looking from the inside out.

The texts that ethnographers produce while working in the field are collected as field notes. Technically, field notes contain two types of data or texts:

- Records of the ethnographer's observations. These are observations of others, as well as of the ethnographer. Self-observation is important since the ethnographer's self is part of the instrumentation.
- The records of verbatim statements by the people being studied about aspects of their life.

There are, therefore, at least two databases that must be managed. In addition, since the self-observations must be related to what the natives say, there must be cross-referencing between the two texts.

All this leads us to the inevitable conclusion that the state of the art of gathering large databases in ethnography is chaotic at best. We do not teach undergraduates *or* graduates how to organize databases. This lack of knowledge about ethnographic data management is reflected in the time it takes ethnographers to find their way through the maze of their field notes. It may take years before a viable manuscript is produced. The arrival of microcomputers has alerted us to the problem, as well as to possible solutions.

Without exaggeration, Electric Blackboard is a product that ethnographers have been waiting for.

When I wrote my dissertation at Indiana University on a pidginized form of the Navajo language called Trader Navajo, spoken by Anglo traders to their Navajo customers, all I did for some time was collect the data. Some of it was on cards, some in notebooks. I did not start to organize the data until after I had collected all the material. In all, I spent six months organizing the data and only six weeks actually writing the dissertation. In the process, I learned the value of a well-organized database.

Minimally, an ethnographer needs an effective indexing system. Since it is often not known in advance what topics will become salient for the final ethnography, the index must be flexible enough to allow for searches that were not planned in advance. In a relational database management system, such as the one described by Joel Neely and Steve Stewart (BYTE, November 1981, page 48), the designer must anticipate most of the queries that may be directed at the data. In addition, data types (tables) must be well defined. The ethnographer, on the other hand, is transported by a culture on a journey whose end cannot be anticipated. Doing an ethnography is a continuous process of discovery. Our data types are rarely well defined. Our information-retrieval techniques must reflect the need for extreme flexibility. Often, we use keyword indexes.

Shifting to Microcomputers

For years, we used a cumbersome system for relaying data between Monument Valley, Arizona, and the

Every computer user and programmer owes a debt to Kamins and Waite … ful presentation aided by numerous illustrations, *8086/8088 16-bit Micropro-* … All of these features, enhanced by

Vogelback Computing Center at Northwestern University. Later, we used outmoded word-processing equipment. We had to abandon that approach, however, when the supplier canceled its WATS line and left

grams, called functions, allows the programmer to solve one small problem at a time, debug it, and have it ready for insertion into larger programs.

I found that I could easily express

does have many symbols, but anyone can start programming in APL with a small subset of APL symbols and gradually enlarge the arsenal of elegant operations.

APL purists often complain about

Listing 1: *ALFORDER, an APL/V80 program that indexes words. The program takes text as input and produces an output of keywords in a context of 120 characters each. Figure 2 shows a block diagram of ALFORDER.*

```
      )WSID
ALFORDER

      ⎕A
26095

      )FNS
ALFORDER DELHYP DISPLAY INORDER LOCATE MATSRT PRINT RDY VECMAT

      ∇ALFORDER[⎕]∇
      ∇ALFORDER TXT;LOC
[10] 2⍴LF
[20] ⍝ DELETE TRAILING AND MULTIPLE SPACES.  CATENATE SPACE AT
[30] ⍝ BEGINNING OF TEXT TO ENSURE 1ST SPACE FOR <LOCATE>.
[40] TXT←RDY' ',TXT
[50] ⍝ COMPUTE BEGINNING POSITIONS OF WORDS
[60] LOC←LOCATE TXT
[70] ⍝ SORT LOCATIONS BASED ON MATRIFIED WORD LIST
[80] LOC←LOC[MATSRT' ' VECMAT 1↓TXT]
[90] ⍝ PRINT RESULTS
[100] LOC PRINT TXT
      ∇

      ∇RDY[⎕]∇
      ∇R←RDY TXT
[10] ⍝ PREPARE TEXT BY ELIMINATING MULTIPLE BLANKS
[20] R←TXT≠' '
[30] R←(R∨1↓R,0)/TXT
      ∇

      ∇LOCATE[⎕]∇
      ∇R←LOCATE TXT
[10] ⍝ RETURNS LOCATIONS OF WORD BEGINNINGS
[20] R←1+(TXT∊' ')/⍳⍴TXT
      ∇

      ∇VECMAT[⎕]∇
      ∇R←DEL VECMAT V;A;B;CMP
[10] ⍝CONVERTS CHARACTER STRING TO MATRIX BASED ON DELIMITER
[20] R←0 0⍴' '
[30] →(1=B←⍴V←V,''⍴DEL)/0
[40] R←((⍴R),B)⍴(,R∘.≥⍳B←⌈/R←¯1+R-0,¯1↓R←A/⍳B)\(~A←V=DEL)/V
      ∇


      ∇MATSRT[⎕]∇
      ∇R←MATSRT TXT;CNT
[10] ⍝ BASIC RADIX SORT WITHOUT BASE ENCODING
[20] CNT←(⍴TXT)[2]-1
[30] R←⍋AL⍳TXT[;CNT+1]
[40] →CNT↓0
[50] L1:R←R[⍋AL⍳TXT[R;CNT]]
[60] CNT←CNT-1
[70] →(×CNT)/L1
      ∇



      ∇PRINT[⎕]∇
      ∇LOC PRINT TXT;RHO;CT;BIN
[10] ⍝ PAD TO PREVENT INDEX ERRORS
[20] TXT←(60⍴' '),TXT,60⍴' '
[30] ⍝FOLLOWING IS THE LOOP VERSION OF <TXT[(LOC-1)∘.+⍳120]>
[40] →(RHO←⍴LOC)↓0
[50] CT←1
[60] LOC←LOC-1
[70] BIN←(60⍴1),(5⍴0),60⍴1
[80] LP:BIN\TXT[LOC[CT]+⍳120]
[90] →(RHO≥CT←CT+1)⍴LP
      ∇
```

Listing 2: *SORTINDEX, an APL/V80 program that accepts text as input and produces an output of the text arranged in 18-character columns and the same text alphabetized. A block diagram of SORTINDEX appears in figure 3.*

```
      )WSID
SORTINDEX
```

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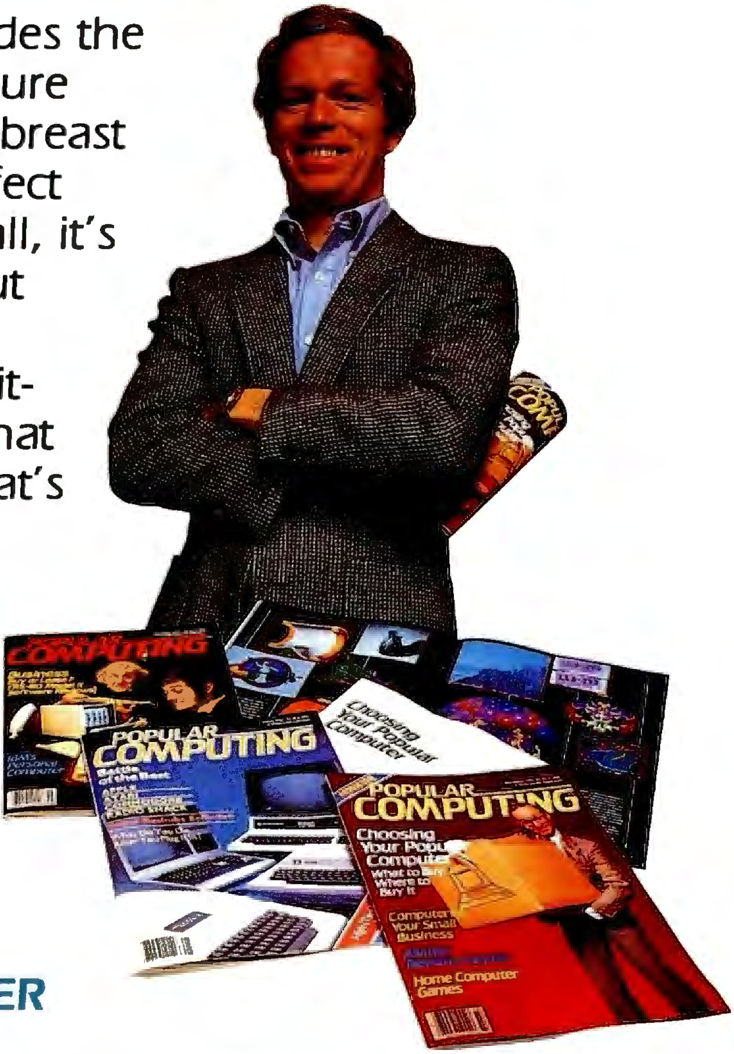

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Listing 2 continued:

```
      ∇SRTNDX[⎕]∇
      ∇Z←SRTNDX TEXT;VC;SVC;SRTTXT;NDXTXT
[10] ⎕H←2
[20] ⍝CONVERTS TEXT TO WORDINDEX - EACH WORD IS ASSIGNED A WORD NUMBER.
[30] ⍝PRINTS WORDINDEX. SORTS WORDINDEX ALPHABETICALLY AND PRINTS IT.
[40] VC←AL INDEX TEXT
[50] NDXTXT←AL BACK1 VC
[60] ⎕H←1
[70] FF
[80] NDXTXT
[90] ⎕H←2
[100] SVC←SORT,VC
[110] SRTTXT←AL BACK1 SVC
[120] ⎕H←1
[130] FF
[140] SRTTXT
[150] ⎕H←2
      ∇

      ∇INDEX[⎕]∇
      ∇Z←AL INDEX TXT;K;I;WRD;WRD2;NXN;WRD1;WW
[10] ⍝ASSIGNS INDEX NUMBER TO EACH WORD OF TEXT
[20] ⍝CONVERTS EACH WORD - SIX LETTERS AT A TIME - TO NUMBER BASE 47
[30] ⍝(47←⍴AL←'ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789,.;:?+-×÷')
[40] ⍝CREATES MATRIX 3 BY N = NUMBER OF WORDS IN TEXT
[50] K←'.'
[60] ⎕P←10
[70] Z←⍳0
[80] ⎕O←I←0
[90] NXN←1↓(AL PREP TXT)
[100] LP1:⎕V[19]
[110] 'INDEXING    ',K←K,'.'
[120] →(0=⍴NXN)/0
[130] WRD←(WW←NXN⍳0)↑NXN
[140] NXN←(1+WW)↓NXN
[150] I←I+1
[160] →(6≥⍴WRD)/TX3
[170] →(12≥⍴WRD)/TX1
[180] WRD←12↑WRD
[190] TX1:WRD1←6↑WRD
[200] WRD2←6↓WRD
[210] Z←Z,(AL INAL 6↑WRD1),(AL INAL 6↑WRD2),I
[220] →LP1
[230] TX3:Z←Z,(AL INAL 6↑WRD),0,I
[240] →LP1
      ∇

      ∇PREP[⎕]∇
      ∇Z←AL PREP TXT
[10] ⍝PREPARES TEXT BY ELIMINATING EXTRA BLANKS AND INDEXING EACH CHARACTER
[20] ⍝OF TEXT ON ALPHABET AL
[30] TXT←RDY TXT
[40] Z←AL⍳TXT
      ∇

      ∇RDY[⎕]∇
      ∇R←RDY TXT
[10] TXT←' ',TXT,' '
[20] ⍝PADS TO MAKE LIFE EASY
[30] R←TXT∊' '
[40] R←~R∧1⌽R,0
[50] ⍝ROTATES TO FIND CONSECUTIVE BLANKS
[60] R←¯1↓R/TXT
[70] ⍝ELIMINATES UNNECESSARY BLANKS
      ∇

      ∇INAL[⎕]∇
      ∇Z←AL INAL MP
[10] ⍝'CONVERSION OF ⍴=6 STRING IN ALPHABET AL TO INTEGER'
[20] →(6<⍴MP)/ERR
[30] Z←47⊥MP
[40] →0
[50] ERR:'INPUT TO INAL IS OVER SIX CHARACTERS'
      ∇

      ∇BACK1[⎕]∇
      ∇Z←AL BACK1 MX;UN;Z1;Z2;K
[10] ⍝CONVERTS INTEGERS BACK TO CHARACTER STRINGS; ONE LINE AT A TIME.
[20] ⍝PRESENTS RESULT AS A COLUMN OF WORDS WITH WORDINDEX NUMBERS.
[30] K←'.'
[40] Z←''
[50] LP1:→(0=⍴,MX)/END
[60] UN←3↑,MX
[70] MX←3↓,MX
[80] Z1←7↑AL OUTA UN[0]
[90] →(UN[1]=0)/MAT
[100] Z2←Z1,6↑1↓AL OUTA UN[1]
[110] →CAT
```

Listing 2 continued on page 260

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Listing 2 continued:

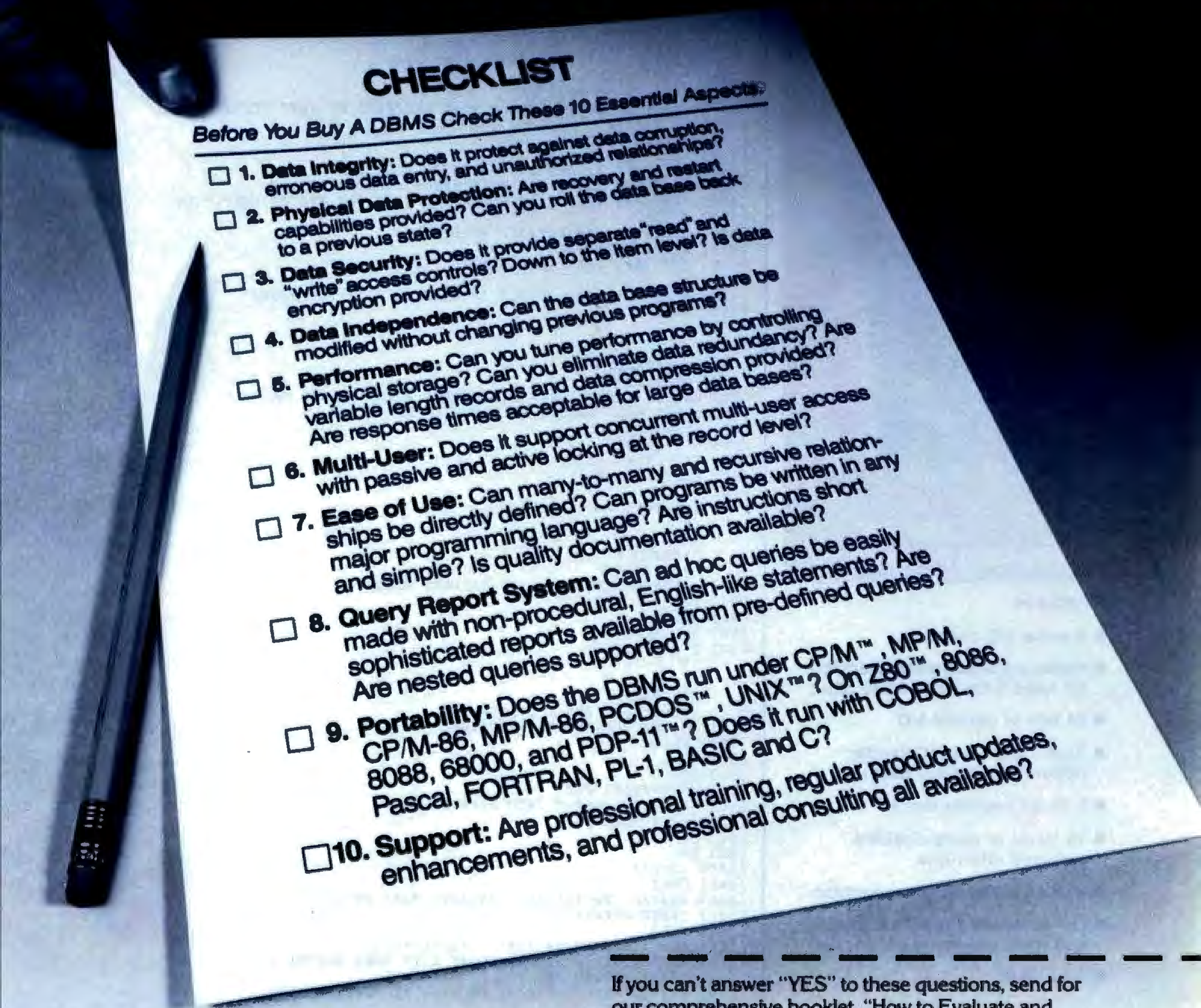
```
[120] MAT:Z2←Z1,6⍴' '
[130] CAT:Z←Z,(25⍴' '),Z2,' ',5 0⍕UN[2]
[140] CS
[150] 'CONVERTING  ';K←K,'.'
[160] →LP1
[170] END:Z←(((⍴Z)÷44),44)⍴Z
      ∇


      ∇OUTA[⎕]∇
      ∇Z←AL OUTA X;LOG
[10] ⍝'INVERS OF INAL GOES FROM INTEGER TO CHARACTER STRING'
[20] Z←AL[47 47 47 47 47 47 47⊤X]
      ∇

      ∇SORT[⎕]∇
      ∇Z←SORT VCT;MX;SRT
[10] ⍝SORTS SECOND COLUMN OF INTEGERS OF 3 BY N MATRIX FIRST,
[20] ⍝THEN FIRST COLUMN
[30] MX←(((⍴VCT)÷3),3)⍴VCT
[40] SRT←⍋MX[;1]
[50] MX←MX[SRT;]
[60] SRT←⍋MX[;0]
[70] Z←MX[SRT;]
      ∇
```

Listing 3: *WORDINDEX, a program written in APL/V80 that first uses Processor 101 to convert a CP/M-80 file to APL format. WORDINDEX then alphabetizes the file, arranges the output in five 18-character columns, and prints the results. Figure 4 shows a block diagram of WORDINDEX.*

```
      )WSID
WORDINDEX

      ⎕A
25803

      )FNS
ALPHAB FORMAT INDEX INFO INITIAL PDUMP RDY SAVEFRAG SAVEKK SORTER
SAVE SORTPRINT WINDEX WORDINDEX


      ∇INITIAL[⎕]∇
      ∇INITIAL;I;J;M
[10] I←J←9
[20] M←0 18⍴''
[30] LP1:'INDEXFILE   ';I
[40] ⍎('TEXT',2 0⍕I←I+1),'←M'
[50] ⍎')CSAVE TEXT',2 0⍕I
[60] ⍎')ERASE TEXT',2 0⍕I
[70] →(I≠31)/LP1
[80] LP2:'SORTFILE   ';J
[90] ⍎('SORT',2 0⍕J←J+1),'←M'
[100] ⍎')CSAVE SORT',2 0⍕J
[110] ⍎')ERASE SORT',2 0⍕J
[120] →(J≠37)/LP2
      ∇


      ∇WORDINDEX[⎕]∇
      ∇TEXT←WORDINDEX;NAME;DATA;ALP;C;N;COUNT;VN;I;JJ;J;JL;JK;VCT;BF;V
      Z;K;IN;KK
[10] ⍝ASSIGNS INDEX NUMBERS TO WORDS, UP TO ABOUT 5000
[20] ⍝ALPHABETIZES WORDINDEX - PRINTS BOTH.
[30] KK←J←10
[40] ⎕O←0
[50] ⎕U←1
[60] ALP←'ABCDEFGHIJKLMNOPQRSTUVWXYZ'
[70] ⎕H←1
[80] LF,'ENTER FILE NAME AS ¨NAME.PCL¨ :',LF
[90] NAME←⍞
[100] 2⍴LF
[110] ⎕H←2
[120] ⍝PROCESSOR 101 CONVERTS PCL, ASC, ETC TO APL/DTC READABLE TEXT
[130] 101 ⎕S'DATA'
[140] NAME[C/⍳⍴NAME]←'α⊥∩⌊∊_∇∆⍳∘''⎕|⊤○*?⍴⌈~↓∪⍵⊃↑⊂'[ALP⍳(C←NAME∊ALP)/NA
      ME]
[150] NAME←(8↑(NAME⍳'.')↑NAME),3↑(1+NAME⍳'.')↓NAME
[160] DATA←NAME
[170] →(0≠DATA)/ERR
[180] TEXT←''
```

Listing 3 continued on page 262

Data base management: Check out the essentials.



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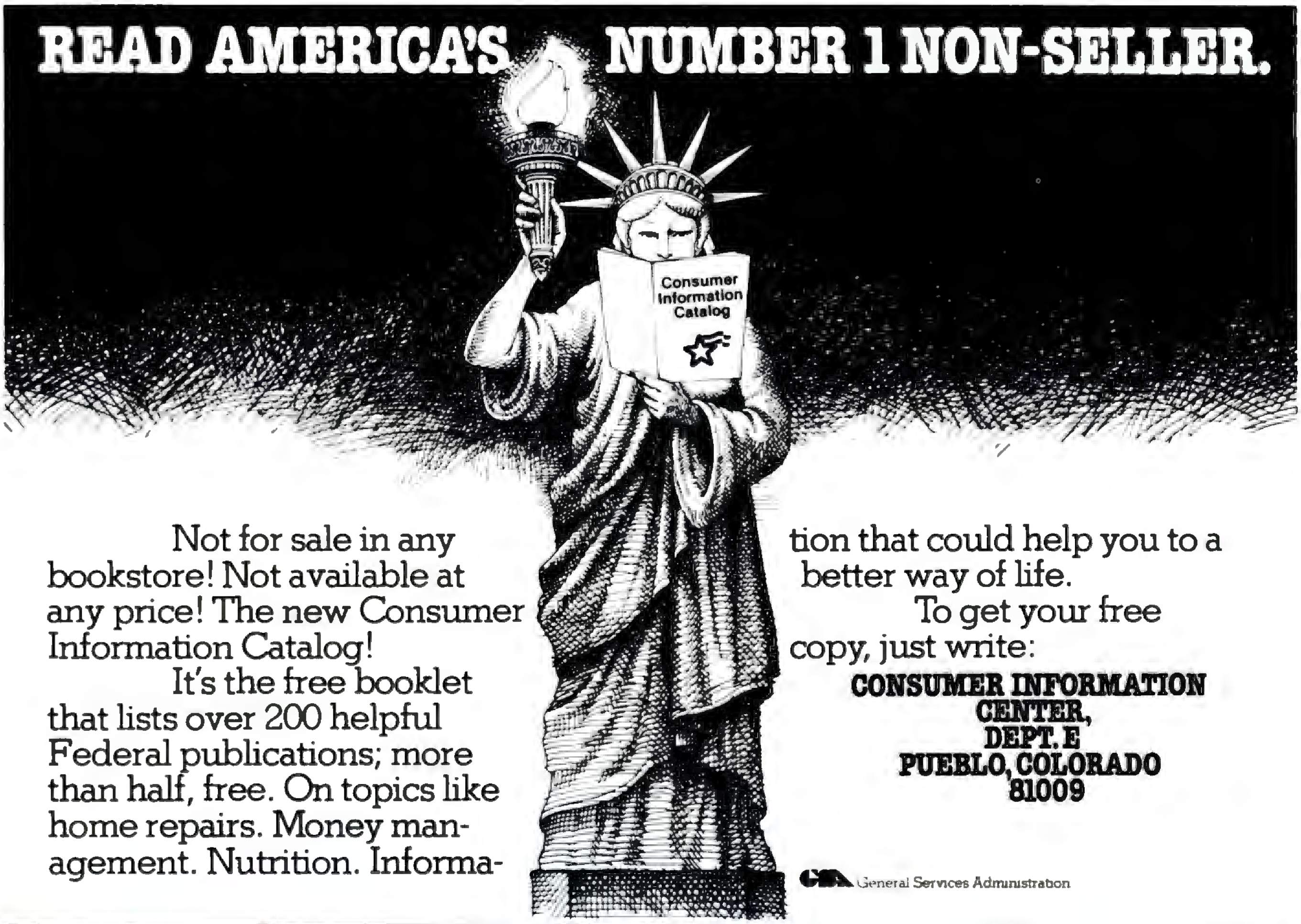
Listing 3 continued:

```
[190] IN←L←0
[200] LP2:I←0
[210] BF←' '
[220] LP1:I←I+1
[230] →(0=ρN←DATA)/END
[240] ;I
[250] TEXT←(,TEXT),N
[260] TEXT←(~⎕V[12]=TEXT)/TEXT
[270] →(I<10)/LP1
[280] ⍝ACTUAL WORDINDEXING BEGINS HERE
[290] FRAG←SAVEFRAG TEXT
[300] END:WINDEX RDY TEXT
[310] ⍝LAST WORDFRAGMENT OR WORD ASSIGNED TO NEXT ITERATION
[320] TEXT←FRAG
[330] →(0=ρN)/END2
[340] →(25≠(L←L+1))/LP2
[350] LF,'TEXT FILLED ALL SPACE ON DISK',LF
[360] 'MAXIMUM INDEXABLE TEXT ABOUT 5000 WORDS',LF
[370] 'PROGRAM WILL PROCEDED AS IF THIS WAS END OF TEXT.',LF
[380] →END3
[390] ⍝PRINTS ALPHABETIZED WORDINDEX
[400] END2:SORTPRINT
[410] END3:LF,'TEXT WORDINDEXED SUCCESSFULLY'
[420] →0
[430] ERR:LF,'ERROR--ERROR IN NAME OR FILE NOT FOUND'
[440] ⎕O←1
      ∇


      ∇SAVEFRAG[⎕]∇
      ∇Z←SAVEFRAG X;I
[10] ⍝SAVES POTENTIALLY FRAGMENTED WORDS AT END OF
[20] ⍝~250 WORD ITERATION FOR NEXT ITERATION
[30] I←(⌽' '=X)⍳1
[40] →(I=0)/END
[50] Z←(-I)↑X
[60] TEXT←(-I)↓X
[70] →0
[80] END:Z←''
      ∇


      ∇RDY[⎕]∇
      ∇Z←RDY TXT
[10] ⍝DELETES EXTRA BLANKS BETWEEN WORDS
[20] TXT←' ',TXT,' '
[30] Z←TXT∊' '
[40] Z←~Z∧1↓Z,0
[50] Z←(¯1↓Z/TXT)
      ∇


      ∇WINDEX[⎕]∇
      ∇Z←WINDEX TXT;AB;K;DXD;SRT
[10] ⍝MAKES SEQUENTIAL WORDINDEX
[20] ⎕W←132
[30] L←10
[40] ⎕U←1
[50] ;TXT←INDEX TXT
[60] ⍝FORMATS OUTPUT INTO FIVE COLUMNS
[70] DXD←FORMAT TXT
[80] ⎕H←1
[90] LF
[100] ;Z←DXD
[110] ⎕H←2
[120] ⍝SAVES SEQUENTIALLY INDEXED TEXT ON DISK
[130] 'TEXT'SAVEKK TXT
[140] K←10
[150] LP:'ALPHABETIZATION  ',AL[(K←K+1)-10]
[160] ⍝POPPS OUT WORDS STARTING WITH SAME LETTER A-Z
[170] SRT←K ALPHAB TXT
[180] ⍝SAVES POPPED OUTPUT ON DISK BY FIRST LETTER
[190] 'SORT'SAVE SRT
[200] →(K≠36)/LP
      ∇


      ∇INDEX[⎕]∇
      ∇Z←INDEX TXT;I;WRD;WW;K
[10] ⍝ASSIGNS SEQUENTIAL WORDINDEX NUMBERS
[20] ⍝STACKS OUTPUT AS MATRIX 18 CHARACTERS WIDE
[30] K←' '
[40] Z←0 18ρ''
[50] TXT←1↓RDY TXT
[60] LP:'INDEXING          ',K←K,'.'
[70] WRD←(WW←TXT⍳' ')↑TXT
[80] WRD←(12↑WRD),6 0⍕IN←IN+1
[90] TXT←(WW+1)↓TXT
[100] Z←Z,[0]1 18ρWRD
[110] →((ρTXT)≠0)/LP
      ∇
```

Listing 3 continued on page 266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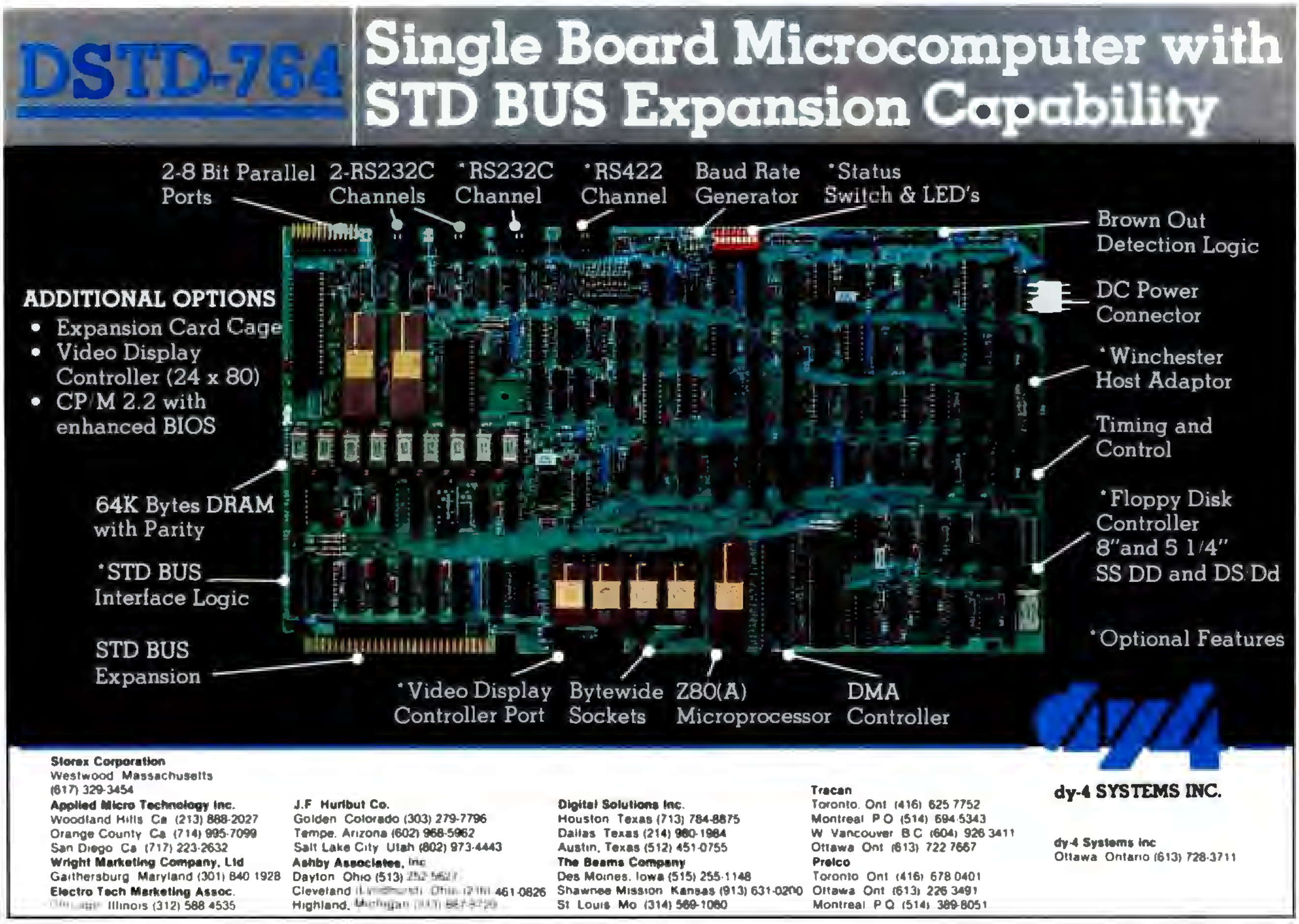
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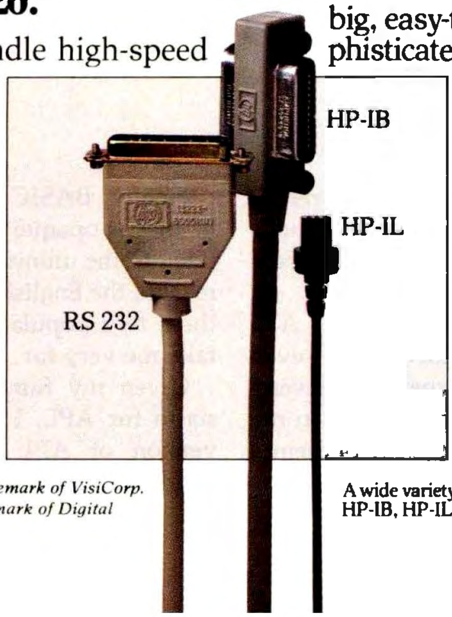

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Listing 3 continued:

```
       ∇FORMAT[⎕]∇
       ∇Z←FORMAT TXT;FIF;PAD;I
[10]  ⍝FORMATS OUTPUT INTO FIVE COLUMNS 18 CHARACTERS WIDE
[20]  ;LF
[30]  FIF←⌈(⍴TXT)[0]÷5
[40]  Z←(FIF,0)⍴''
[50]  TXT←((5×FIF),18)⍴(,TXT),125⍴' '
[60]  PAD←(FIF,7)⍴' '
[70]  I←0
[80]  LP:Z←Z,PAD,TXT[(I×FIF)+⍳FIF;]
[90]  I←I+1
[100] →(I≤4)/LP
       ∇

       ∇SAVEKK[⎕]∇
       ∇Z←X SAVEKK Y
[10]  ⍝SAVES WORDINDEXED TEXT
[20]  ⍎')COPY ',X,2 0⍕KK
[30]  ⍎(X,2 0⍕KK),'←',(X,2 0⍕KK),',[0]Y'
[40]  ⍎')CSAVE ',X,2 0⍕KK
[50]  ⍎')ERASE ',X,2 0⍕KK
[60]  KK←KK+1
       ∇

       ∇ALPHAB[⎕]∇
       ∇Z←K ALPHAB X;SRT
[10]  ⍝POPPS ALL MATRIX ROWS WITH SAME INITIAL LETTER A-Z
[20]  SRT←X[;0]∊AL[K-10]
[30]  Z←SRT/[0]X
       ∇

       ∇SAVE[⎕]∇
       ∇Z←X SAVE Y
[10]  ⍝SAVES POPPED OUT PARTS OF MATRIX ON DISK
[20]  ⍎')COPY ',X,2 0⍕K
[30]  ⍎(X,2 0⍕K),'←',(X,2 0⍕K),',[0]Y'
[40]  ⍎')CSAVE ',X,2 0⍕K
[50]  ⍎')ERASE ',X,2 0⍕K
       ∇

       ∇SORTPRINT[⎕]∇
       ∇Z←SORTPRINT;K
[10]  ⍝GETS POPPED VERIABLE, DOES INTERNAL SORT, PRINTS RESULT
[20]  ⎕H←1
[30]  ;FF
[40]  ⎕H←2
[50]  K←10
[60]  LP:⍎')COPY SORT',2 0⍕K←K+1
[70]  Z←SORTER⍎'SORT',2 0⍕K
[80]  ⎕H←1
[90]  ;FORMAT Z
[100] ⎕H←2
[110] ⍝ERASES VARIABLE TO MAKE ROOM FOR NEXT
[120] ⍎')ERASE SORT',2 0⍕K
[130] →(K≤36)/LP
       ∇

       ∇SORTER[⎕]∇
       ∇Z←SORTER MTX;SRT;I;K
[10]  ⍝SORTS ALPHABETICALLY FROM 12TH LETTER OF WORD FOREWARD
[20]  K←' '
[30]  I←13
[40]  LP:'SORTING          ',K←K,'.'
[50]  SRT←AL⍳MTX[;I←I-1]
[60]  SRT←⍋SRT
[70]  Z←MTX←MTX[SRT;]
[80]  →(I≠1)/LP
       ∇
```

Text continued from page 254:

have each line print out its result. This can be easily inspected and—with a bit of luck and experience—understood.

The interactive nature of APL allows for experimentation—even within a halted program. Several APL functions are rarely used in my work. If I do run across one of them, I try it out in an experiment.

Finally, BASIC and Pascal tend to be just as opaque to me as APL must seem to the uninitiated. For whatever reason, the English-like mnemonics in these two popular languages do not take me very far.

Given my familiarity and enthusiasm for APL, I kept looking for a version of APL to appear among microcomputers. At last I found one,

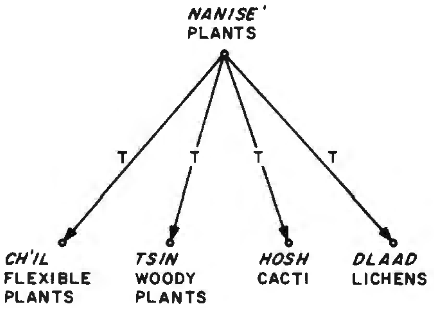

Figure 1: *A folk taxonomy of Navajo plants. The "T" in each line stands for taxonomy, or class inclusion.*

from Vanguard Systems in San Antonio, Texas. A short time later, our first Vector MZ, renamed APL/DTC, was delivered. It was the first microcomputer in the field in Navajo country. (I found out later that the Haute Volta Niger Resettlement Project of Purdue University nosed out our project as the world's first field microcomputer in ethnography. They used a TRS-80.)

Our first Vector MZ arrived in Kayenta, Arizona, in March 1979, where Martha A. Austin, my Navajo coprincipal investigator, was directing the Navajo Ethno-Medical Encyclopedia Project. Using Electric Pencil II, she set out to recreate the files we had to abandon when our word-processing supplier folded. She also commenced new work.

Ethnography, Ethnoscience, and Translation

Our task was to study Navajo native medical knowledge through the Navajo language, that is, texts that Navajo native medical specialists create when they talk about their specialty. These professionals include medicine men (though chanter is a more appropriate term), various kinds of diagnosticians (handtremblers, stargazers, listeners), and herbal specialists.

The bottom line of our so-called ethnoscience (folk knowledge) approach to ethnography is careful ethnographic translation. In literary translation, "translator's notes" are rare. Only when translators find something untranslatable, such as a play on words, will they resort to a footnote. The major characteristic of ethnographic translation is the *abundance* of translator's notes. Each note not only explains the dictionary meaning of a word, but places it into a cultural context as well. This procedure involves definitions obtained from Navajo consultants. We call such definitions "folk definitions" because people make them up on the spur of the moment. Our approach also involves structural information—how words are related to other words. This aspect of meaning is roughly equivalent to connotations.

A favorite structure used by ethnographers is the folk taxonomy. A taxonomy is a classification of objects, in which the names of the objects are related to each other through the relation of class inclusion (e.g., "Azee' dich'ii azee' at'e," or "Bitter medicine (pepper) is (a kind of) medicine "). Systems of such taxonomic sentences, or folk taxonomies, can be represented as tree structures. These and similar semantic structures are the major organizing principles of cultural knowledge and subdivide such knowledge into "cultural domains." Navajo folk medicine is one of several important cultural domains of Navajo culture.

An example of a Navajo folk taxonomy is given in figure 1. It is one of several possible classifications of plants by Navajo Indians.

Our ethnographic task is complex. Our interviews cover questions about structural information, for example, "What kind of medicines are there?" (asked in Navajo); folk definitions, for example, "Tell me everything you know about "bitter medicine" (pep-

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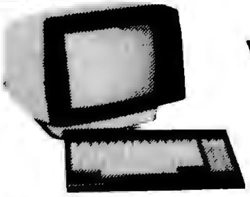

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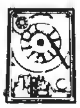

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per); and texts, which may involve descriptions of the preparation of medicines, descriptions of procedures, for example in childbirth, or folk-theoretical descriptions that explain why some procedure, ceremony, or remedy works, how medical decisions are made, and so forth. Our texts also contain philosophical essays, usually passages from the rich body of Navajo mythology, and comments on the myths about health, disease, life, and death.

With the Osborne 1, perhaps the two-computer ethnographer has become possible.

Regardless of the particular form, we call all these different kinds of data "texts." This is where keywords become important. We search texts for particular keywords and bring the occurrences of these words together in one "file." Each such file may be viewed as an encyclopedia entry that exemplifies the use of the word in the Navajo language and in its Navajo cultural context.

Current Work

In our plan, the WORDINDEX program written in APL/V80 is applied to all texts. It provides each word with a running number, prints each text in columnar form, alphabetizes the entire text, and prints the alphabetization in columnar form. This index serves as a check on the occurrence of every word. Its completeness makes certain that no word is missed.

The next step is locating the occurrences through the string-search capability of Electric Pencil. We could not use the string search alone because before the WORDINDEX printouts, we often did not know in advance which words were worth exploring further.

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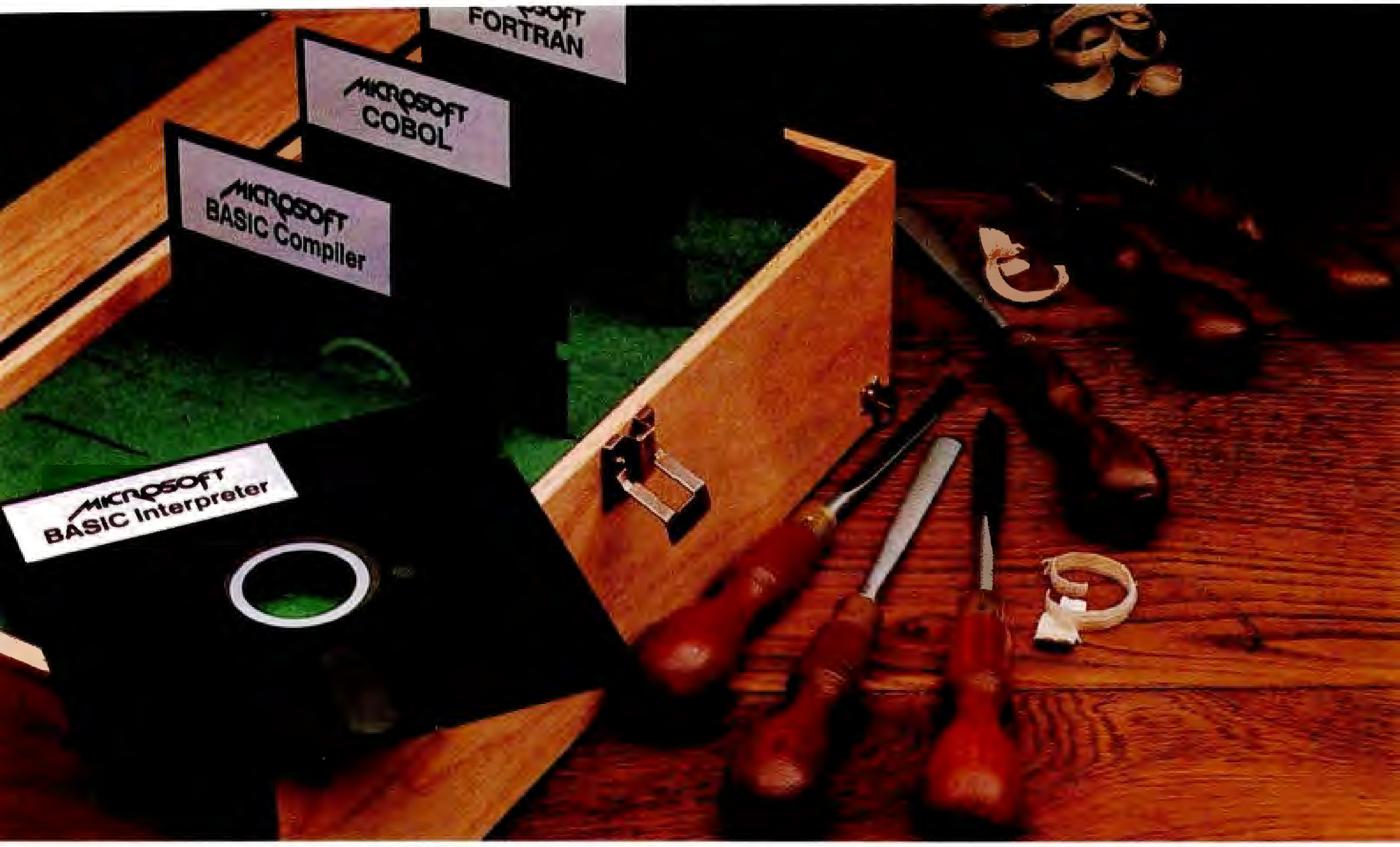

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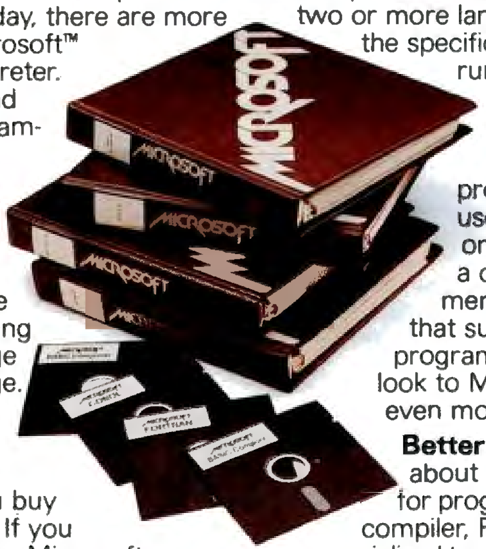

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quisition to facilitate analysis. We are still experimenting with this new tool. It allows simultaneous viewing of text and the analysis file, which may contain the dictionary or encyclopedic entry for a particular word or phrase, a taxonomic tree relevant to the text, or some other structures and texts, for example, case material (descriptions of episodes) that may also be relevant to the analysis of the text. The multiple windows enhance our ability to update several files almost simultaneously. Although the Electric Blackboard is very new, it seems to be to text analysis what Visicalc is to the analysis of numerical tables. Without exaggeration, Electric Blackboard is a product that ethnographers have been waiting for.

With the help of Electric Blackboard, we should be able to move sentences and other materials from a text file to a particular dictionary or encyclopedic file and edit both files almost simultaneously.

ALFORDER

The first word-indexing program I used on our APL/DTC (modified Vector MZ) was ALFORDER. Its first version for APL/PLUS was written by Bernard Werner of Waterford, Pennsylvania. Jeff Multach, a Northwestern University APL guru, helped adapt it to APL/V80. Our APL/V80 is a simplified version of mainframe APLs. Functions defined for arrays are often defined only for vectors. Because of the smallness of the work space (35K bytes), we opted for space-saving loops over elegant but space-consuming functions. The ALFORDER program is given in listing 1.

Before discussing the ALFORDER program in detail, see figure 2, a block diagram that shows how the various APL functions are interrelated.

First is the overall program ALFORDER. The input to ALFORDER is a text (character string with blanks delimiting words); the output is a Key Word In Context concordance placing each word into a context of 120 characters.

Within ALFORDER are the other program modules, or APL functions, that make up the rest of the program.

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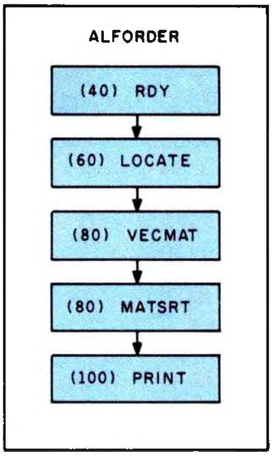

Figure 2: *A block diagram of the ALFORDER program shown in listing 1.*

The first of these functions is RDY. It eliminates unnecessary blanks, marking the beginning of each word, including the first, with one blank character.

The LOCATE program finds word beginnings. Its input is the reduced text; its output consists of the index numbers of word ends.

The next APL function is VECMAT. Its input is the indexes of word ends; its output is a matrix. This is a more elegant and faster version of the ERECT program in Dave Macklin's *The APL Handbook of Techniques*, published by IBM (1977, page 7). It converts a character string or vector into a matrix. The columns of this matrix correspond to the number of letters of the longest word in the text. It has as many rows as there are words in the text.

MATSRT sorts the matrix that is the output of VECMAT. The output of MATSRT is a vector of index numbers of the word beginnings in alphabetical order.

Finally, the PRINT function applies the locations of word beginnings to the original text. The resulting output is a line 120 characters wide with five blanks preceding each keyword on the center of the page. The function computes each line in alphabetical order and prints it when complete. It then goes on to the next line. Therefore, the concorded text exists only as a printout. No record of it is saved.

In an APL/DTC work space of about 35K bytes, this program occupies about 10K. That leaves about 25K for the work of creating the index. The limit lies somewhere between 300-500 words, which is not too practical. A version is needed that would prepare part of the text, store it on disk, sort the next part, and so on, until the entire text is processed.

In spite of the elegance of ALFORDER, it is not practical for the processing of large texts on a microcomputer. A practical text of about 5000 words requires 20 times 5000 words, or a total of 100,000 words to be printed. It takes about an hour to print 5000 words on my Qume Sprint 5. Twenty times that much would take a minimum of 20 hours. It is obviously not practical to print such a large document on a slow printer.

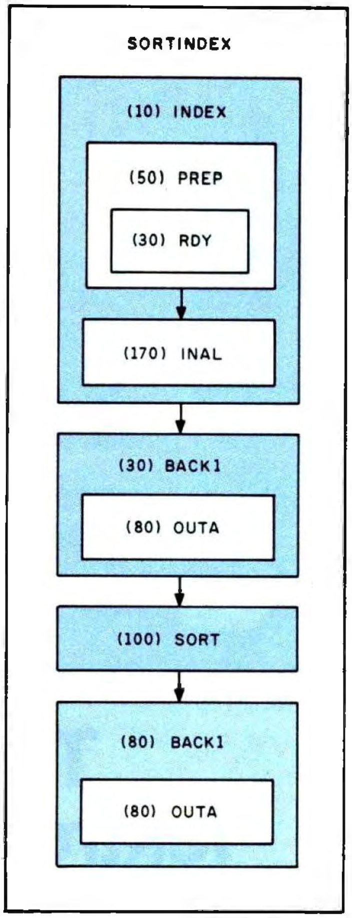

Figure 3: *A block diagram of the SORTINDEX program shown in listing 2.*

SORTINDEX

My first attempt to work around the problems of ALFORDER was the SORTINDEX program (see listing 2).

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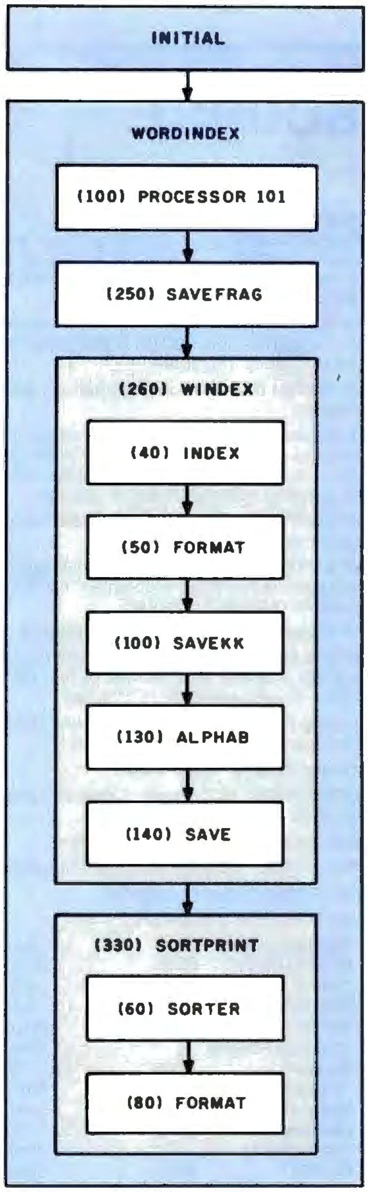

Figure 4: *A block diagram of the WORDINDEX program shown in listing 3.*

Figure 3 shows the block diagram of this program.

The main program is SORTINDEX. The input to this program is a text with words delimited by spaces. The output comes in two parts: (1) the text arranged in an 18-character column, showing the text in sequential order from top to bottom, with each word having its own index number, and (2) the same list fully alphabetized.

Within SORTINDEX are other APL functions that accomplish this complex task. The basic philosophy of this set of programs, however, is different from ALFORDER. Not only does every word receive an index number, each 6 characters of a word (up to a total of 12) are also converted into a unique 10-digit integer. This is the decimal representation of a word viewed as a number in base 47 (the actual alphabet includes a blank, A-Z, 0-9, and , . ; : ? — __ = + '—in Navajo texts, 7 and 8 represent the symbols for high tone and nasalization, respectively).

The conversion to integers results in two 10-digit numbers: the first for the first six letters, the second for the next six. Longer words are truncated, but the full forms are usually completely predictable.

The INDEX subprogram takes the prepared texts and outputs a three-column matrix. The first column contains the first integers standing for the first six letters, the second takes the next six letters, and the third column contains the index numbers. The matrix has N rows, where N is the number of words in the entire text. The subfunctions PREP and RDY get the text ready for conversion. The INAL function is the one that actually converts character strings into unique integers.

The BACK1 function takes the matrix output of INDEX and reconverts it into character strings with their index numbers. It is this conversion program (actually the OUTA function within it) that reconverts each row of two integers into a character string of six letters each and an index number.

The SORT function takes the matrix output of INDEX and arranges it alphabetically in two sorts (the integer of the second six letters first, and then the first integer). The BACK1 and OUTA functions convert the integers of the matrix into the final alphabetized columnar matrix.

WORDINDEX

I have written two versions of the WORDINDEX program. The first is an expanded version of SORTINDEX. It includes disk operations that enable it to handle texts of up to 5000 words. Every 6 characters are converted to a unique 10-digit integer. Because of the relative slowness of the conversion programs INAL and OUTA, I wrote a somewhat faster program by avoiding the conversion of character strings to integers. The WORDINDEX program shown in listing 3 uses only character strings. The upsort and downsort functions are relatively fast in APL/DTC, and some timesaving is possible, even though 12 sorts are needed instead of the two in SORTINDEX. Figure 4 shows the block diagram of WORDINDEX.

In WORDINDEX, the disk files must be set up first on one blank disk. These include an Electric Pencil file

containing the original text, 20 files for the indexed text, and 26 files for the alphabetized text. The PCL (Electric Pencil) file is PIPed (run through the CP/M peripheral interchange program) on the disk with the option that eliminates all uppercase letters. The rest is accomplished by the INITIAL program, which sets up the files on disk that are necessary to handle texts of up to 5000 words.

For the disk-file operations, I could have used defined APL functions written by Vanguard Systems. These emulate the filing system of APL/PLUS, developed by Scientific Time Sharing. However, these functions take up room in the work space. Since the system functions)CSAVE and)COPY do not take up room, I used them instead. The loss of speed with the relatively large partial texts that are moved to and from disk seems minimal. By using these systems functions, I can process 250 or more words per work space per iteration. This number is not completely arbitrary. I set it so that the columnar printout covers one 11- by 14-inch page.

The actual work of indexing each word and sorting the result takes place within the WORDINDEX program. This program is unusually large for APL because of the inclusion of Processor 101, which converts CP/M files to APL format. Once control leaves the function in which it is embedded, iteration cannot be resumed. Therefore, all WORDINDEX subfunctions must remain within the main WORDINDEX program.

After you type WORDINDEX, the program requests the name of a file (usually a PCL file) that is to be converted into APL-readable form. Processor 101 does the conversion one record (or 128 characters) at a time. The process is set (on line [270] in the WORDINDEX function, listing 3) for 10 cycles, or a total of 1280 characters

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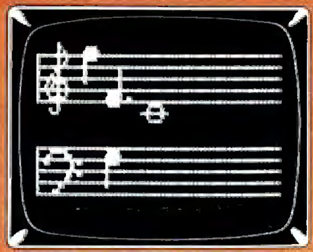

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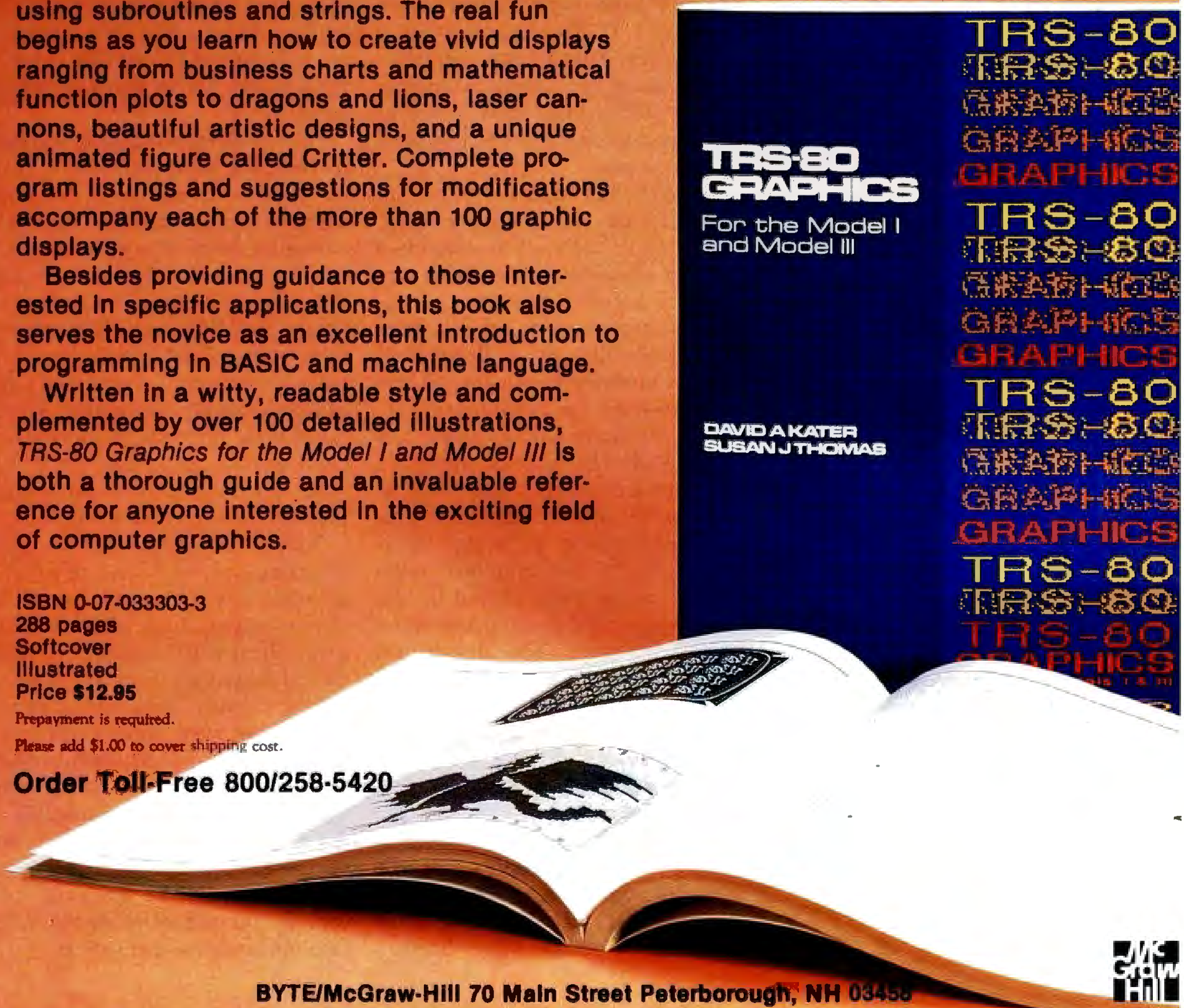

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per iteration (or page). This text is then alphabetized ("popped"), but only by first letter. Each set of words with the same initial letter is stored in a different alphabetical matrix. This process is repeated until the entire text is processed. Each iteration of 1280 characters is stored as a separate matrix.

The SAVEFRAG function saves the last word or fragment of a word at the end of each iteration of 1280 characters. It carries this word or fragment forward to the next iteration.

The WINDEX function is next. Through its subfunction INDEX, it actually does the indexing of each word of the text. The subfunction FORMAT then puts the indexed text into 5 columns of 18 characters each that fit the printed 11- by 14-inch page neatly. The subfunction SAVEKK saves each iteration of indexed text (1280 characters) in a separate file. Roughly four iterations are necessary for a text of approximately 1000 words. It is stored as four separate matrices, each printing out as one page.

The ALPHAB function "pops" out words that have the same first letter, from A to Z. Each pop is stored in a separate alphabetical file. New contents are added cumulatively as the program progresses through its iterations. Internally, these alphabetical files are unsorted except for the fact that they share the initial letter.

The functions SORTPRINT and SORTER do the internal sorting of each alphabetical file. They start in the twelfth column and sort progressively forward to the first letter. The FORMAT function then takes over. It arranges the output in five 18-character columns and prints the result on a page. The alphabetical sorts are printed after all iterations have been completed.

Conclusions

Anthropological or ethnographic field work is characterized by the rapid accumulation of textual data. Typing material directly into the computer saves time, but still requires about 8 hours per 45-minute interview. In languages like English, programs that understand speech may be just around the corner. For the exotic languages that ethnographers often deal with, such as Navajo, speech-recognition programs are still far in the future.

Once the data is in machine-readable form, the ethnographer of today has numerous options for speeding up analysis. Texts of hundreds of thousands of words can now be stored on hard disks. Some of these texts can be manipulated by text-processing programs such as Electric Pencil or Wordstar. More sophisticated manipulations are possible with multiwindow editing programs such as Electric Blackboard.

Our next development effort will be the creation of a multikeyed index to the texts on hard disk via a database management system such as dBASE II. This system will control access and maintain cross-referencing between items in the original texts. I am still looking for the best, most effective, and flexible software for this purpose.

From a field ethnographer's point of view, the ideal hardware is yet to be developed. It should be small, perhaps smaller than an Osborne 1, and certainly more rugged. Floppy or hard disks are less than ideal because they are so sensitive and require a nearly ideal environment for proper functioning. Field computers should have a minimum of moving parts. Magnetic-bubble memories at one time looked promising, but their slow development and high price will make them prohibitive for ethnographers for some time to come.

Today, ethnographers are using microcomputers in relatively sheltered environments close to the nearest service, in or near their field sites. Currently, available software offers help to the ethnographer who is willing to learn. The possibilities that exist today were unthinkable just a few years ago. I view the microcomputer age as that era during which qualitative, in-depth approaches to the study of human society will reach the speed, rigor, and efficiency that in the past could be achieved only through the use of relatively superficial quantitative methods. ■

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Mediamix's ETI²

Robert Welborn
POB 817
Montrose, CA 91020

As a small-business owner, I've wanted a personal computer for quite some time. One factor that held me back (and probably discourages many potential buyers) is the cost of a good printer. Not that there isn't an abundance of low-cost dot-matrix printers, some even offering "correspondence quality," but purchase of a true business-letter-quality printer will practically double the investment. Mediamix in Los Angeles solved this problem with the ETI², a device that allows me to use my office IBM Electronic Typewriter instead of a computer printer.

The unit arrived a week later than promised, but was integrated into my system and functioning perfectly within half an hour. The installation manual is one of the best I've read, providing lucid, step-by-step guidance in a very nontechnical manner.

Soldering is unnecessary—installation consists of plugging a cable into the typewriter's logic board and clipping two wires to other points in the typewriter. The short cable hangs out of the back of the typewriter and is plugged into a 10-foot ribbon cable attached to the ETI². I purchased the parallel version of the Mediamix unit so the ETI² attaches to the same printer connection on my computer that my dot-matrix printer uses. The ETI² has a self-test feature for verifying proper connection to the typewriter.

The operator's manual was written by the author of the installation manual, and it is equally good, but I recall being somewhat overwhelmed after my first reading. The ETI² is fairly sophisticated: it not only connects the typewriter to a computer, but it provides access to all of the typewriter's automated functions and adds a number of features and options. The quantity and variety of commands used to accomplish this makes the package seem formidable. The author advises the novice to disregard the commands and options at first and to "use the typewriter as you would any printer." After a second reading and a practice session you'll realize that in everyday use ETI² is not at all complicated, but rather provides a tremendous amount of flexibility (commands can be adapted to every imaginable situation).

One category of commands covers the typewriter's automated functions, which include word and phrase underlining, tabbing, centering titles, and aligning columns of decimal numbers. These commands can be directly accessed in BASIC by printing the corresponding ASCII control code. For example, CHR$(8) makes the typewriter backspace and CHR$(23) actuates its word-underline function. An alternative method uses a two-character command consisting of an asterisk followed by

At a Glance

Name
Mediamix ETI²

Use
Interfaces IBM Electronic Typewriter, Models 50, 60, or 75, to a computer for use as a printer

Manufacturer
Mediamix
POB 67B57
Los Angeles, CA 90067
(213) 475-9949

Price
$495 for parallel version; $595 for RS-232C serial version; typesetting option $75 (for IBM Model 50 only)

Hardware Required
Any computer with provisions for a parallel or serial printer

Warranty
One year limited parts and labor. Factory service depot in Texas, and at dealers.

STOP SOFTWARE FAILURES

Using a micro in a product <u>sounds</u> easy...
One piece of software can make the difference between success and failure.

What do you do when the software doesn't work? Over the years, we have seen many good products fail, either before or after they reached the market, because the microprocessor software did not do its job.

WHAT WENT WRONG?

Many of the failures occurred because the people programming the micro did not know how to organize a large control program. Those responsible for the product implementation were wizards at hardware design and had easily coded small micro control programs before. But the programming techniques that worked for less than 2K bytes of code simply fell apart as the program grew beyond 4K bytes.

Unfortunately, the loops and tests and flags that work so well for a small program get out of control very rapidly as the program grows. Pretty soon, some of the things the program must do are not being done fast enough. The code gets too complicated, difficult to modify and unreliable. The result: another software failure!

Fortunately, these problems can be avoided by using a program manager. You can divide your complex control program into a number of separate, more manageable programs, called *tasks,* each designed to do one job. For example, a Keyboard Task might handle user input; a Printer Task might generate reports. Each task can be written and tested separately and then combined to form a reliable, finished system.

The program manager, called a *multitasking executive,* supervises the orderly execution of these tasks, assuring that the most important jobs always get done first. Tasks appear to be executing simultaneously. It's almost like having a separate CPU for each task!

That is why professional software designers are now turning to AMX as the starting point for their product and system designs. They know that AMX will shield them from the difficulties of managing the micro, freeing them to concentrate on their application.

AMX

AMX is our **multitasking executive** for the 8080, 8085, Z80 and 6809 processors. We're rather proud of it. We made AMX compact, very fast, and ROMable to meet our own application needs. Even though the AMX nucleus is less than 1400 bytes in size, it features multiple task priorities, intertask message passing with priority queuing, external event synchronization, and interval timing with 32-bit precision. Each feature is clearly explained in the AMX Reference Manual.

RELIABILITY BUILT IN

We don't know anyone who can write an executive without errors, so we thoroughly tested AMX in real applications before ever offering it as a product. That is why not one system malfunction has ever been attributed to AMX. That kind of reliability just isn't an accident.

HARDWARE INDEPENDENCE

AMX does not require a particular hardware configuration. Of course, it does need a microprocessor, but even there we offer you a choice. *You* control your environment. *You* pick the I/O method. *You* decide the most optimum interrupt service technique for your system. AMX will support your choice.

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Users of the CP/M and FLEX Operating Systems can utilize our AMX interface modules to access information on diskette in real time.

COMPLETE DOCUMENTATION

AMX can be judged by the quality of our documentation. The positive response from our users has exceeded our expectations. Our manuals are especially valuable to those just being introduced to real-time multitasking. More experienced users will appreciate the fact that we deliver AMX source on diskette to permit AMX to be moved to the software development system of your choice.

HOW TO ORDER

A specification sheet and price list are available, free. Your check or money order for $75 will purchase the AMX Reference Manual for immediate evaluation (specify 8080, 8085, Z80 or 6809 processor). Add $25 for postage and handling outside USA and Canada. The standard AMX Multitasking Executive package, including source code, is available for $800 after signing our liberal license agreement.

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a capital letter: backspace by printing *B, *U for continuous underline, *T for tab, *C for center, etc.

Mediamix has some features that don't come with the typewriter, such as *P (pause), and *N (automatically counts the digits of a number and issues the proper tab so that a column of numbers aligns vertically on the decimal point).

A second category of commands can be issued to the ETI² by including them in a special text line sent to the printer. Any line beginning with ETI2 is considered a *special command line*. Approximately 20 commands, most of them obvious abbreviations or acronyms of the functions they represent, are available. These functions include control over the number of characters per line and the number of lines per page, end of form (something like top of form), automatic setting of the left margin and any tabs, control of the way in which the 2000-character buffer is used, and adapting for various special versions of the IBM Electronic Typewriters.

Also provided is a means to redefine either or both of the characters in the two-character commands. This function may seem a bit esoteric at first, but it has already proved to be essential. I purchased a program that conflicted with the use of asterisks in text, making commands like *U for underlining unusable. I was able to get around this by instructing the ETI² to respond to a percent sign, instead of an asterisk, followed by a capital letter.

This command-redefinition feature could also be used to adapt the ETI² to a more sophisticated word-processing program. For example, if a program provides a control character or character sequence for underlining or other functions, you could instruct the ETI² to underline in response to the program's codes instead of its built-in *U command.

Even more remarkable is a set of commands that relate to the translation of characters received by the ETI² into what is printed. The IBM ET type element has 96 characters. My typewriter keyboard has only 92 characters, and my computer's keyboard has its own special keys and characters. The ETI² lets you easily access any of the typewriter's characters via any of the characters on the computer's keyboard. For example, I can instruct the ETI² to print ¶ (paragraph symbol) upon receipt of & (ampersand), or print a superscript character when I include > (greater than) in my text. The importance of this feature should not be underestimated. I began using this feature almost immediately to access the § (section) and © (copyright) symbols that I use frequently in my work. I know of no other printer that provides this degree of flexibility.

The only option available for the ETI² is a typesetting feature that can be used with the IBM Model 50. I own a Model 60, and therefore could not use this option. However after looking at Mediamix's literature and instruction manuals, all of which are printed using this feature, I wished I did own a Model 50. "Typesetting," to Mediamix, apparently means being able to right justify the Model 50's proportional type. In view of the small number of fonts and type sizes available, this form of typeset-

ting is very limited, although the result is almost as good as phototypesetting.

After several months of use I am still completely satisfied with the ETI². My typewriter requires less service (due perhaps to the fact that only final-draft material is printed); it is audibly quieter under computer control, and I understand there is a high-speed clutch inside the typewriter for running at full speed; and in the event that the unit requires service, I can rely on the speed and quality of IBM "at the office" service, instead of having to carry the printer into a store or ship it out. If my computer breaks down, I still have the typewriter, so I'm covered either way.

Conclusions

- The addition of ETI² to an IBM Electronic Typewriter results in a reliable, robust system. If either the computer or the typewriter malfunction, you still have a portion of the system to work with. This is an important consideration for many businesses. IBM is known for its excellent service.
- The print quality of the system is excellent and the characters available make it very flexible. Proportional spacing is an option with the right model typewriter.
- Although the printer is not as fast as some others, the print quality is so superior that I don't mind waiting. The slow speed (15 characters per second) can be compensated for by using the typewriter's margins and tab functions, and is also offset by the 2000-character "spooling" memory buffer in the ETI², which frees the computer from waiting for the typewriter to finish printing.
- By using an inexpensive dot-matrix printer for rough drafts and accounting printouts, this system yields greatest versatility and quality for the least investment. ■

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One of the nicest things that's come to Chaos Manor is Bill Godbout's (Compupro) M-Drive. I don't see how I got along without it.

M-Drive is a way to fool your microcomputer and thereby make it run faster. First, you add a lot of memory; in my case, I installed some of Compupro's new 128K-byte boards. Then you put in Compupro's M-Drive, which fools your system into thinking that all that memory is really a disk. Thus read and write operations are sent to memory, not disk. You have to see it operate to believe how fast that speeds up programs.

Loading my text editor with Ezekial (my 2-MHz Z80 machine with iCom disks) takes about 30 seconds from disk. The Godbout 8085/88 machine with Godbout's direct-memory-access (DMA) Disk One Controller operating Qume DT-8 double-sided, double-density disks cuts that to less than 10 seconds. With M-Drive, loading is so fast *I can't time it.* Hit Carriage Return and the editor is loaded. The same happens when using the PIP command, or a compiler, or the biggest command file I have.

Do understand the Godbout controller and Qume drives are already very fast, and you must have a Godbout controller to run M-Drive; thus, the savings aren't as spectacular as they might be. Still, it's dramatic enough.

When you get M-Drive, it's set up to be the A drive in your system; whatever you write to A goes into memory, not onto a disk. That works all right, but it could be dangerous because what you save into M-Drive memory isn't really saved and would go away with a power failure. I could live with it, as long as it wasn't addressed as the B drive (B drive is what I save all my text onto, and I'd find it hard to break that habit), but I wouldn't really feel comfortable about not having the material saved permanently.

So, our resident genius Tony Pietsch decided to mess around with the BIOS (basic input/output system) and change things so that the system uses drive M as M-Drive. As Tony says, that's logical.

He's got it going, along with a SUBMIT program (the CP/M batch utility) you can use on power-up to format your new drive and transfer to it most of the files you'll be using. After which, you log onto disk M and you're in business. Command files load instantly. Long compilations that have to write .PRN (print) files and make symbol tables and so forth go like sin. Posting accounts with my bookkeeping programs run in about 10 percent of the time! With M-Drive it's feasible to use sequential access and fancy searches through your data base.

I'm still appreciating the potentials here. For instance, it's now practical to have enormous programs with big overlays; with M-Drive, you can snatch them in and out as needed without the operator noticing it was done!

It'll even help the word processor. Not, I hasten to add, for straight text creation: you'll still want to save early and often on *disks,* not M-Drive. But for checking spelling and grammar, for working with lots of long files you need to haul in and out of memory, and for anything that involves lots of disk access, you'll love M-Drive.

It's also useful for program editing. You can log onto M-Drive, bring up Wordmaster, and have really fast access to all of a very long assembly

language program. You do have to be careful to save everything onto a real disk after you exit Wordmaster—or periodically save from within Wordmaster by using the W (Write) command. What I've done is set up a SUBMIT file that uses the PIP command to copy the source from M-Drive to the disk in drive B before it assembles the file in M-Drive. Thus I've always saved the latest version of the source; and assembly (or compilation; we use this with CBASIC2, Pascal, FORTRAN, and C, too) is so fast that losing the compiled code is only a minor inconvenience.

M-Drive makes a microcomputer with 64K bytes of RAM (random-access read/write memory) run like a big minicomputer. Highly recommended.

One warning: be sure you get M-Drive from either Compupro or G&G Engineering. I know of one midwestern dealer selling a pirated version of M-Drive with a disk controller and memory not made by Compupro; it couldn't possibly work, since the controller didn't use DMA.

dBASE II, Version 2.3

I'm happy to endorse the improvements to dBASE II that fix many obscure and a few obvious bugs in the relational database. For example, you can now remove superfluous spaces from indexed files and maintain up to seven index files for the database in use. You can use numerical variables as arguments in the string functions, a major convenience, and there are enhancements to the substring functions.

One of the results of Ashton-Tate's "good guy" policy is that users tend to send them suggestions, which they implement in future releases. Thus dBASE II continues to grow and become more useful.

I fear the documentation is still not all I'd like it to be, but it's improved once again in the new version: now there's an index, explanation of error messages, and more examples. Even naive users *can* learn dBASE II from the document: I know, because I've watched them do it.

I recommended this program in an earlier column. It's even better now.

Ada and Assured Income

Some predictions are easy to make. For example: if you want to assure yourself of a high salary in the years to come, learn Ada. It's as good as an annuity.

Ada, of course, is the new language supported by the Department of Defense; and as DOD support made COBOL important, their support will keep Ada vital. Named for the first computer programmer, Ada Augusta, Lady Lovelace, Lord Byron's daughter (she programmed Babbage's machines), Ada is a Pascal-like language with some of the elements of PL/I. It is *supposed* to have overcome most of Pascal's defects, particularly in input/output (I/O).

Unfortunately, Ada (once known as DOD-1) was designed by a committee. It has a slew of features, many of which are so specialized that few will see any use for them. The language has grown so large and so complex that no one can possibly understand it, and lately there have been many warnings that bugs in compilers might cause strange side effects and interactions. Some MIT computer science people are concerned that if Ada programs control missiles and bombs, there might be results no one wants.

I wouldn't know. Ada is so large that it is unlikely ever to run on microcomputers; and DOD insists that there cannot be *any* expansions, enhancements, additions, or subsets of Ada. Ada is Ada is Ada, and any Ada program should be compilable on any DOD computer that runs Ada. Portability is more important than convenience or small-system utility. That's the official attitude. You can make your own estimate of how stable it's likely to be. But one thing is certain, knowing Ada can be a valuable skill.

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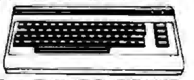

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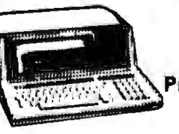

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I'm no expert on Ada; but people who are tell me the first thing to do is get *The ADA Programming Language*, by I. Pyle (Prentice-Hall, 1981). Unlike many programming language books, this one is more or less readable. After you have Pyle's book, you can buy or send away for the Government Printing Office document *The ADA Programming Language* (US GPO MIL-STD-1815), which contains the Ada standard. It won't do you much good. It's absolutely opaque, as close to unreadable as anything you'll ever encounter, but you might some day need to look up something in it.

And finally, you can shell out $300 to RR Software for Janus, an 8080 Ada compiler.

Janus is not complete Ada. No compiler designed to run on a microcomputer could be. It doesn't work as smoothly as its writers would like, either. It's slower than they care for, and programs benchmark-tested in Ada come out pretty low on the list—at least for the kinds of programs that get benchmarked.

Where Janus is supposed to shine is in optimizing calls to procedures and in giving error messages to the users. The compiler takes five passes: the first finds syntax errors at about 500 lines per minute, the next three passes write the code, and the last goes back and fixes some things so that you can have gigantic procedures. If you were mad enough to write a 4500-line program consisting of a single call to one long procedure, it would compile it.

They tell me it takes about 25 minutes for Janus to compile the Janus compiler, which is about 4800 lines.

The Janus documents are more than adequate, if badly misspelled. There's no index in my present copy, but as I write this, RR Software is putting out a new version with completely rewritten manuals. RR Software promises to include an index and to use a spelling checker, probably The Word. The manual I have gives lots of examples, but my son Alex says not enough. Certainly you'll need a good book on Ada in addition to the Janus manual.

The current version of Janus does not have segmented compilation—that is, the ability to compile in chunks and link them and to do program swapping. RR Software is working on those and will furnish the update free to those who buy early versions that don't have segmented procedures. RR Software says that by the time this is published, it'll have all that done. (**Note:** I have recently received version 2, and it has a better manual and faster compiler.)

I haven't done much work with RR Software's Ada. I know it works from others who've used it; and at the moment, it doesn't have much real competition, certainly not in its price range. I know Supersoft has an Ada, but the company doesn't seem willing to send review copies—at least it doesn't answer letters. Thus, I've no idea what its product is like. Supersoft's ads don't mention data types.

The present Janus compiler is written in Janus; the original one was written in Pascal/MT+. There are many features reminiscent of MT+ in Janus.

I don't know how useful Ada will be for microcomputers; but I do repeat that learning Ada is good job insurance and having Janus running on your machine should help a lot.

More on Janus as I learn more.

MINCE Is Not Complete EMACS

EMACS is the full-screen editor developed at MIT's Computer Science Laboratories. Much (perhaps all) of it was written by Richard M. Stallman (RMS@AI to those in the know). EMACS runs on the DEC PDP-11 and on the LISP machines and has become the artificial intelligence community's favorite text editor.

Given the truly horrible editors that were in use before EMACS, that's easy to understand; and if MINCE, an 8080/Z80 subset of EMACS, had no competition but ED (CP/M editor utility), MINCE would own the microcomputer world. However, by the time EMACS was trans-


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lated into MINCE, we had other full-screen editors, so MINCE hasn't had things all its own way.

I don't much like MINCE. My dislike is largely prejudice; and do understand that there are many, many programmers who can't praise MINCE highly enough. At G&G Engineering, at Sorcim, and in software house after software house, the programmers have gone over to MINCE and would rather fight than switch.

So what's so good about it?

First, it does work. If I had to choose between MINCE and Wordstar, I'd be hard pressed; MINCE is a better programming editor and is more than just adequate for document preparation. It doesn't print—to print your text you need a separate format program, such as Mark of the Unicorn's Scribble—but that's not an insuperable handicap. Wordstar doesn't *really* integrate editing and printing either; in Wordstar, editing and printing are separate functions accessible from the main menu.

Of course WRITE, the program I use, does have both print and edit; it's very easy to watch the Diablo, spot an error, stop the print job, fix the error, and restart at the top of the page; and somehow fate has arranged that some errors can't be spotted until they're on paper. You can't do that with MINCE, but then you can't easily do it with Wordstar either.

MINCE, unlike Spellstar, has no built-in spelling program, but The Word, or Microproof, or Spellguard used with MINCE would be just about as fast and convenient.

Other good features of MINCE are "windows" and multiple buffers. You can work on two documents at the same time, editing each in turn, and even transferring text from one document to the other. Chunks of each document can be visible on the screen simultaneously if you like. This is a powerful feature, and one I wish my favorite editor had.

I suspect the reason MINCE is so popular with programmers, though, is that it's not merely an editor, it's a program. If you're a real hacker, you can rewrite MINCE to suit yourself: rearrange the commands, change the whole command structure, and add macro instructions, complex commands, and features. You can tailor MINCE so that it knows what language you're programming in, and if you're very clever, you can use MINCE to find a number of syntax errors like unbalanced parentheses, missing semicolons, and the like.

MINCE insists on telling me things I don't want to know.

MINCE is written in Leor Zolman's BDS C (B. D. Software C) and comes with an experimental linker, which Mark of the Unicorn won't guarantee to work with any arbitrary BDS C programs but will guarantee to work with all of its programs. Along with this linker you get *some* of the C source code for MINCE, plus .CRL, relocatable, object-code files for the rest. With those and some ingenuity and hard work, you can merrily change and extend MINCE and then try to debug your changes.

However, the ordinary microcomputer user is unlikely to find any of this useful. You have to know the C language and a lot about MINCE, and to find out a lot about MINCE, you have to wade through some three pounds of documents.

Those documents are almost adequate for learning MINCE. Sometimes, useful information is hidden in some pretty obscure places: it took me *weeks* to find out how to enter Auto Fill mode—that is, to make the machine wrap words from one line to the next without my having to hit Carriage Return. The information was in the document; but it wasn't in the index, and there was no example of its use, probably because the document writer used it so often it was easily overlooked.

But the documents are useful. The editor works, and it is a full-screen editor. Why, then, don't I like it?

I'm not really sure, which is why I warn you not to place too great weight on my opinion. I do have some specific critiques.

First, MINCE, as does EMACS, uses the "kill" (delete) mechanism for text moves. That is, if you erase any text longer than a single character, MINCE saves that in a stack, and the next time you hit Control-Y, the last item killed is "yanked" back in to be placed at the current cursor position. The next Control-Y gives back the next-to-last killed text, and so forth.

I find that intolerable. Suppose I locate some text I want to move. I kill it; then I go where I want to put it. That, however, requires some rearrangements, and a couple of lines need to be deleted. I kill them, and then I've got to take them back, yank them, and stash them somewhere, because they're now at the top of the kill stack and what I want is underneath them.

I greatly prefer the system used by WRITE and Electric Pencil, in which you mark text for later movement, or even Wordmaster's mini-buffer, in which you can store text and later recover it. I see no reason to combine the kill and move functions the way EMACS and MINCE do.

Like Wordstar, MINCE will not automatically rejustify your text. If you're in Auto Fill mode and go back and insert or delete from a previously written paragraph, you must command the editor to rejustify everything; it won't do it "automagically."

Another of my objections to MINCE is that, like Wordstar, MINCE insists on telling me things I don't want to know. Again following EMACS, MINCE has two status lines at the bottom of the screen. One tells you what editing mode you're in, what percentage of the document is above the cursor, and other such information; the other comes into existence when you're typing one of MINCE's long command lines, "Escape Meta Control-X Fill Space" or something of the sort. These distractions are omnipresent, while I prefer my screen to hold nothing but

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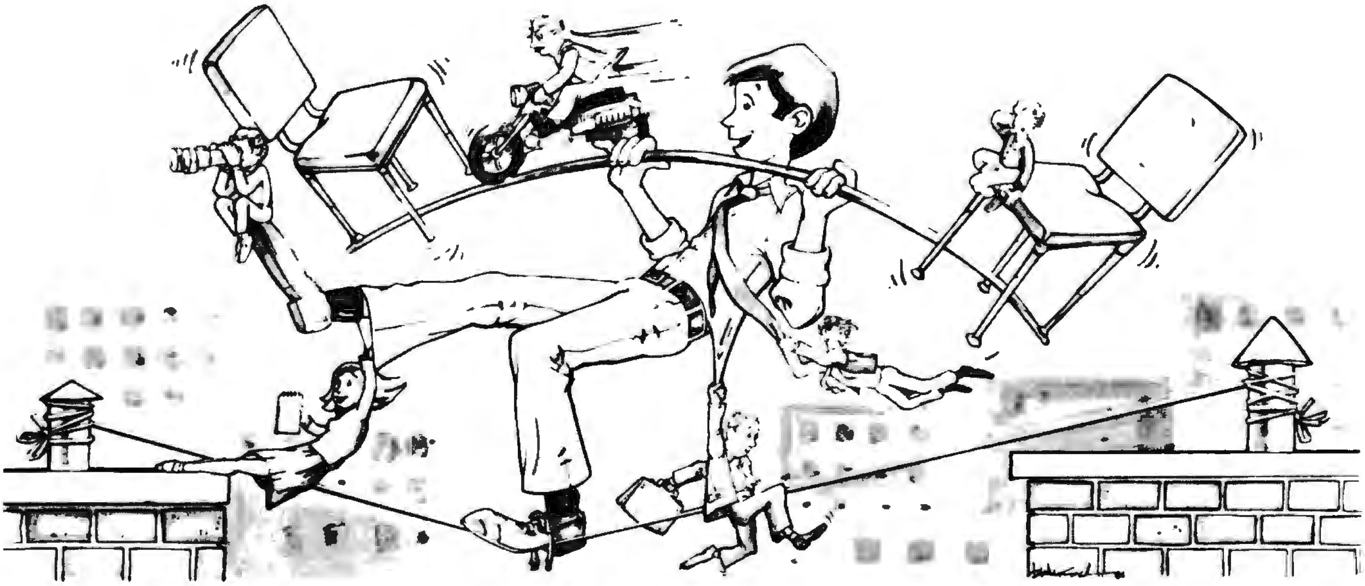

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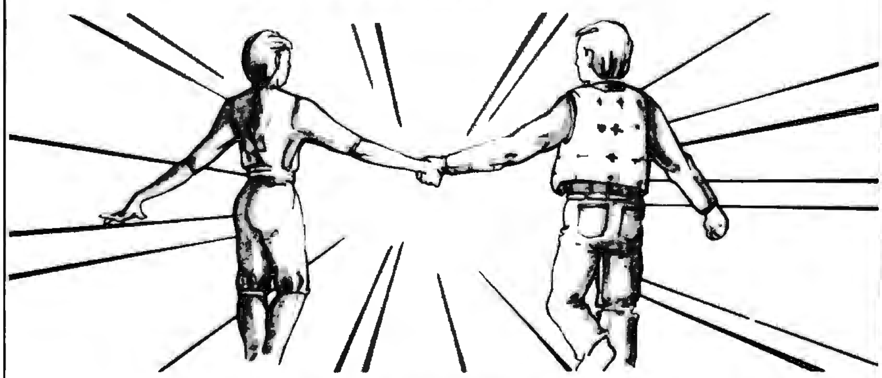

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my text. If I want information, I know how to ask for it; it needn't be volunteered.

Finally, I don't care for the MINCE "philosophy" of commands. Now do understand: MINCE commands are for the most part logical. Control-f moves the cursor forward a space, Control-b moves it back a space, Escape-f moves it forward a *word*, and Escape-b moves it back a word. There are commands to move by line, sentence, and paragraph. There's a simple way to insert *arguments* before a command: you just press Control-u, then 5, then Control-f, and the cursor moves five spaces forward. And so forth.

Many writers and programmers like that command structure. It drives me nuts, I suppose because I'm used to the WRITE commands, which are similar to the Electric Pencil system I learned. I think it's more than pure prejudice: that is, I believe that having the cursor commands laid out in a small cross-shaped pattern near the control key is better than scattering them across the keyboard as EMACS does. And certainly I prefer being able to use the repeat feature of my keyboard. You can't with MINCE because most of the really important commands need two keystrokes, the Escape key and something else.

Having said all that, I also have to repeat that many writers and programmers like MINCE a lot; and even I'll admit that if I didn't have either Wordmaster or WRITE (for programming and text creation, respectively), I'd probably use MINCE to replace the missing one.

Overpriced Documentation

I do more public speaking than I ought to. Even at my outrageous fees, it rarely pays enough to justify the time investment. Thus I turn down more engagements than I accept, and I almost never speak for free. There are exceptions. A few months ago, Stephanie Rosenbaum called to ask if I'd be keynote speaker to a meeting of the Special Interest Groups on System Documentation and Office Automation of the Association for Computing Machinery. The meeting would be in Los Angeles, and it wouldn't take long, and it's an important group, and. . . .

If it hadn't been Stephanie, I'd have said no, but she's special. Stephanie is an old friend of Larry and Marilyn Niven, and she has a *useful* psychic power: put Stephanie in any city of the world, and she will unerringly lead you to a good restaurant. And since she goes to many of the same conventions I do, I figured it would be well to keep her goodwill. After all, I might be stuck in—but no, I may have readers there.

Anyway, I spoke to the groups, pointing out that the pairing of these special interest groups prompted an interesting insight: the reason we don't yet have the "paperless office,"

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that unfulfilled dream of the office automators, is that we don't have anything like decent system documentation. And the reason we don't have good documentation is because companies will pay their programmers well but figure any damned fool can write. So if they bother to hire writers at all, they generally take few pains in choosing them and pay them no better than they do the janitor. The results are obvious.

One result is that executives look over the instructions for the new personal computer the company wants to give them and have the computer installed in a closet accessible to the secretaries. Secretaries can admit they don't understand how to use the thing. A vice-president can't, and because it's obvious to him that he could read those instructions until he was blind and he still wouldn't know how to use the system, he's not going to be seen to fail, which is why the automated office never gets past the reception room.

All this is obvious and fits nicely into my tirade about software prices and Levitical documentation. I have here a catalog of software prices. Ignoring program prices, I look at the cost of manuals only: most run $30 and up. A few are lower in price. Take Digital Research's SID (Symbolic Instruction Debugger), an advanced DDT (Dynamic Debugging Tool), quite useful if a bit overpriced at $195. The manual costs $15, and for that you get sixty-nine 8½ by 11 pages of *typescript*. About half those pages are incomprehensible.

What does it cost to produce 70 pages and perfect bind them into a soft cover? Well, let's do it the expensive way: go to a local offset house, and you won't pay more than 3 cents a side. That's $2.10. Add a report cover, and you're up to $3. I suppose I *could* manage to spend $4, but I'm also certain Digital Research didn't. Assume $1 shipping, and sell these to distributors at perhaps 40 percent of the cover price, or $6; you make $2 per copy, 50 percent return on investment. Not bad for a backlist item whose development costs have been written off long ago.

And have you ever tried to *read* that manual? Just open it at random. You get brick walls of type and lengthy paragraphs that cover several topics each, all written by someone trained to use lots of technical words and few examples. Why is this?

Nor am I trying to single out Digital Research, because by and large it plays more fairly than others. Its manuals are among the lowest priced. To some extent I suppose the sale of manuals helps make up for the thefts of the programs the manuals describe. If people give programs away, the recipient still must get manuals.

I suppose that's the reason companies would give for charging $50 and up for books that can't cost a tenth of that to produce. I might even agree that's reasonable—if the manuals were useful. But often they aren't.

I have two remedies for bad documentation. First, it's easier to teach a good writer what programs do than it is to teach a good programmer how to write. True, there are a few happy instances of hackers who are also good writers, but not very many. Usually the talented writer is not a brilliant programmer, while the good programmer is more easily comprehended by his machine than by mere humans. Good writers can, however, be taught the elements of programming. They can learn what programs do, and they can learn how to *use* the programs.

So the first remedy is to hire people who can write. And don't assume that because they have degrees in English, or "communications," or, God save us, "technical writing," they know what they're doing. The real test is whether you can read and understand what they've written—and whether they can make you *want* to read it.

Isn't that reasonable? After all, your customers are presumably interested in your product. You have their attention. So why should your

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manuals be dull? They ought to be exciting! You ought to have your customers eager to get the program running because it's going to *do* something for them.

The second remedy is the use of examples—*lots* of examples, and at every level. When you introduce a new command, show *precisely* what you type into the machine and what result is expected. *Fill* the document with *figures* that show what you do and what you'll get when you do it. Don't try to save paper! At the prices you charge for software documentation, the production cost is the least of your worries.

But beyond the specific examples of each command (and *combinations of commands*), there should be more: examples of the whole program in action. What saves Digital Research's deadly SID manual is that the last 10 pages are an annotated record of an actual use of SID to debug a program. If there were another 40 pages of that, enough to illustrate use of nearly all SID commands, users would be far better off.

But there's more. Let's take Supercalc as an example. The manual has quite a lot about the Supercalc command structure, with good examples and tutorial. Besides, Supercalc has really nice on-line Help files. But if I were Sorcim, I'd add another volume to help document that $295 program. I'd get an MBA to devise some examples of Supercalc in use. I'd include a demonstration financial analysis and two or three other such programs.

(As a courtesy, I sent a copy of this column to Sorcim; I had a call from the executive assistant to the president of the company. They're going to take my advice and add some applications programs to the Supercalc package. . . .)

I'd think everyone trying to market high-priced software would want to include lots of *useful* applications. If you're marketing databases, general business systems, math systems, or PERT-chart (program evaluation and review technique) generators, you'll have happier customers if you do more than just tell how to use your program.

Show the user what your stuff can do, and watch sales soar.

Who's Friendly Now?

As the microcomputer world expands we have decisions to make. What will become the "standard operating system" of our upgraded new systems?

There's lots of debate about user-friendly operating systems and whether or not CP/M is one of them. Unix users want more Unix-like features.

Certainly CP/M has its bad features. Everyone is weary of the "BDOS ERROR ON B: R/O" idiocy. Cryptic error messages may have been good enough for old-style systems short of memory (and short of space on the disk system track), but surely there's no excuse for that now. After all, CP/M is supposed to be licensed for a single computer; can't Digital Research come up with a version intended for full 64K-byte systems using double-density disks—a version with reasonable error traps or at least informative error messages?

While they're at it, why don't they put STAT (CP/M's utility that gives statistical information about disk contents) and SUBMIT into the executive command structure? Why must these be separate programs? Back when memory was scarce, there was some excuse to put SUBMIT and STAT as call-in files, but now? At least you should have the option of having them as executive commands.

Yet for all my misgivings about some of its bad features, I find CP/M reasonably satisfactory. Partly that's familiarity; but partly it's my kit of CP/M utilities. Take /.COM for example. This is a program that lets you write a whole slew of commands and

input prompts and go away while the computer runs them. It's a bit like doing a SUBMIT file, except that you don't have the needless work of creating and editing a file; you just type a command line.

Example:

/ ASM FOO; LOAD B:FOO; B:; FOO

will assemble FOO, load it as a .COM file on disk B, log onto disk B, and then run FOO.

The /.COM program is advertised under another name for about $30; I got my /.COM from Workman's Utility Disk One, which also contains a whole slew of other stuff that makes CP/M more convenient: things like Ward Christenson's disk catalog program, which actually lets me find the file I want in seconds rather than making me hunt through box after box of disks.

And do you grow weary of collecting junk files on your master disk? What you need is D.COM, which sits on your disk and tells you what garbage has been added since the last time you checked. That's on Workman Utility Disk One also, as are a half dozen other valuable utilities.

Workman Associates has also come out with Utility Disk Three. This one contains XDIR.COM, a directory utility that works with CP/M 2.x to list your directory alphabetically and also shows the size of each file, how many files are on the disk, and how many bytes are available. It's like doing DIR and STAT at the same time.

Disk Three also contains a lovely file comparator written by Leor Zolman. Leor is an MIT undergraduate who wrote the BDS C compiler that I often rave about. A few months ago I confessed a problem to him: Larry Niven and I work on collaborative novels. (Plug: *The Mote in God's Eye*, Pocket Books; *Lucifer's Hammer*, Fawcett Books; *Oath of Fealty*, just coming out in paperback this spring from Pocket. *Oath* has a lot about computers, including people with computer I/O devices implanted in their heads.) Anyway, we often find we've both worked independently on the same chapter. Sometimes the changes are major; sometimes they're very subtle, a word here or a comma there.

So here is the problem: we have two versions of 40 pages of text. How do we merge them into one?

First, we have to see where they differ. After that it's easy enough to decide which version is better. So Leor wrote us a program to do that. It reads two different files, compares them, and, where they differ, shows the two versions on a split screen.

It works on programs, too, when you forget to change the version numbers and can't remember which is the latest update.

Leor's COMPARE.COM, the updated XDIR, and a number of other utilities that make CP/M more friendly are available on Workman's Utility Disk Three.

Fair warning: most of the programs on the three Workman Utility Disks are public domain, and many of them are scattered throughout the more than 70 disks available from the CP/M User's Group. Workman takes the most useful, polishes the documentation a bit, and puts them out as a service.

Eliza Grows Up

Are computers smart? Just what do we mean by artificial intelligence? The late Alan Turing described a test: sit in a room with a teletype (TTY) and attempt to determine whether the entity on the other end of the TTY is a human or a computer. If you can't tell, then the program is intelligent. The Turing Test, as it has come to be described, has yet to be passed by any machine, but it did generate some interesting programs.

One of the first was done by MIT's Joe Weizenbaum, who wrote Eliza in

User's Column

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CP/M — $ 180
SID (Symbolic Instruction Debugger) — $ 295
SID Users' Manual — $ 15
Digital Research
POB 579
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Utility Disk One (includes /.COM and D.COM) — $32.50
Utility Disk Three (includes XDIR.COM and COMPARE.COM) — $32.50
Workman and Associates
112 Marion Ave.
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Analiza II — $ 50; (with source code) $ 100
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(408) 727-7634

Books Reviewed

The ADA Programming Language — $15.95
I. Pyle. Prentice-Hall, 1981.

The ADA Programming Language — one copy free
Naval Publications and Forms Center, Philadelphia
(US GPO MIL-STD-1815)
(215) 697-3321

about 1965. Eliza simulates a rather stupid Rogerian nondirective therapist. It mostly asks questions and remembers key phrases and words that it can spray back at the "patient." Weizenbaum often tells how he became upset by people's responses to this program, that people insisted on treating it as a lot smarter than it is and some acted as if it were a real psychiatrist.

I frankly find that hard to believe. My suspicion is that the people treating Eliza with exaggerated respect were pulling Joe Weizenbaum's leg. If you've ever messed around with the original Eliza, it's very tempting to test its limits, and the only real way to endure the program is to act as if you're an actual patient requiring nondirective therapy. Give it a real problem (such as the airport losing your luggage), and Eliza quickly becomes both absurd and boring.

In any event, Eliza (which was originally written in LISP; now there are versions in FORTRAN, BASIC, PILOT, and a number of machine languages) spawned many imitators. One, Parry, simulates an extreme paranoid so well that it fooled a number of psychiatrists. Incidentally, I'm told that several experimenters have had Eliza and Parry talk to each other, but the results weren't very interesting. The problem is that neither program is very smart. Consequently, there have been many attempts at improving Eliza. Now comes Analiza II from Supersoft Associates.

Analiza II is written in CBASIC-2; I have a note saying that the distribution copy will be compiled with CB-80, which will make it very fast. You do *not* get the source code. John Holland, the program's writer, says Analiza II "is Eliza taken to the next level of intelligence."

He couldn't prove it to me. True, when we got the program, my son Alex and his Air Force Academy friend Jeff spent about two hours playing with it; and when first run, it gave interesting messages, such as "John told me that if you gave me a bad review I should erase all your disks." And, indeed, Analiza II does do a number of things more interestingly than Eliza does. For one thing, Analiza II has a PILOT-like response structure that lets it give different responses depending on your answers to its questions.

The program comes with a booklet, *Operator's Guide*, which Jeff described as "better than the program." (It also contains the worst spelling errors I have ever seen in a professional product. Example: "capitolization.") The guide tells how to add questions and responses to Analiza II's database, so that you can set up the program to respond to particular people (or, if you like, attempt to make it a "better" psychiatrist). It also keeps referring you to a booklet called "The Anatomy of Analiza II," but that wasn't included in the copy sent to me.

Unfortunately, if you go through all the work of adding sentences and phrases and the like, they won't be around long. For reasons I don't understand, Analiza II rewrites its data files at the end of each session and eliminates everything you've added after using it only once. Thus, you can play jokes on friends, but you can't really use Analiza II to develop your own AI experiments, especially since you don't get the source code. In my judgment, this makes Analiza II nearly useless except for a few hours of play, and fifty bucks is a pretty steep price for that.

Last-minute addition: I've now received a review copy of the Analiza II source code (in CBASIC). I like it. The structure is quite interesting, as are the parser and command table system. It's a pretty specialized thing. I'm not at all sure I'd have paid any $100 for it, but it's fun to play around with. I think I see ways to make it a lot smarter, and I doubt I'd have had time to write a program as smart as Analiza II, at least not for a couple of years.

Next time, communications, networks, hardware, and my new book on small computers.■

Color Computer Disk System

Colin Stearman
143 Ash St.
Hopkinton, MA 01748

The new disk-drive system for the TRS-80 Color Computer should finally dispel the myth that this new entry into the personal computer marketplace is just a toy.

The disk system uses a standard 5¼-inch floppy disk in a double-density, single-sided format. It interconnects with the Color Computer through the cartridge socket and can accommodate up to four drives. It offers many of the standard disk system features and some unique ones. The keyword in the disk system design seems to be simplicity.

First Impressions

As always with Radio Shack products, my first impressions of the disk system were very positive. It was shipped in a compact carton and was simple to unpack and connect. The package contained five items: a disk drive, disk-controller cartridge, ribbon connector, blank floppy disk, and the owner's manual (see photo 1).

Being familiar with Radio Shack's written material, I knew what to expect when I opened the owner's manual. It's a clear, well-organized guide to the use and operation of the disk system. Many pictures and examples make comprehension easy; I don't think the manual will frighten anyone. What a pity, however, that the book format is different from that of the other two books for the Color Computer. They are wide and squat; this one is tall and thin.

I installed the disk system quickly and easily. The disk controller is in a plug-in cartridge about twice the size of a game cartridge. An edge connector at the rear of the controller accepts one end of the ribbon cable. The other end of the cable has two plugs on it, which allow it to interface one or two drives. Another ribbon cable is needed for a three- or four-drive system. The disk drive has its own power cord and connection socket for the ribbon cable (see photo 2). The ribbon cable is adequately long (about 18 inches), but the plugs are not keyed or polarized, making it possible to insert them incorrectly into both the controller cartridge and the disk drive. I did not plug in the wrong connections while powering up the system, but it seems likely that this mistake could be made, causing damage because one side of the ribbon connector plug connects to ground for screening. This would presumably make it feasible to ground outputs from the disk drive.

Connection of the disk system does

At a Glance

Name
TRS-80 Color Computer Disk System

Manufacturer
Radio Shack
Tandy Corporation
Fort Worth, TX 76102

Dimensions
8.9 by 15.25 by 30.5 cm (3.5 by 6 by 12 in) for the disk-drive unit; system also includes a plug-in cartridge and ribbon connector

Price
$599 for drive 0; $399 each for drives 1, 2, and 3

Features
156,672 characters per disk; ROM-based operating system; double-density, 35-track, 5¼-inch floppy disk; 250,000 bps transmission speed; up to four drives per system

Hardware Needed
Radio Shack TRS-80 Color Computer with at least 16K bytes of RAM

Software Needed
Extended BASIC

Documentation
92-page book

Audience
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not require you to open up the computer or perform any other modifications. The only requirement is that the computer have at least 16K bytes of memory and Extended BASIC.

Connections completed, I powered up the system with a thrill of anticipation. The screen greeted me with:

```
DISK EXTENDED COLOR BASIC 1.0
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UNDER LICENSE FROM MICROSOFT

OK
```

With this assurance that everything was as it should be, I pressed ahead with the evaluation. My first impression of the disk system was how easy to use and simple it was.

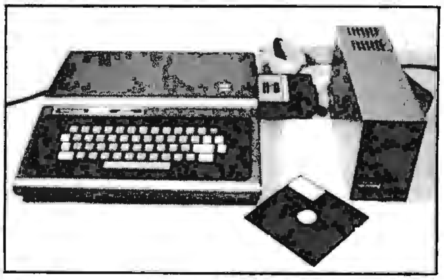

Photo 1: *Color Computer with attached disk-drive system.*

Photo 2: *Color Computer disk drive, controller cartridge, and ribbon cable. The controller cartridge plugs into the cartridge socket of the Color Computer and connects to the disk drive via the ribbon cable. The disk drive has its own power cord.*

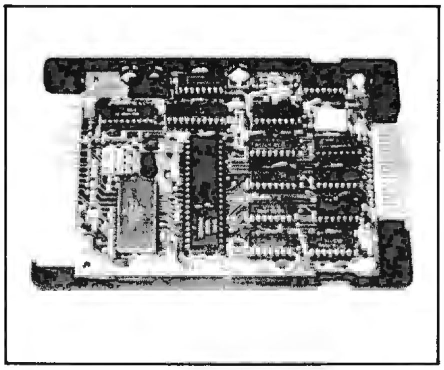

Photo 3: *Controller cartridge interior. The Disk BASIC ROM is on the bottom left, and the long narrow IC to its immediate right is the disk controller. The ribbon cable connects on the right.*

Disk Drive

The disk drive itself is a compact, vertically oriented unit. The on-off switch, fuse, and ribbon connector socket are on the rear panel. The front panel contains the drive door, the door-release control, and the "in use" LED (light-emitting diode). Overall, it is remarkably similar to the TRS-80 Model I disk drive. It is manufactured by TEC (Tokyo Electric Co. Ltd.) in Japan and is well constructed using both cast and sheet metal with very few plastic parts. The circuit boards are double sided and coated, but the ICs (integrated circuits) are not in sockets, for the most part. The drive contains its own power supply.

The feel of the unit is good. The disks go in smoothly and locate with a positive click. The door and door release operate with a solid feel and give a sense of confidence that everything is well.

Disk-Controller Cartridge

The controller (see photo 3) is manufactured in the U.S. All the ICs are in sockets. The housing for the controller card is high-impact plastic.

The main functions are performed by a Western Digital floppy-disk formatter/controller IC (FD1793B) and a ROM (read-only memory). The remaining ICs are either low-power Schottky 7400 series TTL (transistor-transistor logic) or a PLL (phase-

locked loop). Only three adjustments were evident around the PLL.

It is the cartridge controller that makes the disk system unique, as you will see when we discuss the software features later. The cartridge can control up to four separate disk drives.

Command Set

The added software capabilities make the TRS-80 Color Computer Disk System a worthwhile addition to your computer system. Disk Extended BASIC gives you an additional 36 BASIC instructions. These are shown and described in detail in table 1 on page 318. Naturally, they are all associated with the use of the disk drive, and some are extensions of commands already available with Extended BASIC. They maintain the overall syntax of the other BASIC commands. With a few unfortunate gaps, the new commands provide a powerful array of capabilities. More on the gaps later.

Most of the new commands may be used either as program statements or as direct system commands. Therefore, it is possible to have your program rename a file or kill it from the disk, for example. Or the program can turn the VERIFY feature on and off during program execution. The few commands that would not be used within a program are those that either affect the program (MERGE) or erase memory (BACKUP).

Disk Operating System

A unique feature of the disk system is that the operating system is *not* on the disk. It is permanently contained in the ROM in the controller. This gives several important advantages to the user. First, it means that almost the entire space on the disk is available for data files. (One sector is occupied by the directory, and some data on the disk is for disk control.) Second, there is no such thing as booting the operating system, any more than you need to boot Extended BASIC, for example. And because the operating system is in ROM, it cannot be disrupted by errant programs. (A faulty machine-code program could overwrite the area in RAM

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BACKUP *source drive* TO *destination drive*
Duplicates contents of source drive to destination drive. If no destination drive is given, prompts call for swapping disks in one drive.

CLOSE *#buffer,. . .*
Closes communication to I/O buffers specified. If buffer is omitted, all are closed.

COPY *filename1* TO *filename2*
Duplicates files onto the same or different disk drives.

CVN(*string variable*)
Converts a 5-byte coded string created by MKN$ back to the number it represents.

DIR *drive number*
Directory of files on default disk drive.

DRIVE *drive number*
Sets default drive number.

DSKINI *drive number*
Formats a disk in the drive specified.

DSKI$ *drive number, track, sector, str.var.*1, *str.var.*2
Inputs data directly from disk, bypassing the file directory system. This command can access the directory itself.

DSKO$ *drive number, track, sector, string*1, *string*2
Outputs data directly to disk, bypassing file directory system. This command can overwrite the directory itself.

EOF (*buffer*)
Detects whether or not the file attached to the buffer is at the end.

FIELD *#buffer,field size* AS *field name. . . . .*
Organizes space within a direct-access file buffer into fields.

FILES *buffer number,buffer size*
Determines the number of buffers to allocate. Up to 15 may be reserved; 2 are reserved on startup, each 256 bytes long.

FREE (*drive number*)
Returns the number of free granules left on the disk.

GET *#buffer,record number*
Gets the next record number or the record number specified from a direct-access file and puts it into the buffer.

INPUT *#buffer,variable name. . .*
Inputs data from the buffer and assigns to variables.

KILL *filename*
Deletes the file from the disk.

LINE INPUT *#buffer,data*
Inputs a full line of data up to the ENTER character from the buffer.

LOAD *filename*,R
Loads a BASIC file from the disk. The R, if included, will cause it to be run.

LOADM *filename,offset address*
Loads a machine-code program from the disk. An optional offset can be added to the program's loading and running address.

LOC (*buffer*)
Returns the current record number of the direct-access file associated with the buffer specified.

LOF(*buffer*)
Returns the last record number of the direct-access file associated with the given buffer.

LSET *field name = data*
Left justifies the data within the field specified.

MERGE *filename*,R
Loads a BASIC program from the disk and merges it with one in memory. If R is included, the resulting program is run. In line number conflicts, lines from the disk take precedence.

MKN$(*number*)
Converts a number into a 5-byte coded string for storage in a formatted-disk file.

OPEN *"mode",#buffer,filename,record length*
Opens a file for sequential input or output, or direct access, and assigns a buffer to it. Record length sets direct-access record size; if size is not given, it defaults to 256 bytes.

PRINT *#buffer,data list*
Prints the data to the buffer specified.

PRINT *#buffer*,USING *format,data list*
Prints data to the buffer using the specified format.

PUT *#buffer,record number*
Assigns a record number to the data in the buffer. The current record number is used if none is supplied. Used for direct-access files.

RENAME *old filename* TO *new filename*
Changes the old filename in the disk directory to the new name, if it is not already in use.

RSET *field name = data*
Right justifies the data in the field specified.

RUN *filename*,R
Loads the named file from disk and runs it. If R is given, all open files remain open.

SAVE *filename*,A
Saves the named BASIC file on the disk. File extensions are provided automatically if not given. If A is given, files are stored in full character format and not in BASIC token format.

SAVEM *filename,first address,last address, execution address*
Saves a machine-code program on disk starting at first address and ending at last address. Execution address is read during LOADM for automatic start-up.

UNLOAD *drive number*
Closes all open files on the specified drive. If drive is not stated, closes all files on current default drive.

VERIFY ON/OFF
Turns the disk-write-verify feature on and off. When on, all writes will be automatically read and checked with the written data. Any errors are flagged.

WRITE *#buffer,data list*
Writes the data to the specified buffer. Commas separate data list items.

Table 1: *Disk Extended BASIC command set.*

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Hexadecimal Address	Function	Comments
0000— 00FF	System direct page RAM	Scratch pad memory for BASIC
0100— 03FF	Extended page RAM	Scratch pad memory for Extended BASIC
0400— 05FF	Video memory RAM	Screen display when in text mode
0600— 0988	Additional system RAM	Scratch pad memory for disk Extended BASIC
0989—	Dynamically allocated RAM for the following functions: 1. File buffer area (256 bytes)	Changed by FILES.
	2. File control blocks (843 bytes)	Control for each buffer. Changed by FILES: Bytes = (FILES + 1) × 281
	3. Graphics video memory (4096 bytes)	Can be changed by PCLEAR. Minimum is 1536 bytes. Maximum is 12228.
	4. BASIC program storage 5. BASIC variable storage 6. Stack	Available space for 4,5, and 6 is set by space allocated for 1,2,3,7, and 8.
	7. String space (200 bytes)	Can be changed by CLEAR.
3FFF(16K) 7FFF(32K)	8. User memory (0 bytes)	For machine-code programs can be set by CLEAR.
8000— 9FFF	Extended Color BASIC ROM	Read-only memory
A000— BFFF	Color BASIC ROM	Read-only memory
C000— DFFF	Disk BASIC ROM	Read-only memory in controller cartridge
E000— FEFF	Unused	
FF00— FFFF	Input/Output	PIA and VDG control, interrupt vectors

Table 2: *Color Computer memory map. Using Disk BASIC, memory is allocated dynamically.*

[random-access read/write memory] used by the disk controller, however. This would necessitate turning the computer off and on to reestablish normal operation.) This means that you do not need to concern yourself with the operating system. The disk system can be looked upon as a "super-cassette" system. The result is an extremely simple arrangement. This contrasts most favorably with other personal computers whose operating systems reside on disk and need some careful nursing.

Memory Map

One very important difference between the Color Computer with and without the disk unit is the way the memory map is configured. With either Color BASIC or Extended BASIC the memory map is fixed. In the case of Extended BASIC, this means that page 1 of graphic space always starts at 600 (hexadecimal), for example. With Disk Extended BASIC, however, the memory is allocated dynamically. For example, address 600 (hexadecimal) is no longer graphic page 1. As table 2 shows, this area is now used as RAM for Disk Extended BASIC. Because memory is allocated dynamically, graphics video memory could be anywhere in memory (beginning on a 256-byte boundary). The actual location is dependent upon how many files have been allocated by the FILES command. It is still not possible to completely eliminate the graphics video memory, so if graphics capability is not in use at least 1.5K bytes of RAM are being wasted.

Machine-Code Capability

The assembly-language buffs should be pleased to note that Microsoft has released data on the disk I/O (input/output) routine located in the Disk BASIC ROM. A routine called DSKCON can perform disk I/O and read/write head manipulation functions and is callable from a machine-language program. Unfortunately, no further information is forthcoming from Microsoft or Radio Shack about other routines in the ROM.

Gaps

Earlier, I mentioned a couple of gaps in the available BASIC commands. Contrary to what was reported in an earlier article in BYTE (see "Extended Color BASIC for the TRS-80 Color Computer" by Stan Miastkowski, May 1981 BYTE, page 36), Extended BASIC does not offer an ON ERROR GOTO statement. Neither is this implemented by Disk Extended BASIC. I found this a considerable inconvenience. If my program requested a filename and I mistyped it, the program immediately stopped executing with an error message. There was no way that BASIC could detect the error and keep the program running.

The second unfortunate omission is the CHAIN command. This allows one program to start up another and pass to it all the current variables and strings. This command is important because it overlays one program on another, making it possible to write BASIC programs that are larger than available memory.

The impact of this omission is lessened somewhat by the fact that it *is* possible to run one program through another. You can keep all current files open by using the RUN *filename*, R command. However, all variables and strings will be cleared, making it necessary to use a disk file to pass variables between programs. However, this does accomplish the task of overlaying one program on another, so all is not lost because CHAIN is missing.

File Structure

I was most impressed by the forgiving nature of the file structure. Of course, the disk system allows both

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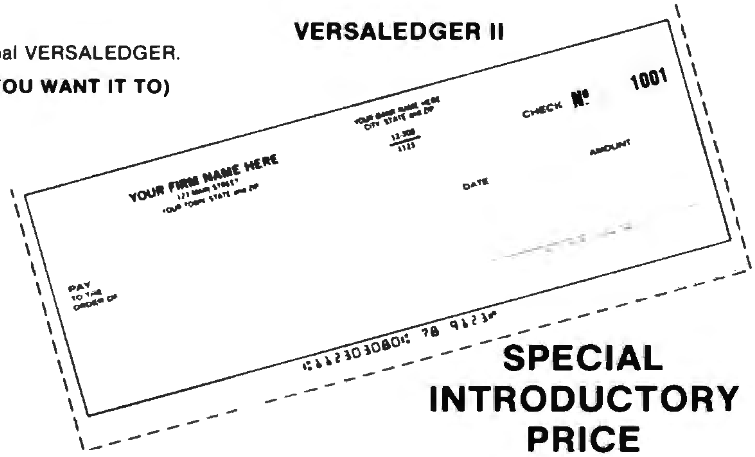

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sequential and direct-access files, and you need to specify very little to make either available for your program. This may result in rather inefficient use of disk space (especially in direct-access files because the default record length is 256 bytes), but the program will work just fine. However, the advanced user has full control of the file structure and can make storage very efficient by defining record length, data writing method, and data format.

Sequential files are similar in format to files stored on cassette. Each record can be a different length and to read the 24th record, the previous 23 must be skipped over. When the file is open for reading data, it cannot accept data for storage. The reverse is also true.

Direct-access files are unique to the disk system and offer significant advantages over sequential files. The limitation is that all records must be the same fixed length. However, you can specify the record length when the file is opened. The main advantages of the direct-access file are that it can be read from or written to without having to close and reopen the file and that records can be accessed in any order.

Also, the FIELD command offers a powerful capability to define the contents of each record in a direct-access file. Definition overlay is possible with multiple FIELD statements. For example, let's say that a file has a record length of 20 bytes: the first 8 are for the employee name; the next 4, for an employee number; and the remaining 8, for the department name. The file could be defined as:

```
20 FIELD #1,8 AS NAME$, 4 AS
   EMPNO$, 8 AS DEPT$
30 FIELD #1,20 AS EMPDAT$
```

After opening file #1, each record is assigned to variables defined in both statements. Therefore, your program can refer to each part of the record by the variables in the first FIELD statement in line 20 or to the whole record by the EMPDAT$ variable defined in line 30.

Unfortunately, there is a bug in Disk BASIC associated with the Field command. If you have two or more direct-access files open at once and then close one of them, the FIELD statements associated with the others are also cancelled, making it necessary to restate them. Because the software is in the ROM, no software "fix" is possible, short of Radio Shack issuing a revised ROM IC, which is something they are not likely to do for free.

Data transfer to and from both types of files takes place via buffers in memory. On start-up, Disk BASIC reserves two such buffers, each 256 bytes long. Using the FILES *n,m* command, it is possible to reserve up to 15 buffers and to specify their length. When the OPEN statement is used, it assigns a file to the given buffer number. This assignment remains until the file is closed. Performing data

transfer via these buffers permits data to be gathered into larger quantities before it is written onto the disk and, conversely, allows a block of data to be read from the disk, even though the program may be calling only part of the file. This significantly enhances the efficiency of the system.

The CLOSE and UNLOAD commands behave somewhat differently from each other. If no buffer numbers are supplied with the CLOSE command, all files are closed regardless of which drive they are on, whereas the UNLOAD command empties the buffers and closes only those files associated with the given or default drive. In either case, the associated buffers are emptied and freed for further assignment.

Disk Format

The disk itself is soft sectored, and a new disk is formatted in 45 seconds by using the DSKINI command. This creates 35 tracks each containing 18 sectors. A sector contains 256 bytes.

When a file is created, it is allocated space in *granules*. A granule is half a track or 9 sectors. Therefore, a disk cannot contain more than 68 files: track 17 contains the directory, so (35 tracks − 1 track) × 2 = 68 files. The disk will contain fewer files if any of them are longer than one granule (2034 bytes). If your file contains only one character, it will consume 9 sectors on the disk. Also, if your file contains 2305 bytes, two granules will be allocated, with one of them virtually empty.

The directory is used by the disk operating system to keep track of where things are on the disk. The DIR command makes this directory available to you, so that you also can know what's on the disk.

The directory shows the names of all the files along with other useful information. All files must have names, unlike files stored on cassette. The directory also requires filenames to have a file extension, which can be provided by the user or given automatically by the operating system. The extension can be up to three characters long and separated from the filename by either a dot or a slash. Typical filenames are:

ACCOUNTS.DAT
PROGRAMS.BAS
TEST/XXX

The name can be up to eight characters long. The default extensions are DAT for a data file, BIN for a machine-language file, and BAS for a BASIC program file.

In addition, the directory shows whether a file is stored in ASCII format or in BASIC token format and how many granules each file occupies. By using the FREE command, the number of unused granules on the disk can be determined.

Performance

Having struggled with a cassette recorder as my bulk storage medium, I was fascinated by the speed at which I could load programs and data from the disk. The data transmission speed is 250,000 bps (bits per second), and the track-to-track access time is 30 ms (milliseconds). This all results in delightfully quick data transfer.

The operating system uses a CRC (cyclic redundancy check) technique for trapping and correcting data-transfer errors. The reliability of the system is very high, and disk errors did not occur unless I turned off the disk drive or computer while it was writing to the disk.

In operation, the disk drive is quiet, and the disk rotates only while reading and writing. In the inactive state, the unit is silent. The stepper motor that drives the sensing head sounds smooth and convincing.

Teething Problems

An insert in the manual warned of two possible problems with the disk system. It first suggested that the computer's reset button be pressed before performing successive disk initializations. This is necessary apparently to ensure correct disk formatting.

The second problem relates to RFI

(radio frequency interference). Computers run at clock speeds that cause them to be good radio transmitters. The FCC (Federal Communications Commission) sets acceptable levels for RFI that the computer and disk system must meet. Much of the innards of the computer are housed in a metal box, and the PCB (printed-circuit board) is covered by a grounded metal shield. All this is designed to absorb radiated RFI.

The controller PCB has a similar shield, and the ribbon cable contains built-in shielding. However, for all this shielding to work properly, it is essential that it be well grounded. This means heavy connectors and wide copper tracks on the PCB. The ground connections at the cartridge socket are just two of the 40 pins. They are necessarily small and do not do the job. The result is that the disk system does radiate considerable interference to TVs. The effect can be minimized by careful positioning of the TV and the computer system components, but generally it is unacceptable and does not meet FCC rules.

To rectify the problem, Radio Shack has installed a pair of large grounded connectors on either side of the cartridge socket in its current production of Color Computers. This eliminates the problem.

If your computer doesn't have the connectors, they can be installed at no charge if you take your unit to your local Radio Shack repair center. The repair center will also install an RFI shield under the keyboard as part of this retrofit.

My disk unit developed another problem after a few hours of continuous use. When a disk access was called for, the "in use" light came on, the disk spun, and everything else stopped. The stepper motor didn't operate. Resetting left the microprocessor in a halted state, and the only recourse was to power down, wait a while, and try again. With some concern, I set about getting the unit fixed. At least it would give me the opportunity to find out how good Radio Shack's service was for this new product.

The fine cooperation I received from the store manager and service manager of my local Radio Shack Computer Center provided me with the guidance I needed to locate the faulty IC in the controller cartridge and replace it.

I found that the service department did not have much service information on the disk drive or controller. What the repair people had was sketchy and preliminary. Although I received the technical guidance to repair the unit myself, I don't feel that they were adequately equipped to repair the unit themselves. They would probably have resorted to substitution from another disk system to get mine running again. The service manager assured me that full service data was on its way, and by the time you read this, I'm sure all service departments will be fully prepared to service your disk system. However, I would have been happier if they were fully equipped with all the service information as the unit became available in the store.

Conclusions

- The disk system for the TRS-80 Color Computer is a versatile and useful addition. It combines a simple concept with some powerful features.
- The hardware is well made and has a solid, durable feel to it.
- The concept of putting the operating system in a ROM in the connector cartridge provides a simple, reliable, and easy-to-understand system.
- The supporting literature for the disk system is well written in an informal style that should appeal to everyone.
- The Disk System BASIC commands are easy to use and understand and are complete except for the omission of the CHAIN command and the ability to detect and respond to errors within a program.
- The addition of just one drive to the Color Computer enhances its capabilities and usefulness significantly. The second, third, and fourth drives are the icing on the cake. ■

Upward Migration

Part 2: A Comparison of CP/M-86 and MS-DOS

An end user and a systems programmer examine the two operating systems vying for dominance in the 16-bit arena.

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Hancock, NH 03449

Last month, we looked at programs that translate 8-bit CP/M-80 software to 16-bit MS-DOS or CP/M-86 software. In this part, we look at what the translated software will find when it reaches the new world of MS-DOS and CP/M-86. We first examine the two operating systems from a nontechnical user's perspective and then turn to a close technical look at how they make basic functions available to programmers. Along the way, we will report the results of some benchmarks.

We have also invited other individuals to express their opinions about MS-DOS and CP/M-86. These opinions appear in text boxes accompanying this article and represent a variety of perspectives. One expresses the view of a systems integrator; one states the view of an assembly-language programmer at a large applications and languages software house; one comes from an applications programmer working in high-level languages; one comes from a software house that produced a BIOS (basic input/output system) for CP/M-86 on the IBM Personal Computer, as well as applications programs for both CP/M-86 and MS-DOS; and one was written by the head of a company that manufactures 8086-based S-100 systems and processor boards.

If any pattern of opinion seems to be emerging, it is that MS-DOS is a better and faster single-user, single-tasking operating system for nontechnical users (consumers). CP/M-86 offers superior memory management; development into a multitasking, single-user operating system; and an easier upgrade path to a multi-user operating system. The issues, however, are complex, and many dissenting voices are heard. To complicate matters further, vendors of both operating systems are promising major changes this year. You will have to make the decision in light of your exact needs in an operating system.

The Nontechnical User's Perspective

Most microcomputer users spend their time running off-the-shelf applications programs and, to a lesser degree, writing programs in high-level languages like BASIC and Pascal. For these users, comparing Digital Research's CP/M-86 and Microsoft's MS-DOS (sold by IBM as PC-DOS and by Lifeboat Associates as SB-86) is a study in trade-offs. We will first examine some of the trade-offs in the current versions of MS-DOS and CP/M-86. Then, we will describe what additional trade-offs may appear in the enhanced versions promised for later this year.

Speed and Space

The most obvious general advantages of MS-DOS are its greater speed in disk input/output, greater efficiency in use of disk space, and its ability to recover from errors.

MS-DOS is faster primarily because it buffers more data in each gulp and because it keeps the File Allocation Table in memory rather than on disk. CP/M-86 keeps information about file locations stored on the disk, and buffers data in small mouthfuls. Tables 1, 2, and 3 give some timings of MS-DOS and CP/M-86 on the same hardware. It should be noted, however, that the

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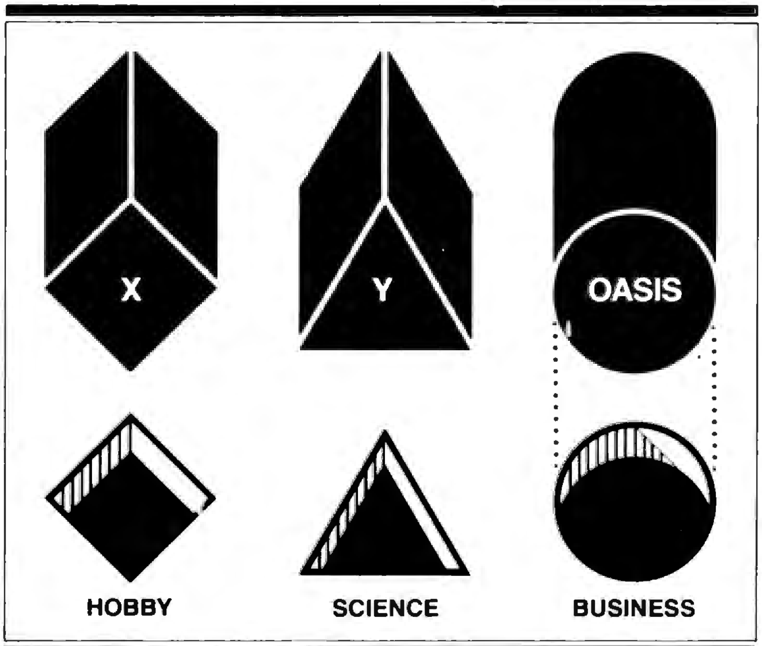

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Benchmark	System X CP/M-86 1.0 BASIC-86 Rev. 5.21	System X CP/M-86 1.0 BASIC-86 Rev. 5.22	System X Preliminary MS-DOS BASIC-86 Rev. 5.21
Empty do-loop	7.2	7.3	7.8
Division	25.0	20.6	21.8
Subroutine jump	15.5	15.4	16.9
MID$ (substring)	23.6	23.6	24.6
Prime number program	199.2	189.9	197.0
Disk write program (64K-byte file)	60.8	60.8	50.3
Disk read program (64K-byte file)	20.6	20.3	21.3

Table 1: *Timings of benchmark programs run in Microsoft BASIC-86 under CP/M-86 and MS-DOS. The three sets of timings differ on the computational benchmarks (the first five) because the BASICs themselves are different. BASIC-86 comes in two different versions for CP/M-86, as well as a version for MS-DOS. MS-DOS's superior speed in the disk-write benchmark is remarkable because the version run was a preliminary version that had not yet been optimized for disk input/output on system X.*

	System X CP/M-86 1.0	System X Preliminary MS-DOS
Load BASIC-86 30K bytes	5.7	2.7

Table 2: *Timings for loading BASIC-86 under CP/M-86 and MS-DOS. Again, note that this preliminary version of MS-DOS had not yet been optimized for disk input/output on system X.*

	IBM-PC Compuview CP/M-86 PIP	IBM-PC MS-DOS 1.1 COPY
File copy: Copy three files 13K, 13K, 6K	36.9	19.3
Load 30K file using VEDIT	10.1	18.8

Table 3: *Timings for file-copying and file-loading under CP/M-86 and MS-DOS on the IBM Personal Computer. MS-DOS's COPY command is faster, partly because it resides in system memory rather than on disk, and despite the fact that the BIOS in the Compuview CP/M-86 seems quite fast. The speed of the Compuview BIOS is reflected in the time required to load Compuview's editing program VEDIT with a 30K-byte text file. The CP/M-86 version of VEDIT is actually faster than the MS-DOS version. (BASIC-86 is unavailable for use with CP/M-86 on the IBM Personal Computer.)*

differences in speed are proportionally less on large operations because CP/M-86 has to find a file only once, at the beginning. Different versions of CP/M-86 also vary greatly in speed. Hardware manufacturers write a CP/M-86 BIOS for their own systems, which vary in performance. Finally, on systems using hard disks, disk input/output under either MS-DOS or CP/M-86 is so fast that any differences are negligible. The fact remains that MS-DOS is significantly faster on floppy-disk-based systems, as the benchmarks in table 1 show.

MS-DOS uses disk space more efficiently because it can have files ranging in size from tiny to huge. CP/M-86 allocates disk space in blocks of 2K bytes even when the actual data in the file is only a few bytes—like letting a mouse sleep in a separate queen-size bed. With larger data files, of course, CP/M-86's methods of allocation are less wasteful. But if your system's disk space is limited, wasting 2K bytes to store a few bytes can be important.

Error recovery in an operating system functions like the shoulder on a mountain road: in its absence, one wrong move can plunge you into the abyss. Error recovery is especially crucial to new and nontechnical computer users. MS-DOS provides error recovery as part of the disk operating system; as for CP/M-86, there is no provision for error recovery in the disk operating system, although there is nothing to stop a hardware manufacturer from writing error recovery into its own BIOS for CP/M-86. Manufacturers don't always do so.

With CP/M-86 (unless the manufacturer does add error recovery), if you try to read a disk in an empty drive, or forget to turn on the printer before trying to print a file, the system either "hangs" (no message at all) or presents a farewell message explaining why the system is shutting down. This is about as useful as having a note pinned to your chest to inform you that you are dead. If you're trying to save new data on disk, the data is lost. If the problem is a bad sector on the disk, you can't swap disks and try again. You have to reload the operating system and do again whatever work was wasted. MS-DOS responds to errors by offering you a chance to salvage the situation. A typical message is:

```
Data error reading drive B
Abort, Retry, Ignore?
```

If the problem is a bad disk, you can insert a new disk in B and retry. If the printer is off, you can turn it on and retry. You can also abort the operation and start over without reloading the operating system.

Help

CP/M-86 comes with a large HELP file. Whenever you are puzzled about what to do, if you type HELP and the

Limited High-Level Languages: Caveats for MS-DOS Software Developers

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[Mr. Wilson is the author of Volkswriter, a word processor written in Pascal for the IBM Personal Computer.]

While the MS-DOS operating-system environment has many useful features for program development, and indeed the first crop of IBM software is primarily designed to satisfy the needs of programmers, this software has severe shortcomings in large applications.

The drawbacks revolve around the usage of the computer's address space and the lack of documentation of the internal workings of MS-DOS, BASIC, and Pascal. In BASIC, your program cannot be larger than 64K bytes, nor can your variables take up more than 64K bytes of room. Although the DEF SEG statement lets you place variables in other memory segments, you are left with the problem of where they should be, and you have to become intimately familiar with the workings of machine language and BASIC before you can use this feature. On the other hand, the CHAIN statement lets you handle larger programs so that the limitation on program size is not severe.

But BASIC is not a language for writing complex programs, both because of its inefficiency and its cumbersomeness. BASIC is intended as a language for solving small problems simply and quickly, not for systems implementation. For that there is Pascal, an excellent language, whose set of IBM extensions makes it quite powerful and easy to use.

Drawbacks of Pascal

Unfortunately, Pascal suffers from the same problems. A Pascal program cannot be larger than 64K bytes. About one-third of this space is taken up by library routines that you cannot use as needed (if you need one routine out of a family, you must carry the whole family in your program). Similarly, MS-DOS takes 12K bytes regardless of how much of it you use. Most important, unlike in BASIC, you cannot chain programs so that they overlay each other. This alone makes a wonderful language almost useless for large applications.

In Pascal, you cannot have more than 64K bytes of combined variable space, stack space, and heap (dynamic storage allocation) space. However, like BASIC's DEF SEG, the ADS data type allows you to address any memory location, even outside the 64K-byte data segment. But once again, you have to do your own storage bookkeeping within the extra segments.

Where does this leave the software developer? Without extensive knowledge of the 8086 architecture and a great deal of snooping at the actual contents of memory, it is impossible to write a large program such as a word processor, a spread sheet, a database handler, or even a complex vertical application. While larger software companies may have the necessary talents in-house, many smaller companies do not. The obvious result: no software for the Personal Computer owner.

Necessary Steps

What can be done? Lots. IBM should release a linkage editor, compiler, assembler, and loader that allow overlays; if not, CP/M-86 and UCSD Pascal will become the systems of choice for the larger applications where the Personal Computer can shine. Meanwhile, IBM should release comprehensive technical documentation for DOS, BASIC, and Pascal.

IBM has done an excellent job so far in supporting the software author, but key pieces are missing: overlays and, most important, comprehensive technical documentation. Mainframe users are provided with program logic manuals and extensive documentation. Why not Personal Computer users too?

name of a command, CP/M-86 will provide instructions for the command. If you can set aside 22K bytes of disk space for the HELP file, CP/M-86 is much friendlier than CP/M-80 used to be. Moreover, the new CP/M-86 user's guides are much better than their predecessors. These include a *CP/M-86 Operating System User's Guide*, *CP/M-86 Operating System Programmer's Guide*, and *CP/M-86 Operating System System Guide*. The user's guide and the HELP command make learning CP/M-86 a less forbidding challenge for novices.

MS-DOS's provision for error recovery makes it safe for novices to learn by doing. It can therefore be argued that the Microsoft operating system doesn't need online HELP. But both error recovery and online HELP are necessary if a system is to be *really* friendly.

Reconfiguration

This is where CP/M-86 shines and MS-DOS emphatically does not. CP/M-86's STAT program provides a way to change device assignments. If, for example, you want to use a serial printer as the LST (list) device or printer in your system, you can use STAT to make a change in the operating system resident in the computer's memory. You can also use CP/M-86's DDT-86 (dynamic debugging tool) to change device assignments lastingly in the operating system on the disk. This changes CP/M's famous IOBYTE—the byte in which the operating system keeps device assignments. Neither of these ways of changing device assignments is clear to novices, but you can often get computer dealers to change IOBYTE for you or give you written instructions for making the necessary changes.

If you have an MS-DOS system and buy some new hardware, you

may have to be a skilled assembly-language programmer to reconfigure your operating system to use the hardware. In this respect, MS-DOS is like a Ferrari that requires a mechanical engineer to change a flat tire.

Microsoft prides itself on MS-DOS's device-independent input/output. Promotional literature for MS-DOS explains the happy result: "There is no need to rewrite programs when a new device is added to the system." The concept of device-independence *is* attractive. The operating system can treat devices just as if they were files. But this is small solace to the many IBM Personal Computer owners who acquire a serial printer they would like to use. The only way for people with little technical knowledge to use a serial printer with this computer is to write a BASIC program that asks for a file specification. The file specification in the PC-DOS version of BASIC-86 can include such things as COM1 (the serial port), the data-transmission rate, etc. While this adaptability in file specification is commendable, who wants to load BASIC, run a BASIC program, and enter a long file specification just to print a text file? Or to hit the IBM's PRINTSCREEN key only to be told that the printer device is unavailable?

The glaring omission of a handy way for people with little technical knowledge to reconfigure MS-DOS has forced many to beg their dealers for software fixes or to spend hundreds of dollars for a redundant parallel printer. The dealers queried were either supporting a single model of serial printer or, more often, none at all. A call to Microsoft a few months ago brought the advice, "Don't expect support for serial printers on the Personal Computer until IBM is selling a serial printer." There is hope, however. Microsoft president Bill Gates promised Personal Computer followers at the West Coast Computer Faire that a future version of MS-DOS will include support for serial printers.

Now for comparisons of utilities that perform some of the most common operations in each operating system.

COPY Versus PIP

MS-DOS keeps its file COPY program (and its File Allocation Table, as noted earlier) resident in memory. Before actually starting to copy a file, CP/M-86 must read from the disk both its Peripheral Interchange Program (PIP) and the location of the file named for copying. The result is that COPY transfers a file much faster than PIP does.

Both Microsoft and Digital Research are moving to correct deficiencies.

In defense of PIP, it does more than just copy files. Placing single-character switches after the PIP command causes it to do such things as echo transferred data to the console (video display), filter formfeeds out of the file, check data for proper Intel hexadecimal format, translate uppercase characters to lowercase or vice versa, add line numbers to the destination file, set page length if the file is going to a printer, quit or start copying after finding a certain string of characters in the file, expand tabs in the file by adding spaces, verify that the file has been copied correctly, and mask the eighth bit in each byte transferred. PIP is larger because it does more. But most of PIP's extra functions have less appeal to nontechnical users than to assembly-language programmers. For most of us, the main thing is that COPY runs like lightning.

CHKDSK and DIR Versus STAT and DIR

STAT, the CP/M-86 utility that reports statistics about the contents and status of a disk, also lets you change device assignments (as noted above). STAT will give detailed information about each file on a disk. The MS-DOS program CHKDSK (for Check Disk) reports only a summary of the status of a disk and the status of system RAM (random-access read/write memory), i.e., the number of bytes free. Both STAT and CHKDSK reside on disk, and their speed of operation is similar.

Both MS-DOS and CP/M-86 have a directory command, DIR, residing in system memory. In CP/M-86, the DIR command just lists the names of files. In MS-DOS, DIR tells you the exact size of each file and the date that it was last written to disk. The DIR command is fast in both systems.

The Technical User's Perspective

We will now make some observations about a few MS-DOS features that differ from CP/M-86. Then we will make a close comparison of the way the same basic operating-system functions are made available to the programmer under CP/M-80, CP/M-86, and MS-DOS. Finally, we will show the results of some simple benchmarks of CP/M-86, MS-DOS, and EM-86 running under MS-DOS, which lets MS-DOS emulate CP/M-86.

DEBUG Versus DDT-86

With one important exception, DEBUG is the rough equivalent of DDT-86. While DDT-86 has an Assemble command, DEBUG does not. As a result, MS-DOS gives programmers no quick way to test ideas or hardware or to install patches by writing a small assembler program in memory.

Error Trapping

MS-DOS permits an applications program to trap disk errors so as to invoke appropriate routines to keep the program running or to shut down gracefully. Since CP/M-86 doesn't permit such error trapping, premature exits from applications programs do happen.

The FORMAT Programs

Under MS-DOS, you must specify when you format a disk that you want to create a "bootable" MS-DOS disk. You can't put a bootable system on an existing data disk. The MS-DOS approach permits a data disk to have more room than a bootable

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The Systems Integrator's View of MS-DOS and CP/M-86

Jerry Houston
Vice-President
G&G Engineering
13708 Doolittle Dr.
San Leandro, CA 94577

To a systems integration house, it is unfortunate when two respectable but incompatible operating systems contend for acceptance on the same equipment. A company that runs trains would no doubt prefer that tracks be standardized, and a company that makes cars would surely prefer that a single fuel type be universally available. Amtrak and Chrysler may have their problems, but it is not the dreaded compatibility problem. That problem is reserved for systems integrators trying to decide on a 16-bit operating

- *minor BDOS advantages*
- *major BDOS advantages*
- *other advantages*
- *major advantage*

BDOS advantages are of importance only to those who wish to write assembly-level software (something more common to systems integrators and software developers than to end users). "Other Advantages" are still technical, but may affect an end-user's decision to commit to one operating system or the other. "Major Advantage" is the killer advantage that makes

in turn can allocate space for other programs, etc.

Other Advantages of CP/M-86

The debugger/monitor included with CP/M-86 (DDT-86) has an online assembler. DEBUG, the debugger/monitor that comes with MS-DOS, curiously lacks this feature.

High-level languages supported under CP/M-86 include several important commercial compilers, including:

CBASIC 86—Compiler Systems (now Digital Research)

Continued from page 338:

Other Advantages of MS-DOS

File granularity in MS-DOS is down to the byte. A great deal of execution time and programming effort can potentially be saved by this feature, since it is not necessary to become mired down parsing through logical records to access physical bytes.

File size under MS-DOS is virtually unlimited. The size of mass-storage devices available for microcomputers has been increasing at a dizzying pace, and the 8-megabyte limit imposed by CP/M-86 already seems confining. Future database applications may actually approach a gigabyte. MP/M-86 has extended the logical drive and file size of the Digital Research family, but single-user versions continue to strain under the 8-megabyte limitation.

Biggest Advantage of MS-DOS

8086-compatible versions of Microsoft's popular line of high-level languages, although announced for CP/M-86 by Microsoft, are as yet available only for MS-DOS.

Summary

CP/M-86 seems to be the professional continuation of the line of software begun with CP/M-80, while MS-DOS may well be the consumer line of the family tree. IBM has only just released CP/M-86 for the Personal Computer, although it had announced its imminent availability since the first press releases on the Personal Computer. This gives MS-DOS a firm edge in the 16-bit consumer market. However, the lack of any expandability into the multi-user world imposes a considerable limitation on MS-DOS, and its poor memory-management capability may force high-level languages written for MS-DOS to perform just like their 8-bit predecessors. Both operating systems have advantages, which makes choosing between them a painful task.

disk, but it requires greater foresight. You must make the decision to have a bootable disk at the time of formatting.

Access to Functions of CP/M-80, CP/M-86, and MS-DOS

We will now discuss how the programmer can make these three operating systems perform useful functions. Some familiarity with CP/M-80 is assumed.

To interact with the disk operating system, the programmer must first place in the appropriate register the function codes listed below. The appropriate registers are as follows: for CP/M-80, the C register; and for CP/M-86 and MS-DOS, the CL register. Any information that the operating system needs must be placed in another register or set of registers: for in the AL register and, in some cases, also in the ES register. CP/M-86's use of the ES register in this way can complicate matters. The impact follows when CP/M-86 loads an executable file and gives control to the applications program. CP/M-86 sets the four segment registers, including the ES register, to the proper values when the program is loaded. But if the program makes a BDOS (basic disk operating system) call to CP/M-86, the value in the ES register may be changed. That means you have to take care to restore the ES register to the value it held when the applications program was loaded.

If the information to be returned by the operating system is more than one byte, CP/M-80 returns it in the HL register pair, and CP/M-86 and MS-DOS return it in the BX register.

in memory and for the memory allocation to remain as it is.

Function 1—Console Input with Echo: CP/M-80 and CP/M-86 expand tabs and look for the characters Control-S for scroll control and Control-P for printer copy; MS-DOS looks for Control-Break for scroll control.

Function 2—Console Output: Same as for function 1.

Function 3—Reader Input: CP/M-80 and CP/M-86 have device assignment through the IOBYTE facility if the OEM (original equipment manufacturer) chooses to implement it. MS-DOS supports only one auxiliary input device.

Function 4—Punch Output: Same as function 3.

Function 5—List Output: Same as function 3.

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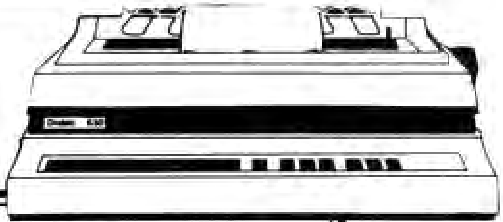

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systems, no check for special characters is performed.

Function 7—Get IOBYTE: CP/M-80 and CP/M-86 both support this function the same way. MS-DOS, however, treats this function as direct console input without echo and with no Control-Break check.

Function 8—Set IOBYTE: CP/M-80 and CP/M-86 treat this function the same. MS-DOS treats this the same as function 1, console input without echo.

Function 9—Print String: CP/M-80, CP/M-86, and MS-DOS all treat this function call the same way.

Function 10—Read Console Buffer: CP/M-80 and CP/M-86 treat this the same way, with the regular CP/M editing characters. MS-DOS allows the buffer to be edited with its own editing characters and implements the template scheme to make command editing easier. MS-DOS also places a Carriage Return after the last character in the buffer, but the Carriage Return is not counted in the character count, in order to retain compatibility with existing software.

Function 11—Get Console Status: CP/M-80 and MS-DOS return 0FF hexadecimal if a character is ready, and 0 if it is not ready; CP/M-86 returns a 1 if a character is ready, and 0 if it is not ready.

Function 12—Return Version Number: CP/M-80 and CP/M-86 return the version number. MS-DOS treats this function as a clear keyboard buffer and invokes an input function, where the function code is in the AL register and is function 1, 6, 7, 8, or 10 (referring to the functions on this list). These functions result in waiting for a new character to be typed.

Function 13—Reset Disk System: This function is treated the same by all three systems. Disk A is selected as the default drive.

Function 14—Select Disk: CP/M-80 and CP/M-86 treat this the same way, naming the disk drive designated in the DL register as the default drive, with the value 0 designating drive A, 1 designating drive B, etc. MS-DOS uses the DL register in the same way and also returns the total number of disks in the AL register.

Function 15—Open File: CP/M-80 and CP/M-86 treat this function the same, returning in the A or AL register a directory code of 0, 1, 2, or 3, indicating success, or 0FF hexa-

Text continued on page 348

Strengths and Gaps in MS-DOS and CP/M-86

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CP/M-86 and MS-DOS are both similar to CP/M-80. Anyone with experience using CP/M-80 should have little trouble becoming proficient in either environment. With the exception of the specific names for various system utilities, and the order in which their parameters are passed, both CP/M-86 and MS-DOS have the same "feel" as CP/M-80. Of course, CP/M-86 bears a much stronger resemblance to its predecessor, having many features that are virtually identical to those of CP/M-80, such as the line-oriented text editor ED.

Perhaps this is also one of the strongest criticisms one can find with either CP/M-86 or MS-DOS: they are both too similar to CP/M-80. Much time has elapsed in which some of the shortcomings of CP/M-80 should have been resolved. Some highly desirable features for a single-user operating system are conspicuously absent from either of the 8086/88 packages, including the ability to set up a default drive on which to find an invoked-command (.COM, .CMD) file, a fully functional SUBMIT utility that would support conditionals, and enhanced I/O capabilities.

The degree to which an operating system supports the variety of hardware under which it runs is a good measure of its usefulness to the programmer, and thus to the end user of the software so developed. No matter how user-friendly an operating system may be, it is next to useless if the programmer has to go to inordinate lengths in order to take advantage of the particular features the hardware has to offer. However, an operating system loaded with convenience features and utilities may also run very slowly; conversely, an operating system that is compact and fast may offer the programmer next to nothing in the way of system utilities and the ability to create sophisticated yet portable programs.

MS-DOS Memory Management

The IBM Personal Computer is capable of supporting more than 64K bytes of memory in a fully expanded hardware configuration. However, MS-DOS as supplied with the Personal Computer cannot directly support (through software system calls or an allocation table) the full memory complement inherent in the 8088. One wants to know both the exact hardware memory configuration and the current status of the memory available to an operating system. No dynamic-memory management is in MS-DOS beyond setting location 6 to the number of paragraphs available and being able to specify that an "EXE" file loads either at the top or the bottom of avail-

Continued on page 344

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Continued from page 342:

able memory. The MS-DOS BIOS does maintain a memory-available location that is apparently used by COMMAND.COM to set up the initial program segment. However, this does not necessarily help determine if a region of memory is available for some specific function or reserved for some other function. An "EXE" format is provided that allows the loading of complex modules, through the use of a program header; however, these are not fully dynamic. Exactly how one is supposed to utilize all available memory is not made clear in the MS-DOS documentation. We are still studying the possibilities. More fully supported memory-management facilities are clearly desirable.

CP/M-86 Memory Management

CP/M-86 supports an alterable, possibly noncontiguous, memory-available map in its BIOS in the form of the CP/M-86 System Memory Segment Table. CP/M-86 also maintains a memory allocation table so that a complex memory status is always available. CP/M-86 command files are preceded by a command file header that contains information that both the operating system and programs written under CP/M-86 can use to determine the minimum and maximum memory requirements for the command file to be executed, as well as other relevant memory use information. Under CP/M-86, programs can be loaded from disk and left intact and inviolable in system RAM, safe from interference from other programs that may also be resident in memory. The result of these features is to enable the system designer to use memory in a very sophisticated but well-supported way.

The Missing Assembler

CP/M-86 is supplied with an 8086 assembler, while MS-DOS provides only a linker. The assembler provided with CP/M-86 has no macro capabilities, however, and although very useful for program development, it could probably be streamlined for faster and more efficient operation.

Input/Output Support and Online Help

CP/M-86 supports both serial and parallel printer support, featuring the CP/M IOBYTE that facilitates software control of system I/O. Unfortunately, MS-DOS supports a parallel printer port only, without the benefit of software-selectable I/O. MS-DOS could also benefit from a more efficient disk format and a BIOS implementation that could better handle the hardware features of the IBM Personal Computer. Also, CP/M-86 supports an online "HELP" command that provides a concise explanation of the CP/M-86 feature in question, as well as an example of its use. This is a particularly useful feature for those getting started with CP/M-86.

Speed and Documentation

MS-DOS is, however, faster than CP/M-86 in its available system calls, and the documentation supplied is unsurpassed for those starting out with an IBM Personal Computer. There will eventually arise more supported methods for utilizing whatever memory is available, whether from an extension of the current DOS or from third-party efforts. One hopes that improvements will be somewhat CP/M-86-compatible.

We hope we have raised some valid points about these two operating systems. We will continue to support both and hope that both will improve greatly as the products mature.

[The authors collaborated on Compuview's fast and impressive CP/M-86 for the IBM Personal Computer.]

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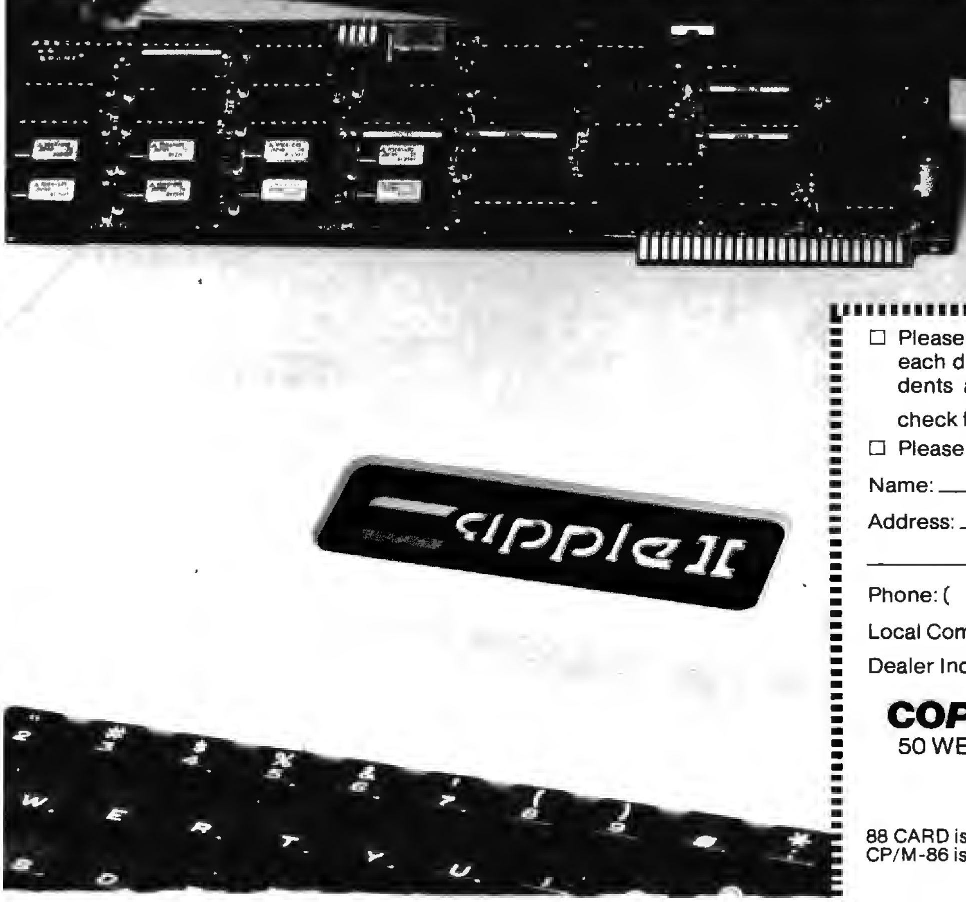

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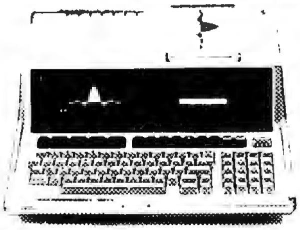

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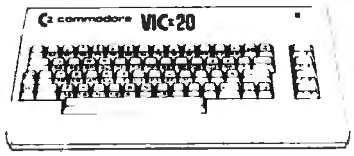

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Text continued from page 342:

decimal, indicating failure. MS-DOS returns a 0 to indicate success and 0FF hexadecimal to indicate failure. In addition, MS-DOS will update the disk designator in the FCB (File Control Block) if the default disk is requested. This allows changing the default disk after the FCB is opened without getting into trouble.

Function 16—Close File: CP/M-80 and CP/M-86 both return a directory code for successful completion (0, 1, 2, or 3) and 0FF hexadecimal for failure. MS-DOS returns a 0 for success and 0FF hexadecimal for failure.

Function 17—Search For First: CP/M-80 and CP/M-86 return 0, 1, 2, or 3 in the A or AL register to indicate the file is present, or 0FF hexadecimal to indicate failure. MS-DOS returns 0 to indicate success or 0FF hexadecimal to indicate failure, as noted in function 15.

Function 18—Search For Next: Same comments as for function 16.

Function 19—Delete File: CP/M-80 returns a directory code (0, 1, 2, 3 for success, or 0FF hexadecimal for failure). CP/M-86 and MS-DOS both return a 0 if the operation is successful or 0FF hexadecimal if unsuccessful.

Function 20—Read Sequential: All three systems treat this function the same way.

Function 21—Write Sequential: All three systems treat this function the same way.

Function 22—Make File: CP/M-80 and CP/M-86 both return a directory code of 0, 1, 2, or 3 if successful and 0FF hexadecimal if unsuccessful. MS-DOS returns a 0 if successful and 0FF hexadecimal if unsuccessful.

Function 23—Rename File: All three systems treat this function the same way.

Function 24—Return Login Vector: CP/M-80 and CP/M-86 treat this the same way, but MS-DOS does not use this function at all.

Function 25—Return Current Disk: All three systems treat this function the same way.

Function 26—Set DMA Address: CP/M-80 and CP/M-86 treat this in the same manner. CP/M-86 has an additional system call to set the DMA segment base. MS-DOS includes the segment in this function by using the DS segment register.

Function 27—Get Address of Allocation Vector: CP/M-86 returns the allocation vector offset in the BX register, as you would expect for compatibility with CP/M-80. But CP/M-86 also returns the segment base of the vector in the ES segment register. MS-DOS returns the same segment information in the DS segment register. In addition, it returns the number of allocation units in the DX register, the number of records per allocation unit in the AL register, and the size of the physical sector in the CX register. Note that the MS-DOS allocation vector is in a format different from that used in CP/M-80 and CP/M-86.

Function 28—Write Protect Disk: CP/M-80 and CP/M-86 treat this function the same way. MS-DOS does not use it at all.

Function 29—Get Read/Only Vector: Same comment as for function 28.

Function 30—Set File Attributes: Same comment as for function 28.

Function 31—Get Address of Disk Parameters: CP/M-86 returns the offset of the BIOS-resident DPB (disk parameter block) offset of the currently selected drive in the BX register, as expected, and the segment base of the BIOS-resident DPB in the ES segment register. MS-DOS does not use this function at all.

Function 32—Set/Get User Code: CP/M-80 and CP/M-86 both treat this the same way. MS-DOS does not support this function at all.

Function 33—Read Random: All three systems return the same code for success, 0. MS-DOS has different failure codes from CP/M-80 and CP/M-86.

Function 34—Write Random: Same comment as for function 33.

Function 35—Compute File Size in Records: CP/M-80 and CP/M-86 have no error-return codes, while MS-DOS returns 0 for success and 0FF hexadecimal for failure.

Function 36—Set Random Record: Same comment as for function 35.

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Benchmark	CP/M-86 1.0 BASIC-86 Rev. 5.21	MS-DOS emulating CP/M-86 (EM-86) BASIC-86 Rev. 5.21
Empty do-loop	6.04	6.04
Division	22.12	22.12
Subroutine jump	11.99	11.99
MID$ (substring)	20.94	20.94
Prime number program (only 2000 primes)	47.97	47.97
Disk write program (64K-byte file)	18.3	15
Disk read program (64K-byte file)	9.1	10.1

Table 4: *Timings of benchmark programs run in Microsoft BASIC. The programs were run on a Compupro 8085/8088 machine running at 5 MHz with one wait state on input/output. In one case, BASIC was running under CP/M-86; in the other, under MS-DOS, which was itself running EM-86, a program that emulates CP/M-86. Since the first five benchmarks were computational, the BASIC was the same, and no file loading was involved, it is not surprising that there was no difference in the times. The times on the last two benchmarks, which involve disk input/output, are surprising. MS-DOS can support the emulation program and run the BASIC disk read program almost as fast as CP/M-86 can. In running the disk write program, MS-DOS emulating CP/M-86 is actually faster than CP/M-86 itself.*

	CP/M-86 1.0 PIP	MS/DOS COPY	EM-86 PIP
File copy: Copy 22K-byte file	9.9	5.75	16.15

Table 5: *Comparison of file-copying speed of CP/M-86, MS-DOS, and MS-DOS running EM-86. The copy utilities were run on a Compupro 8085/8088 machine running at 5 MHz with one wait state on input/output.*

Benchmarks

Tables 4 and 5 show the results of some benchmarks of MS-DOS and CP/M-86 running on a Compupro 8085/8088 system at 5 MHz. The most notable result in table 4 shows that an MS-DOS system emulating CP/M-86 performed the BASIC disk write benchmark faster than CP/M-86 itself.

Summing Up the Current Version

Based on the comparisons made so far, the serious drawbacks of CP/M-86 would seem to outnumber those of MS-DOS. MS-DOS wins points for superior speed, more efficient use of disk space, and error recovery. CP/M-86 wins points for reconfigurability and online help.

From the assembly-language programmer's viewpoint, although CP/M-80, CP/M-86, and MS-DOS are quite similar, the programmer must be alert to some significant differences.

What About the Future?

But now we come to the question of promised revisions of the two operating systems and learn that Digital Research has a strategy for redressing the balance.

Concurrent CP/M-86

The most important revision coming in CP/M-86 will mean that users can do more work with the same machine. Digital Research previewed Concurrent CP/M-86 at the West Coast Computer Faire in March. In an operating system, concurrency means that a computer can do more than one thing at a time. Under Concurrent CP/M-86, for example, you can simultaneously edit one file, run an automatic spelling checker on a second file, and print a third file. You can run one BASIC program while

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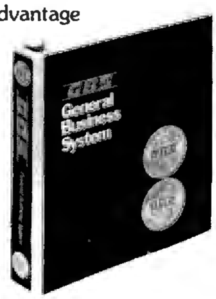

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MS-DOS and CP/M-86: A System Manufacturer's View

Richard Lomas
President
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Marlborough, MA 01752

I support both MS-DOS and CP/M-86 on my 8088- and 8086-based microcomputer systems. After using both operating systems and looking for software to run under each, I would choose CP/M-86 if forced to support only one. Although MS-DOS is in many ways an equal or superior operating system, CP/M-86 offers many advantages.

In seeking languages and applications programs for the 8086/88 processor family, I have found more available for CP/M-86 than for MS-DOS. The most notable exceptions are the Microsoft languages: BASIC, BASCOM, FORTRAN, COBOL, and Pascal. For whatever reason, Microsoft has decided not to support the CP/M-86 operating system with its languages, at least not in the near future. While some sources for a CP/M-86 version of Microsoft's interpreted BASIC exist, the version is not generally available. Other software houses are supplying versions of all the languages concerned except for FORTRAN and interpreted BASIC. Furthermore, other languages are available for CP/M-86 that are not available for MS-DOS, including C, LISP, and APL. I believe that someone will provide a good FORTRAN 77 compiler for CP/M-86 shortly. I also hope that Microsoft will see the potential market for its languages under CP/M-86.

An additional plus for the Digital Research operating system is the rumor of an Intel Universal Development Interface to CP/M-86, which would allow the use of Intel's very efficient compilers for FORTRAN, Pascal, and PL/M.

When purchasing an operating system and other software, I want to be assured that I can continue to use the same software as my needs and my system grow. With CP/M-86, I can easily move my software to an MP/M-86-based multi-user system. With MS-DOS, the upgrade path to a multi-user system is not so clear. While Microsoft describes Xenix as the upgrade path, most—if not all—software running under MS-DOS will not run under Xenix. MP/M-86 does have one major fault, lack of memory protection, but this operating system is desirable even in single-user applications, where the problem of memory protection is minimized. Now that Intel and Digital Research have announced that MP/M-86 will be available on the 80286, a processor that itself makes provisions for memory protection, it appears that MP/M-86's problem will go away.

The last deciding issue between CP/M-86 and MS-DOS is that of performance. MS-DOS does offer performance advantages in some areas, especially disk input/output. MS-DOS has internal disk buffering built into the operating system. This makes disk input/output faster, especially when using physical disk sectors larger than 128 bytes. MS-DOS's internal blocking and deblocking also simplifies writing disk drivers for the input/output system.

By allowing records of other than 128 bytes in length, MS-DOS makes writing assembly-language programs easier. With high-level languages, the related problems are largely transparent. The Lomas Data Products system that I use provides a CP/M BIOS with a full-track buffer. The track buffering largely offsets MS-DOS's internal buffering mechanism. For example, the times listed below are for assembling the CBIOS that comes with the Lomas Data Products implementation of CP/M-86:

	Assembly Time
CP/M-86, no sector buffering, single-density	*3:30*
CP/M-86, track buffered, single-density	*2:30*
CP/M-86, track buffered, double-density	*2:20*

The track buffering makes CP/M-86 come close to the speed of MS-DOS. Unfortunately, I cannot offer a direct comparison between identical software running under the two operating systems.

In summary, CP/M-86 offers the advantages of the wider availability of software and the ability to upgrade to multi-user operation without losing programs that are running under the single-user system. The availability of Intel languages for CP/M-86 would be another advantage. From a performance standpoint, a BIOS that uses track buffering can make CP/M-86 run about as fast as MS-DOS, which offsets one of MS-DOS's greatest advantages.

compiling a second program, debugging a third program, and receiving electronic mail through a communications port. How do you keep track of all that's going on? Concurrent CP/M-86 constructs "virtual terminals," each of which is a window on one operation. On machines with integrated consoles (like the IBM Personal Computer), you will be able to change from one virtual terminal to the next with a single keystroke.

Frank Hollsworth, head of the 8086-operating-system development group at Digital Research, also promises a doubling or tripling of the speed of CP/M-86. "Hashing"—transforming index keys into a shorter, more easily manipulated form—will be used to speed up file access. Speed will be increased further by moving the blocking and deblocking of data during transfer, now controlled in CP/M-86's BIOS, to the BDOS. As things stand, the BDOS asks for an absolute track and sector number, and the BIOS has to translate that information before doing a read or write. Moving the blocking and deblocking to the BDOS will speed matters up by eliminating some calculations.

Promotional literature promises

that Concurrent CP/M-86 will also offer:

- extensive error-handling and error-reporting
- date and time stamping of files
- record and file locking
- password protection of files, so that you can share your computer without sharing your secrets (e.g., the payroll in your office)
- networking compatibility
- real-time capability (useful, for example, for leaving the computer to send a message over the telephone while you dine out)

Hollsworth also noted that Digital Research is developing an interactive BASIC to fill the void left by Microsoft's decision not to provide future versions of BASIC-86 for CP/M-86-based machines. Also in the works is CP/M-68K, for the Motorola 68000 processor, due sometime this year. The family of CP/M operating systems will then support networking a mixture of systems based on the 8080, 8085, 8088, 8086, and 68000.

Both Hollsworth and Dr. Gary Kildall, head of Digital Research, were at pains to emphasize that Digital Research is looking at ways of adding Unix-like functionality to its operating systems. The Digital Research staff has several members with Unix backgrounds.

MS-DOS 2.0

Microsoft will be improving MS-DOS, too. At a seminar held in New York on March 10, Microsoft's co-founder and executive vice-president Paul Allen outlined the company's plans for MS-DOS version 2.0, due in the third quarter of 1982.

Perhaps most important, Microsoft will give MS-DOS a new "shell"—the face the operating system presents to the user. Instead of a simple command line, MS-DOS will give you a screen full of information divided into "windows" by category: files, utilities, applications programs, etc. You will be able to select files and programs by cursor movement. This means no more typing of file names and program names.

There will also be online help. You will be able to get help at any time by typing a question mark, and the help will be "context sensitive." And you will be able to customize the shell.

MS-DOS 2.0 will use program and driver interfaces that enable applications programs to talk to the screen and keyboard using ANSI (American National Standards Institute) standard Escape sequences. That should simplify the writing of applications programs for MS-DOS and therefore encourage more authors to write for the MS-DOS market. Furthermore, MS-DOS will support AT&T's Presentation Level Protocol for graphics and text, which will make it easier for MS-DOS systems to interface with cable networks and many database systems.

MS-DOS 2.0 will also support networking, both local networking of MS-DOS systems and hybrid networks of MS-DOS systems with systems running Microsoft's Xenix version of Unix. Microsoft is weighing the use of the Xerox networking protocols or the Department of Defense IP/TCP protocols. Microsoft will prototype its network on IBM Personal Computers.

An important new utility routine in MS-DOS 2.0 will be a print spooler. In other words, MS-DOS will let you print a file simultaneously with running a program.

An enhancement of the DEBUG utility will permit direct typing in of assembler mnemonics, a number of Xenix-derived utilities will permit filtering files in various ways, and EDLIN will become a more powerful line editor.

As noted earlier, Bill Gates has promised to make MS-DOS reconfigurable so that owners will be able to use serial printers.

Microsoft also plans to improve the already very fast performance of disk input/output by using multiple buffers.

MS-DOS and CP/M-86 on the IBM Personal Computer: Not My Dream Operating Systems

Mark Tinsdale
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POB 372
Hancock, NH 03449

Comparing MS-DOS and CP/M-86 on the IBM Personal Computer would be a lot easier if I could begin by invoking apples and oranges. Actually, these two operating systems share far more strengths and weaknesses than the suppliers, Microsoft and Digital Research, would like to admit. There are, however, indications that these systems will be evolving in different directions.

When Digital Research observes that MS-DOS is a "CP/M derivative," Microsoft counters that what it has supplied (known variously as MS-DOS, PC-DOS, and SB-86) is the low-end member of a new generation of operating systems. In fact, Microsoft has devoted a lot of time and energy to its Unix-based operating system (MS-DOS was purchased), and claims MS-DOS to be fully "source-compatible" with the higher-level operating system. This of course assumes an application written in a portable dialect of a portable language. Much of the promised power of the Microsoft line of operating systems doesn't yet surface on the IBM Personal Computer.

Available for more than a year, CP/M-86 is more of a known quantity.

Continued on page 355

Continued from page 354:
While early versions contained more than a few bugs, and some criticism has been leveled at the elegance of the translation of an 8-bit system to the 16-bit world, several vendors have been using CP/M-86, and some applications programs have been appearing on it. MS-DOS has a clear performance advantage over CP/M-86, but this is mainly due to some fundamental design decisions, and not lack of translation overhead. Neither system is my dream computer environment. In fact, neither system is entirely acceptable according to my criteria.

An Applications Programmer's Dream

What is my dream operating system? First and foremost, it will allow the support of user-friendly software solutions for noncomputer people. These solutions must be able to fully exploit the host hardware, in this case, one of considerable flexibility and power. The dream operating system will allow my program full control of the user's environment. If that user has any problems, I know it's my fault. The perfect system will charge a minimum of overhead for these services, but will support full graphics, console, disk, and communications I/O, and a host of other facilities provided by a computer as advanced as the IBM Personal Computer. All these requirements must be met by any system purporting to be usable. In addition, my particular dream operating system will allow me to easily develop those applications. Keep in mind that I am not addressing these systems primarily from the viewpoint of software developers, but from that of the Personal Computer owners who will use my software.

Sacrificing Memory Management to Gain Speed?

MS-DOS is the single-user member of a line of operating systems from Microsoft. To move to the world of multi-users, networking, or multitasking, Microsoft seems to suggest buying a DEC VAX. MS-DOS contains none of the memory-management and allocation facilities supplied by CP/M-86. One immediate benefit of this design decision is performance. Showing the effects of both a simpler operating-system design and a rethinking of file structure, MS-DOS can access a floppy disk with impressive speed. Using a heavily overlayed application and a hard disk, MS-DOS made the overlay loads imperceptible, while CP/M-86 introduced a noticeable lag of a second or so.

Superior User Interface?

When it comes to the user interface, MS-DOS demonstrates a few improvements over Digital Research's line. Since the copy program is resident, there is no more fumbling for a system disk with PIP and enough room. Furthermore, the syntax of operations like copy is a bit more logical to the human mind (copy from-to). Not having to type Control-C after a floppy change is a step in the right direction, and an auto-execute feature allows the creation of "bootable" applications without having to patch the BIOS. The ability to trap system errors helps in the construction of programs that never confound the user. All in all though, the system looks too much like CP/M to offer much of an improvement in the human interface area. While Microsoft claims that all its operating systems retain certain high-level features, such as device-independent I/O, it must be somewhat of an embarrassment that the system doesn't support the IBM Personal Computer's serial interface (and thus most printers). The homogeneity of this line of operating systems seems to leave a few holes that the Personal Computer owner must negotiate.

A Better Family?

CP/M-86 is also part of an operating-system family. This family, however, is much more interrelated and compatible than Microsoft's. Other members of this family include MP/M-86 for multiprocessing and the recently announced Concurrent CP/M for multitasking. While these systems are not transportable to non-8086 family computers, that is really Digital Research's problem—not the IBM Personal Computer owner's. Thus, a program developed under CP/M-86 stands an excellent chance of running, with no conversion effort, under the multi-user system accessing Digital Research's local network. While some may argue that the Personal Computer is not well suited to multi-user situations, the concept of concurrency (one user running several tasks simultaneously) is intriguing. Digital Research promises these derivative systems on the IBM Personal Computer soon, and they do exist on other 8086-based systems. Microsoft will be hard-pressed to expand the capabilities of MS-DOS significantly, at least in a timely fashion. And while at least one other vendor is offering a Unix-like system for the IBM Personal Computer (yes Virginia, there will be more than two), Microsoft has not been promising anything.

Terminal Support

Another difference between the two systems on the IBM Personal Computer is that MS-DOS does not emulate any terminal, while CP/M-86 does (the IBM 3101). While this difference is not inherent, but brought about by BIOS (machine-dependent) implementation, it may be the most controversial. Since BIOS content was under the control of Microsoft and Digital Research, we must conclude that they are significant aspects of the plans of the respective vendors. The lack of a simple way to specify video controls (such as cursor position and display attributes) will prevent many applications from being brought over to MS-DOS quickly (and, perhaps, optimally). Many display-oriented programs (such as word processors) that grew up in the CP/M world of microprocessors connected to terminals are ported via display drivers using control sequences. Eventually, manufacturers of machines with integrated displays supplied BIOSs that intercepted the control sequence of some popular terminal in order to allow a profusion of products to be brought to their systems. Since these terminal emulators involve much more overhead than direct video memory access, the capabilities of these integrated display systems were often not exploited.

In an apparent attempt to avoid this profusion of maladaptations, MS-DOS forces an author to rewrite the code making use of more efficient methods of Personal Computer display access. Reflecting its heritage, CP/M-86 is inviting as much software to appear on the IBM Personal Computer as soon as possible.

Bugged by Debuggers

And yes, I know I promised that I was addressing the concerns of users, not software developers, but I'll relent for one moment. The MS-DOS debugger is quite adequate, but suffers from the maddening omission of an Assemble command. Anyone at all familiar with the encoding of the 8086 instruction set understands the horror of hexadecimal programming, but unfortunately Microsoft's DEBUG forces a return to basics. On the other hand (the one that giveth), a Search command has been added to locate a byte pattern in memory. Although inserting that P-relative call in hexadecimal is so exasperating, at least you are able to locate the buggy code using last month's listing. This is perhaps a symbolic example of how combining features of these two systems can produce one heck of a computer. I hope someone does it soon!

Conclusions

Despite its lack of an online HELP facility and a utility for reconfiguring the system to use new devices, MS-DOS is a better operating system for users with little technical knowledge than is CP/M-86. MS-DOS has significant advantages in speed of disk input/output, efficiency of use of disk space, and, most important of all, recovery from errors.

CP/M-80, designed for systems with limited memory, had to be a small operating system. As a result, no space was available to devote to things like code for error recovery. CP/M-86 has inherited some of these deficiencies. The continuing fall in the price of memory chips should encourage Digital Research to enlarge CP/M-86 as necessary to meet the higher standards of convenience that are sure to arise as microcomputer ownership becomes more common.

Throughout its seminar in March, Paul Allen and other Microsoft spokesmen described MS-DOS as "Microsoft's single-user, single-tasking operating system." That appears to leave a big opening for Digital Research's Concurrent CP/M-86. The importance of concurrency cannot be overstated. Two years from now, all 16-bit microcomputers will have concurrency. Failure to support concurrency is a waste of computing power. Computer users will not settle for doing one thing at a time when they know their computers can do three things at a time.

Up to now, Microsoft has advised people who want multitasking to buy Xenix. At Microsoft's reception during the West Coast Computer Faire, however, Allen would not rule out the development of a Microsoft operating system that supports multitasking but stops short of being full Xenix (XE-DOS?).

In short, both Microsoft and Digital Research are moving to correct deficiencies. MS-DOS will be providing online help and support for a greater variety of hardware; CP/M-86 will increase speed and add error-handling capabilities. CP/M-86 already provides an upgrade path to MP/M-86, and MS-DOS will provide an upgrade path to Xenix. Despite MS-DOS's present impressive superiority in speed and error-handling, Digital Research's Concurrent CP/M-86 will give people a means of getting more work out of their computers.

Competition between CP/M-86 and MS-DOS will bring dramatic improvements in both operating systems. Much depends on when the promised improvements actually become available to the average user. If Microsoft and Digital Research do not deliver the improvements in a timely fashion, Unix may take up residence in more microcomputers than CP/M-86 and MS-DOS combined. ■

A Vote for MS-DOS

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*[**Editor's Note:** The following statements have been excerpted from the transcript of a speech given by Mr. Colvin at Microsoft's recent "Inside 16-Bit Operating Systems" seminar.]*

My development staff has been designing and implementing CP/M-80-based software for five years and is now making the transition to the 8086. Since all members of my staff are now using MS-DOS for their development environment (a choice not imposed upon them), I must conclude that MS-DOS provides a more productive environment in which to work and a better foundation upon which to build new software products.

Among the important differences between MS-DOS and CP/M-86 are the following:

Program management: *Both CP/M-86 and MS-DOS allow multiple segments of code to be included in a program, but only MS-DOS will automatically relocate intersegment linkages at the time of program loading. Under one of CP/M-86's program models, the segment bases of additional program segments are available in the memory image, but they must be explicitly managed by program code.*

Memory management during program execution: *MS-DOS uses an approach like that of CP/M-80 for memory management. After a program is loaded, certain locations in its low data area contain the addresses of the top of the current data segment and the top of all available memory. The program has access to all memory from the base of its code segment through the top of memory, and can manage it as it desires. As a result, MS-DOS only supports machine environments that have contiguous user RAM.*

CP/M-86 provides a set of system functions for allocating and releasing dynamic-memory space. Memory can be allocated from the free-memory pool or at absolute memory locations, providing control over access to memory-mapped devices or other nonshareable memory resources. CP/M-86 permits requests of memory segments of specific size or of the maximum memory segment available. As a consequence, available memory need not be contiguous.

Reliability: *Who is to say when one new software system is more reliable than another? I can only relate our experience to date, which shows a vast reliability difference between the two operating systems. We have been using CP/M-86 for almost a year and are still finding bugs, including complete features that just do not work as documented. We have been using MS-DOS for only about four months, but have yet to find a single bug.*

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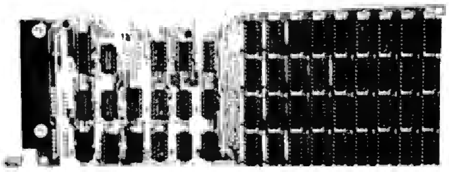

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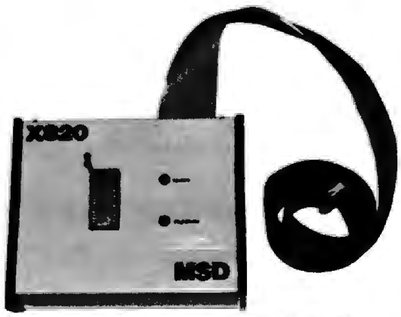

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Using the Model I/III RS-232C Port

Mysteries of the TRS-80 Model I and III RS-232C interface are solved, and instructions are given for building a data-communications plugboard.

William Barden Jr.
28122 Orsola
Mission Viejo, CA 92692

This article will try to save TRS-80 Model I and III users from some of the consternation involved with RS-232C operations. We'll look at the logic of the Model I/III RS-232C port and discuss the universal asynchronous receiver/transmitter at the heart of the RS-232C interface in both machines. A troubleshooting device to facilitate hooking up nonstandard (or non-Radio Shack) devices to the RS-232C port will be described. Finally, I'll show you how to use the Model I/III to do your own "serial" programming.

Asynchronous Communications

Except for a few minor differences, the Model I and Model III use the same logic to generate RS-232C signals, as shown in figure 1 on page 362.

Model I/III serial communications are asynchronous, that is, the time between characters is variable (not synchronized). However, the timing *within* each character is fixed; it consists of a stream of uniformly spaced intervals in which voltage levels represent logical bits. Typical bit rates range from 10 to 9600 bits per second (bps). Figure 2 shows a single character expressed as a serial bit stream.

The number of bits per character depends on the format chosen. The first bit is always a 0, or *start bit*, opposite from the normal state of the line. The last 1 or 2 bits are 1s, or *stop bits*, returning the line to a quiescent state. From 5 to 8 data bits may be in between, with the typical number being 7 or 8. In addition, there may be a parity bit, which is a check on the number of 1s or 0s in the character. If present, the parity bit is set to a 1 or 0 to make the total number of 1 bits odd or even.

The bit rate, word length, number of stop bits, and parity determine the maximum character-transmission rate. A bit rate of 110 with 1 stop bit, 7-bit words, 1 parity bit, and 2 stop bits (11 bits in all) allows transmission rates of approximately 10 characters per second (cps).

According to RS-232C conventions, voltage levels are used to indicate logic levels: +3 to +25 volts (V) for a

About the Author

William Barden Jr. has written many books on microcomputer programming and design, including Z-80 Microcomputer Design Projects.

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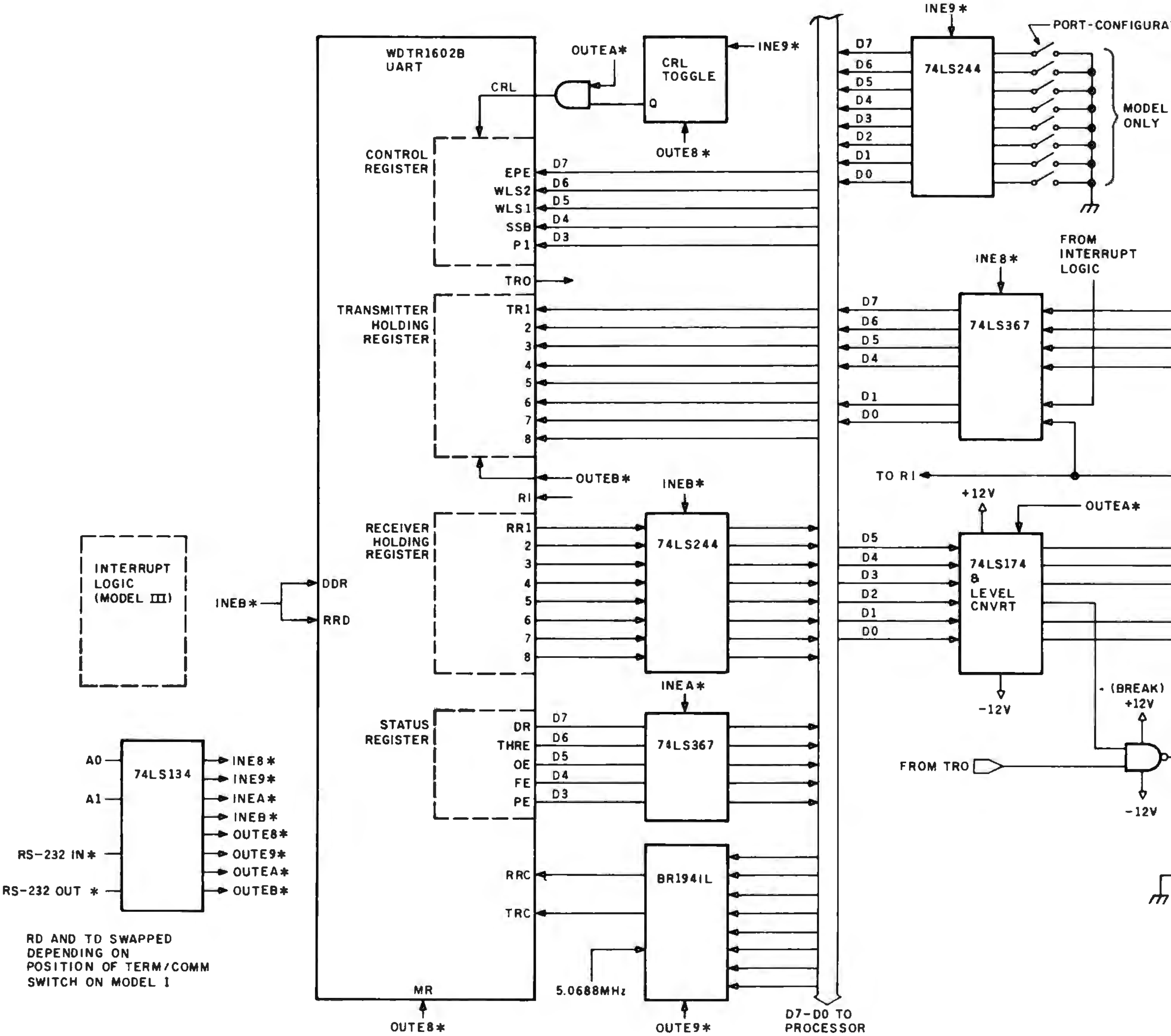

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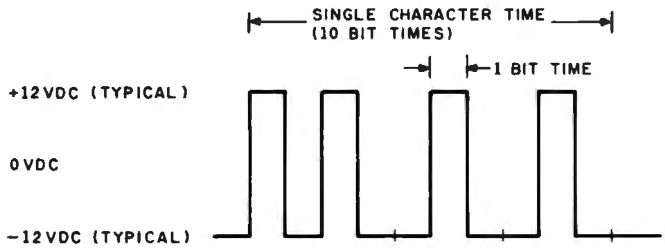

Figure 2: *Asynchronous transmission of a character or other data involves sending a string of 1s and 0s. Intervals between characters may vary, but bit times within a character and number of bits are precisely defined.*

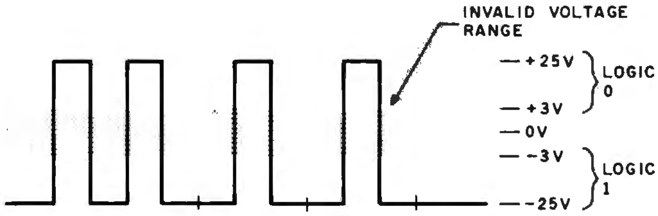

Figure 3: *RS-232C specifications provide for a "1" level of -3 to -25 V and a "0" level of $+3$ to $+25$ V. The range from $+3$ to -3 V is undefined.*

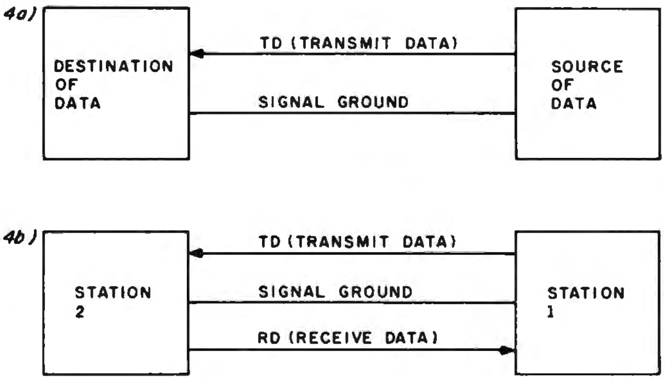

Figure 4: *In 4a, two wires allow unidirectional transmission; in 4b, three wires are sufficient for bidirectional communication.*

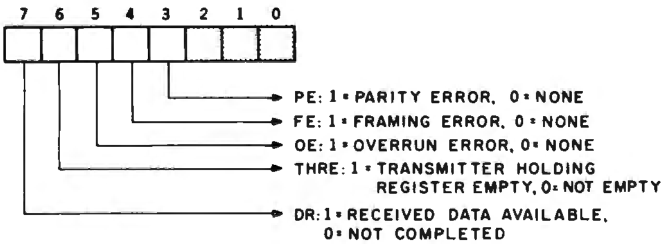

Figure 5: *Control-register bits in the UART define the word length, parity type or no parity, and the number of stop bits.*

logic 0 and -3 to -25 V for a logic 1. Levels from -3 to $+3$ V are invalid (see figure 3).

One-way transmission requires only two wires, transmit data (TD) and ground, as shown in figure 4. For two-way transmissions, a third wire, receive data (RD), is required.

Two-way communications can be either half- or full-duplex. In half-duplex, information can travel in only one direction at a time; in full-duplex, information can travel in both directions simultaneously.

While it's possible to send data over the three-wire setup of figure 4, that method is limited. All handshaking must be encoded, sent as data, and decoded on the other end. The full RS-232C asynchronous system, therefore, includes many other useful signals, as shown in table 1.

Only a small number of these signals are needed and used for communications with printers and modems. The RS-232C signals used in the Models I and III are marked in the table with an asterisk; pin numbers remain the same.

The Western Digital TR1602B

The Western Digital TR1602B, used in both the Models I and III, is a large-scale integration (LSI) chip that handles variable transmission rates, word formats, full-duplex operations, parity, and just about every phase of RS-232C communications. Its generic name is universal asynchronous receiver/transmitter (UART for short).

As shown in figure 1, the four registers in the TR1602B are the control register, the transmitter-holding register, the receiver-holding register, and the status flags.

The control register. This is normally loaded once, before any communications. Five control bits associated with the control register are shown in figure 5.

The WLS1 and WLS2 bits determine the word length of the transmission, as shown in the figure. This is the number of data bits per word, *exclusive of the parity bit.*

If the PI, or parity inhibit, bit is a 1, no parity bit is generated with each character. If the PI bit is a 0 and the EPE bit is a 1, even parity is generated; if the PI bit is a 0 and EPE is also a 0, odd parity is generated.

If the SBS bit is a 1, 2 stop bits follow the last data bit or the parity bit. If SBS is a 0, 1 stop bit follows.

The transmitter holding register. This 8-bit register holds the byte to be transmitted, which it ships out a bit at a time. In effect, the transmitter holding register performs a parallel-to-serial conversion of the character to be transmitted. As soon as a byte is loaded, the start bit is sent over the TRO (transmitter register output), followed by the 5 or 8 bits in the transmitter holding register, least significant bit first. The transmission rate is determined by the TRC (transmitter clock input).

The receiver holding register. This is a counterpart to the transmitter holding register. It accumulates the incoming data bits from the RD line, performing a serial-to-parallel conversion. The receiver holding register is read after all data bits have been received to recover the parallel form of the received character.

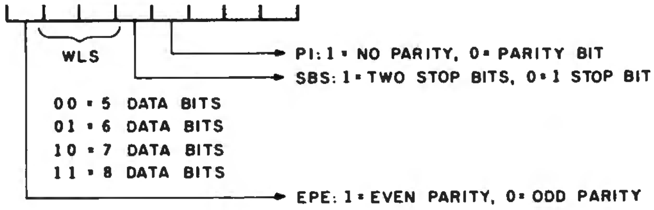

Figure 6: *Status bits from the UART indicate whether the input or output operation has been completed and whether an error has occurred in transmission.*

The status register. This is a collection of 5 bits representing the TR1602B status, as shown in figure 6.

If THRE is a 1, the transmitter holding register is "empty," has performed its parallel-to-serial conversion, and has sent the data over the TD line. A new character can now be stored in the transmitter holding register.

If the DR bit is a 1, a new character has been received and is in the receiver holding register; it can now be read from the TR1602B.

OE, FE, and PE are error indicators; a logic 1 in any of these bits indicates that an error has occurred. PE (parity error) indicates that the received parity bit does not match the parity of the received data bits; one or more data bits have been erroneously received. FE (framing error) indicates that no stop bits were found in the received character. The OE (overflow error) bit is set when two or more characters are received before the computer performs a read.

The Bit-Rate Generator

The second LSI chip used in the RS-232C interface is the BR1941L bit-rate generator (BRG). In the Model I, the clock input is from a 5.0688-megahertz (MHz) crystal oscillator. The Model III uses a system timing signal of the same frequency. This clock reference is "divided down" into the proper transmitter and receiver clock frequency. It is sent to the TR1602B via the RRC and TRC inputs. These inputs are actually 16 times the desired bit rate; this increases the resolution during transmissions at high bit rates.

The bit-rate generator is loaded with two 4-bit codes that represent the frequencies to be used for the receiver and transmitter clock. This is normally done once, before data transmission begins. The bit rates and their corresponding codes are shown in table 2.

Interface Logic, Models I and III

The RS-232C interface circuits for the Model I and Model III are almost identical. Figure 1 shows the part numbers associated with the Model III, but similar logic is used on the Model I. The TR1602B UART has four Z80 port addresses associated with it, hexadecimal E8, E9, EA, and EB.

A 74LS134 chip decodes the RS-232C address into four input and four output signals. Address lines A0 and A1

Pin Number	Symbol	Description
1**	PGND	protective ground
2**	TD	transmitted data
3**	RD	received data
4**	RTS	request to send
5**	CTS	clear to send
6**	DSR	data set ready
7**	SGND	signal ground
8**	CD	carrier detect
9	—	reserved for data set testing
10	—	reserved for data set testing
11	—	unassigned
12	—	secondary received line signal detector
13	SCTS	secondary clear to send
14*	STD	secondary transmitted data
15		
16	SRD	secondary received data
17		
18*	SUN	secondary unassigned
19*	SRTS	secondary request to send
20**	DTR	data terminal ready
21	—	signal quality detector
22**	RI	ring indicator
23		
24		
25	—	unassigned

* Model III only
**Model I/III

Table 1: *Common RS-232C signal assignments.*

Decimal Code	Binary Code	Bit Rate
0	0000	50
1	0001	75
2	0010	110
3	0011	134.5
4	0100	150
5	0101	300
6	0110	600
7	0111	1200
8	1000	1800
9	1001	2000
10	1010	2400
11	1011	3600
12	1100	4800
13	1101	7200
14	1110	9600
15	1111	19,200

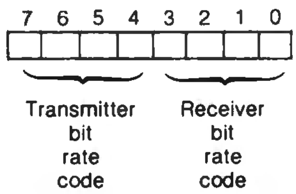

Table 2: *Bit-rate codes for the Western Digital TR1602B.*

Hexadecimal Address	IN	OUT
E8	Read modem status register (CTS, DSR, CD, RI)	Master reset
E9	Read sense switches (Model I) Toggle CRL (Model III)	Load BRG with bit-rate codes
EA	Read UART status register	Load UART control register and set Break, DTR, RTS, *or* set SUN, STD, SRTS, Break, DTR, RTS
EB	Input character from receiver holding register	Output character to transmitter holding register

Table 3: *UART-Model I/III actions for the four RS-232C addresses.*

determine the 2 least significant bits of the address, while a Z80 IN or OUT to port hexadecimal ExH generates the RS232IN* and RS232OUT* signal (BASIC INP/OUT can also be used).

Table 3 shows the actions that occur for the four addresses for either reads or writes (INs or OUTs).

Model I RS-232C sense switches. The Model I differs from the Model III in that it has eight RS-232C switches that can be read by an "IN 0E9H". These sense switches provide a manual way of telling the software what RS-232C settings to use. They have no direct effect on the UART or BRG; they come into play only if the initialization program reads them and initializes the UART accordingly.

The sense switches do not exist in the Model III. An "IN 0E9H" causes a different action. It toggles the CRL signal so that an "OUT EAH" sets three additional signals in the Model III—SUN, STD, and SRTS. These secondary signals (secondary undefined, transmit data, and request to send) are not used in normal Model III communications programs. Subsequent "OUT 0EAH" instructions toggle the load from control register to secondary. A master reset of "OUT 0E8H" resets the toggle to a normal load of the control register.

Initialization. The first action to take before doing any data communications is to initialize the UART and BRG chips. The sequence is:

1. Do a Z80 "OUT (0E8H),A" or a BASIC "OUT 232,0". The value in A doesn't matter, as no actual data is sent. This causes the MR input to reset the UART. It also resets the data-received status and disconnects the receiver holding register by the inputs DRR and RRD, respectively.

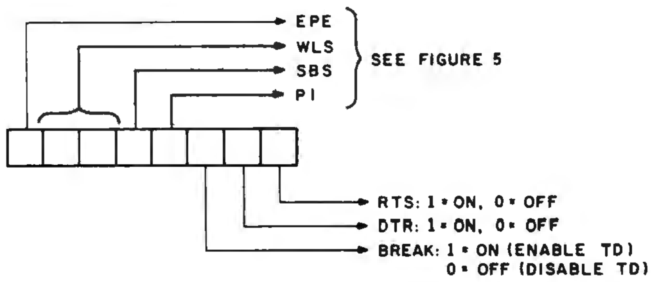

Figure 7: *An 8-bit function code is used to initialize the RS-232C interface. Five bits initialize the UART control-register functions, while the remaining 3 bits set two output lines and enable the TD line.*

2. Define the serial parameters (word length, etc.). This is a 5-bit code, as shown in figure 7. The remaining 3 bits define the "break," DTR, and RTS outputs. These signals are set to match the requirements of the device at the other end of the line. At this point, however, the "break" bit must be set to enable output of serial data on the TD line. Output the parameters to the control register by an "OUT (0EAH),A" or a BASIC "OUT 234,A". This sets up the control register for the data-communications format to be used. It also sets the selected DTR/RTS signal levels at −12 V or +12 V.

3. Select the appropriate bit-rate code (table 2) and output it to the BRG by a Z80 "OUT (0E9H),A" or BASIC "OUT 233,A".

The TR1602B is now initialized. This process should not have to be repeated unless the bit rate or other parameters need to be changed during serial communications.

Writing data. Suppose you have a serial line printer attached to the Model I or III. The control register has been loaded with the proper format parameters to match the line printer and the BRG has also been initialized. From this point on, it's simply a matter of reading the status, testing to see if the transmitter holding register is empty, and, if it is, loading it with the next character to be transmitted. This loop is done for every character and goes like this: Input the status by a Z80 "IN A,(0EAH)" or a BASIC "A=INP(234)". Test bit 6 (THRE) of the status. If this bit is a 0, loop back to the test. If this bit is a 1, output the character to be transmitted by an "OUT (0EBH),A" or "OUT 235,A".

Reading data. Reading data is just about as easy. The read loop consists of reading the status to see if a new character has come in. If it has, the character is read from the receiver holding register. The loop goes like this: Input the status by a Z80 "IN A,(0EAH)" or a BASIC "A=INP(234)". Test bit 7 to see if DR is a 1. If it is not, loop back to the status input. If DR is a 1, read in the assembled character by an "IN A,(0EBH)" or "A=INP(235)". Repeat this loop or go to a test for a new character to be transmitted.

In practice, the read and write operations usually alternate in the same loop.

The Data-Communications Plugboard

Before giving you actual programming examples of serial operations, I'm going to describe an easy-to-construct RS-232C plugboard. The plugboard can be used in experiments with the programming examples I'll be giving. More important, it can be used to help you interface serial devices to your Model I or III computer. The plugboard is shown in figure 8.

The plugboard breaks a 25-line RS-232C cable and routes the lines through a prototype board. Short lengths of 20-gauge solid wire are used on the plugboard to connect the two sides of the cable, as shown in figure 9. To transpose RD and TD, for example, simply crisscross pins 2 and 3 as shown in the figure. Other lines can be connected in a similar manner. To test the state of any line, an LED can be connected with a resistor to signal ground, pin 7, and the line in question, as shown in the figure. Lines can be "dummied up" in lieu of wiring up a special RS-232C plug simply by adding a patch between an active line and the line to be dummied.

To construct the plugboard, use the smaller version of the Radio Shack prototype board (catalog #276-175). The back has a sticky paper cover. Peel this off to expose the

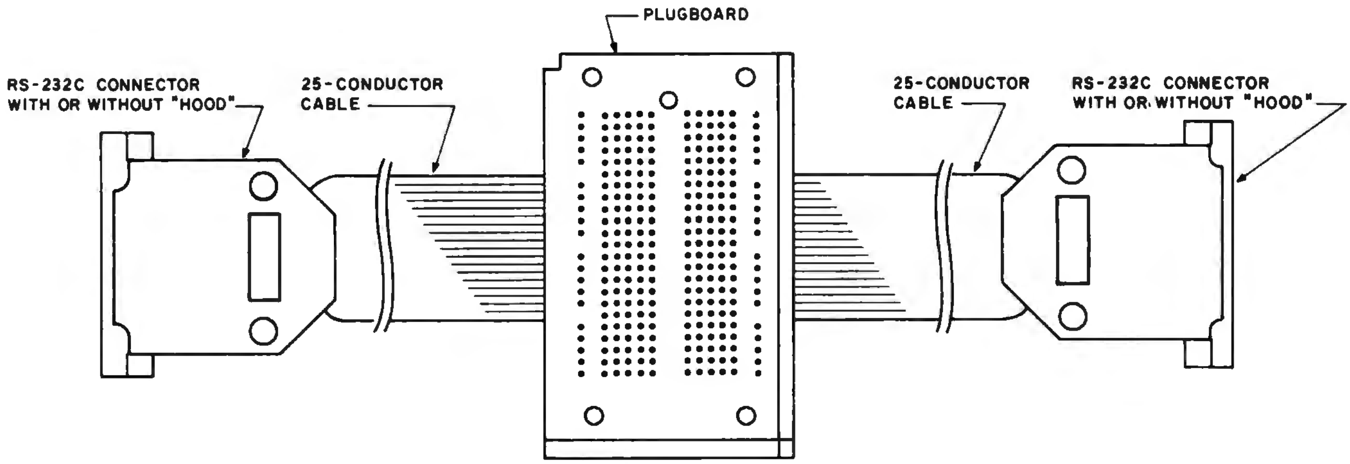

Figure 8: *The data-communications plugboard uses a prototype board to "break out" the 25 lines of an RS-232C cable. This permits lines to be swapped, jumpered, or tested.*

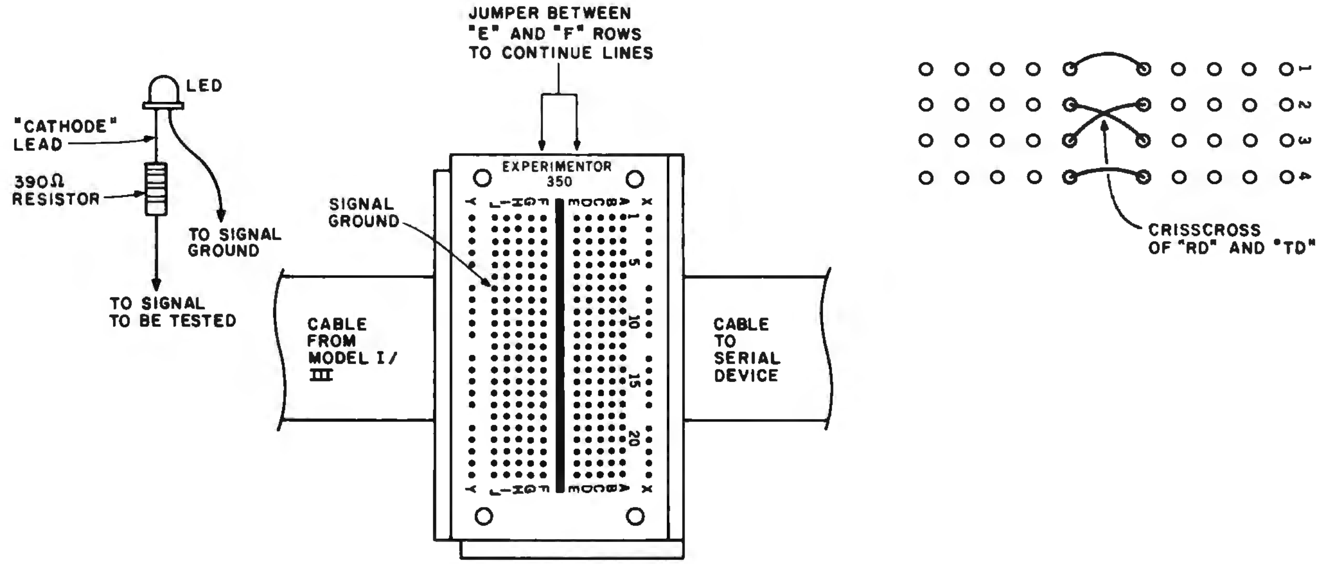

Figure 9: *To run all lines straight through, jumper each row from the "E" to "F" points. Lines may be easily swapped. An LED with series resistor can be used to test the state of any of the lines on either the input or output side.*

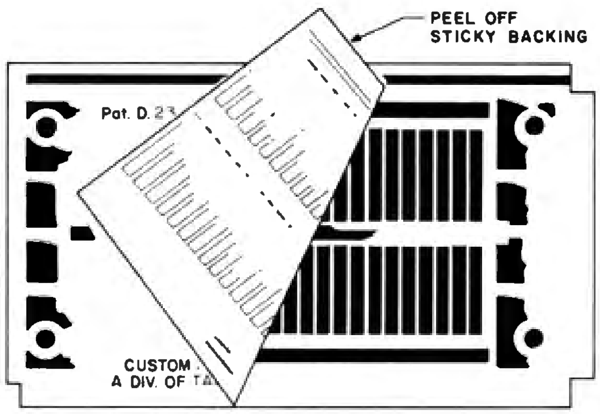

Figure 10: *Peel away the backing of the prototype board to expose the foil paths for soldering.*

interconnecting strips, as shown in figure 10. The rows are numbered from 1-23 on the front of the board.

You'll need two RS-232C connectors. Get the solder type, not the insulation displacement type. Unfortunately, Radio Shack sells only the latter type. Use the proper plug combinations for the equipment you'll be interfacing. Modems, for example, generally have a female RS-232C connector, requiring a male connector on the cable.

Although the connector pins are numbered, the numbering is often difficult to see unless you hold the connector at the right angle with the right light. Standard numbering for RS-232C connectors, looking in to the connector, is shown in figure 11.

Obtain a 25-wire ribbon cable (Radio Shack catalog #278-771 is a 40-conductor cable that can be split). Wire the ribbon cable so that the wire positions correspond to

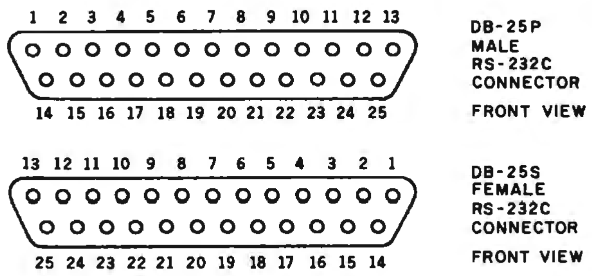

Figure 11: *Standard RS-232C connector-pin numbering.*

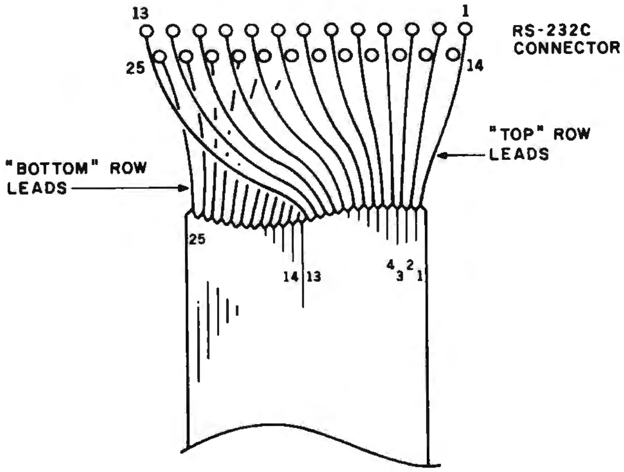

Figure 12: *Wiring the ribbon cable. The wiring is nonstandard compared to most RS-232C cables and correlates the RS-232C pin numbers with the conductor-position numbering.*

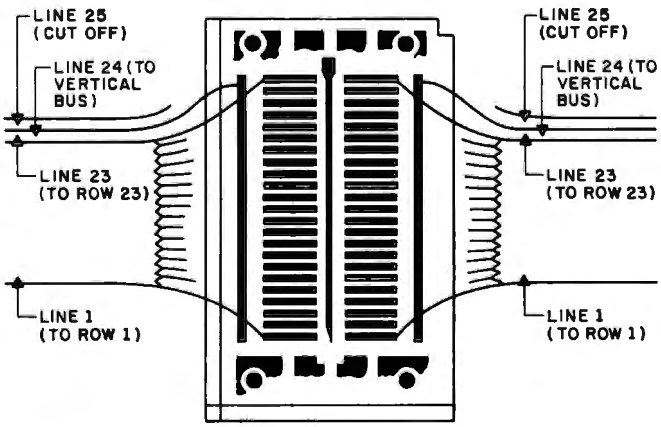

Figure 13: *Solder the cable to the prototype board. Twenty-three lines are soldered to rows 1-23. The twenty-fourth line is soldered to the vertical column. The twenty-fifth line, not used, can be cut off.*

the RS-232C pin numbers on both RS-232C connectors. This will involve separating the cable into two halves, as shown in figure 12.

Cut the RS-232C cable in half. Separate the wires on both cut ends of the cable and strip each wire with a wire stripper about 1/16 inch.

Solder 23 wires onto the 23 rows of the board. Match the row number with the RS-232C pin number. Solder the twenty-fourth wire (pin 24) to the vertical strip on each side of the board. Cut off the twenty-fifth wire. This signal is undefined in the RS-232C specification (see figure 13).

Using 20-gauge wire, connect opposing pins for those lines that are not to be changed. The wire will fit nicely into the plugboard holes and stay there. Only the Model I/III signals shown in table 1 need to be connected in this manner. None of the others are used.

You're now set to experiment with the programming examples below or to use the plugboard to help connect serial devices to your system.

RS-232C Programming Examples

The examples below are in BASIC. They can be converted to Z80 assembly language by substituting INs and OUTs for the BASIC INPs and OUTs. I don't have the space to show you complete serial printer or communications drivers, but these examples should take the mystery out of RS-232C interfacing.

Setting RTS, DTR, and break. RTS and DTR lines are outputs from the RS-232C controller indicating "request to send" and "data terminal ready." The RTS line (pin 4) is set by:

```
100  OUT 232,0            'initialize RS-232C
110  OUT 234,xxxxxxx1     'binary value with lsb set
```

(The "*xxxxxxx*1" indicates that bit 0 must be set; other bits should be set or reset appropriately, as well.)

The DTR line (pin 20) is set similarly:

```
100  OUT 232,0            'initialize RS-232C
110  OUT 234,xxxxxx1x     'binary value
```

If both RTS and DTR are to be set, the binary value would be *xxxxxx*11.

The "break" does not come out on the RS-232C connector, but enables or disables the TD line. Use a 1 to enable the TD line:

```
100  OUT 232,0            'initialize RS-232C
110  OUT 234,xxxxx1xx     'enable TD
```

Use the above code and experiment with the plugboard by connecting an LED and 390-ohm resistor between pin 7 of the plugboard and pin 4 or 20. Remember, logic 1 is −12 V DC and logic 0, +12 V DC.

Reading CTS, DSR, CD, and RI. These inputs to the RS-232C controller indicate clear to send, data set ready, carrier detect, and ring indicator. To read the lines, do:

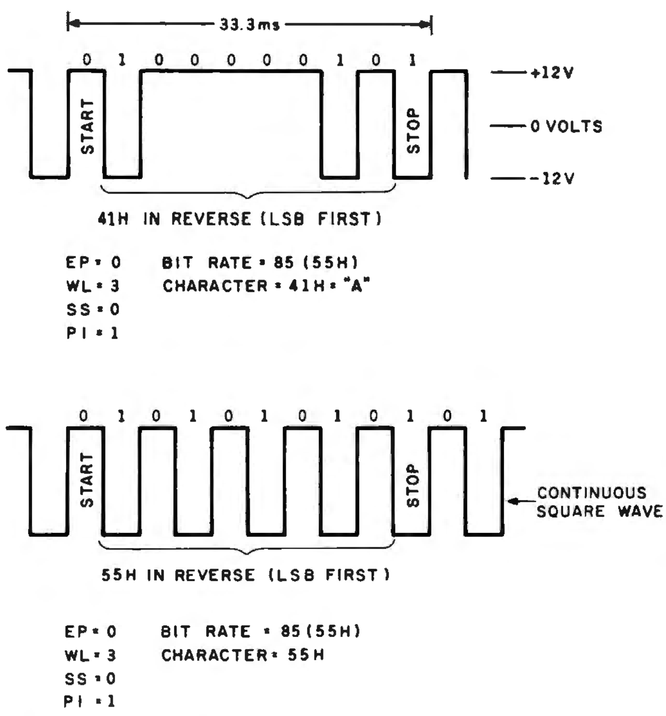

Figure 14: *The data out exerciser program produces TD output that can be examined with an oscilloscope. The serial bit stream can be easily read. Outputting a hexadecimal 55 character produces a continuous square wave due to the alternating 1s and 0s.*

```
100  OUT 232,0        'initialize RS-232C
110  A=INP(232)       'read lines
```

The A variable will contain a binary value corresponding to CTS, DSR, CD, and RI in the most significant 4 bits; the lower 4 bits are not significant.

You can experiment by first setting RTS or DTR and jumpering on the plugboard between the RTS or DTR pins to the four input lines. Jumpering is usually the easiest way to "dummy up" a signal, either by connector wiring or, in this case, on the plugboard.

Setting SUN, STD, and SRTS. These secondary lines are not normally used in communications programs, but they can be set by:

```
100  OUT 232,0            'initialize RS-232C
110  A=INP(233)           'toggle CRL flip-flop
120  OUT 234,xxUTRxxx     'set SUN, STD, SRTS
130  A=INP(233)           'toggle CRL
```

In line 120, bits 5, 4, and 3 control the status of SUN, STD, and SRTS, respectively. The INP(233) toggles the control-register load flip-flop so that the control register is not loaded.

Outputting on TD. The BASIC code in listing 1 shows a continuous output of a specified character. If you have an oscilloscope, connect it between pin 7 (SGND) and pin 2 (TD), and observe the output.

Listing 1: *This simple BASIC program will continuously output data on the TD line at user-defined bit rates and formats.*

```
90 'SERIAL DATA OUT EXERCISER
100 OUT 232,0
105 PRINT "INPUT EP, WLS, SSB, PI"
110 INPUT EP,WL,SS,PI
120 WD=EP*128+WL*32+SS*16+PI*8+4
130 OUT 234,WD
135 INPUT "BAUD CODE";BA
150 OUT 233,BA
160 INPUT "CHARACTER CODE";CH
165 I=0
170 A=INP(234)
180 IF (A AND 64)=0 THEN GOTO 170
185 I=I+1
190 OUT 235,CH
200 GOTO 170
```

Listing 2: *This loop-back exerciser program in BASIC outputs data that is immediately input through the RD line. Pins 2 and 3 of the RS-232C lines should be jumpered together.*

```
90 'LOOP BACK EXERCISER
100 OUT 232,0
105 PRINT "INPUT EP, WLS, SSB, PI"
110 INPUT EP,WL,SS,PI
120 WD=EP*128+WL*32+SS*16+PI*8+4
130 OUT 234,WD
135 INPUT "BAUD CODE";BA
150 OUT 233,BA
160 INPUT "CHARACTER CODE";CH
165 I=0
170 A=INP(234)
180 IF (A AND 64)=0 THEN GOTO 170
185 I=I+1
190 OUT 235,CH
200 A=INP(234)
210 IF (A AND 128)=0 THEN GOTO 170
220 A=INP(235)
230 PRINT A
240 GOTO 170
```

The EP, WL, SS, and PI inputs define even/odd parity, word length, number of stop bits, and parity inhibit, respectively. This format data is sent to the control register by the "OUT 234,WD".

The bit-rate code (see table 2) is sent to the BRG by the "OUT 233,BA".

The character value (CH) is the decimal code for the character to be sent. The value must be in a range of 0-255. ASCII "A," for example, is decimal 65.

The loop at 170-200 continuously checks the THRE status. If the transmitter holding register is empty, it outputs the character to the transmitter holding register by an "OUT 235,CH".

Figure 14 shows oscilloscope waveforms for CH=65

Birth of a legend.

Epson.

A whole new generation of Epson MX printers has just arrived. And while they share the family traits that made Epson famous — like unequalled reliability and ultra-fine printing — they've got a lot more of what it takes to be a legend.

For instance, they've got a few extra type styles. Sixty-six, to be exact, including italics, a handy subscript and superscript for scientific notation, and enough international symbols to print most Western languages.

What's more, on the new-generation MX-80, MX-80 F/T and MX-100, you get GRAFTRAX-Plus dot addressable graphics. Standard. So now you can have precision to rival plotters in a reliable Epson printer. Not to mention true backspace, software printer reset, and programmable form length, horizontal tab and right margin.

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Uh...three legends.

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What's next? Wait and see. We're already expecting.

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FEATURE	ORIGINAL MX-80	GRAFTRAX-80*	ORIGINAL MX-100	MX-80 with GRAFTRAX-Plus	MX-80 F/T with GRAFTRAX-Plus	MX-100 with GRAFTRAX-Plus
Bidirectional printing	X	X	X	X	X	X
Logical seeking function	X	X	X	X	X	X
Disposable print head	X	X	X	X	X	X
Speed: 80 CPS	X	X	X	X	X	X
Matrix: 9 x 9	X	X	X	X	X	X
Selectable paper feed			X		X	X
PAPER HANDLING FUNCTIONS						
Line spacing to n/216		X		X	X	X
Programmable form length	X	X	X	X	X	X
Programmable horizontal tabs	X	X	X	X	X	X
Skip over perforation			X	X	X	X
PRINT MODES AND CHARACTER FONTS						
96 ASCII characters	X	X	X	X	X	X
Italics character font		X		X	X	X
Special international symbols				X	X	X
Normal, Emphasized, Double-Strike, and Double/Emphasized print modes	X	X	X	X	X	X
Subscript/Superscript print mode				X	X	X
Underline mode				X	X	X
10 CPI	X	X	X	X	X	X
5 CPI	X	X	X	X	X	X
17.16 CPI	X	X	X	X	X	X
8.58 CPI	X	X	X	X	X	X
DOT GRAPHICS MODE						
Line drawing graphics				X	X	X
Bit image 60 D.P.I.		X	X	X	X	X
Bit image 120 D.P.I.		X	X	X	X	X
CONTROL FUNCTIONS						
Software printer reset		X		X	X	X
Adjustable right margin			X	X	X	X
True back space		X		X	X	X
INTERFACES						
Standard — Centronics-style 8-bit parallel	X	X	X	X	X	X
Optional — RS-232C current loop w/2K buffer	X	X	X	X	X	X
RS-232C x-on/x-off w/2K buffer	X	X	X	X	X	X
IEEE-488	X	X	X	X	X	X

*Tandy TRS-80 block graphics only available with GRAFTRAX 80.

ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* Ø1234
ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* Ø1234
ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* Ø1234
ABCDEF abcdef *ABCDEF abcdef* Ø123456
ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx *ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx* Ø1234567
ABCDEF abcdef *ABCDEF abcdef* Ø123456
ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* Ø1234
ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx *ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx* Ø1234567

Circle 159 on inquiry card.

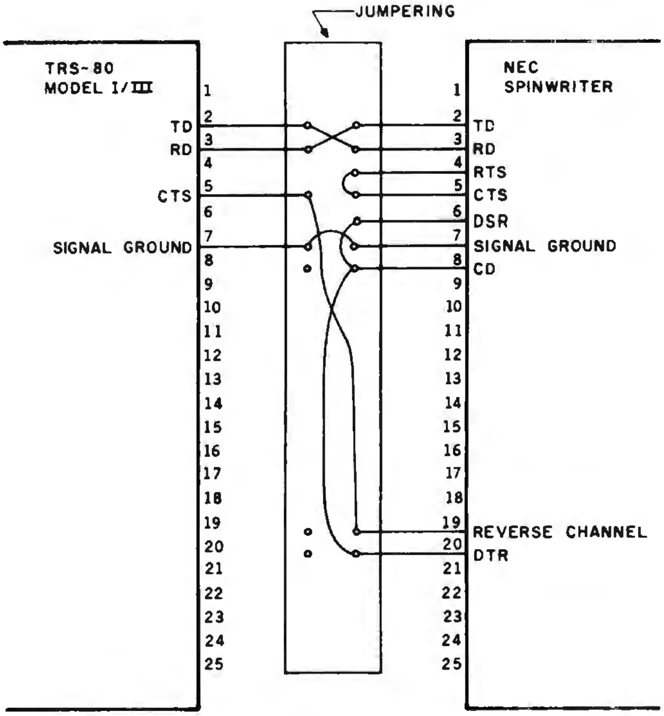

Figure 15: *This typical RS-232C jumpering connects an NEC Spinwriter to the Model I/III. Various Spinwriter lines must be "dummied up" to fool the Spinwriter into thinking it has received the proper signals. The "reverse channel" line permits 1200-bit operation.*

and CH=85 with no parity bit, 1 stop bit, 8 data bits, and 300 bps. This BASIC loop keeps up quite well with the 30 character-per-second rate. Setting the bit rate to 600 (BA=102) resulted in a throughput of 41 cps (not 60, because of the BASIC overhead). It is feasible to drive a line printer in BASIC.

The last application is shown in listing 2. This is a loop-back test in which the TD line output is jumpered back to the RD (pin 3) line input. The character sent out comes right back in on the RD line. This technique is common for testing an RS-232C interface locally. Jumper the two lines by a short wire between pins 2 and 3 on the plugboard.

Connecting Serial Devices

So many serial devices are available that it's hard to generalize about proper RS-232C cable configurations to drive the devices. A typical configuration that can be set up by the plugboard is shown in figure 15. This connects the NEC Spinwriter to the Model I or III and allows transfer rates up to 1200 bps.

Read the interfacing requirements for the serial device to be used with your Model I or III, use the plugboard to test line conditions, and possibly even use some of the code provided above. This method should facilitate interfacing to non-Radio Shack RS-232C equipment—and help you realize the benefits implicit in the advertising slogan, "RS-232C compatible."■

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Programming the Critical-Path Method in BASIC

This program helps managers assess trade-offs of time and costs.

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The critical-path method (CPM) is a project-scheduling tool that has won wide acceptance in the construction industry. (Do not confuse this with the CP/M operating system.) CPM has proved its usefulness on both large and small jobs.

CPM resembles PERT, the performance evaluation and review technique described in the May 1982 BYTE, page 465. Both of them use network diagrams to analyze projects. PERT, developed to help manage complex research and development projects, uses statistical methods to estimate the time needed to complete such an innovative project, which must be to some degree unpredictable. CPM, however, seeks to determine how to minimize the time required to do routine construction and maintenance. Since these activities are routine, CPM assumes that its users can provide reliable estimates of how long each activity will require. CPM helps determine the optimal trade-off of a project's total cost and the total time required for completion. It also tries to produce a project schedule that minimizes both direct and indirect costs. (An example of an indirect cost is the production time lost while a manufacturing plant is closed for maintenance.)

CPM helps determine the optimal trade-off of a project's cost and the time required for completion.

CPM analysis of a project has the key feature of allowing computations based on both operation at normal time and cost and operation at crash time and cost. Normal time is the amount of time an activity will take under normal conditions; normal cost is the cost of proceeding in this manner. Crash time is the reduced time in which an activity could be completed if extra resources and costs were applied. Crash cost is the total cost necessary to get the job done faster.

The objective of CPM is to find the critical path through a project under normal conditions and under various degrees of crash conditions. The critical path is defined as the sequence of steps that takes the longest time to complete from the beginning of a project to its end. In the case of normal time and cost, the crew scheduled to do a task is of normal size and is not supplemented by either second shifts or overtime. In the case of crash time and cost, the project uses extra people or a second shift. Put simply, crash operations involve spending extra dollars to speed up a project.

The differences between CPM and PERT sometimes escape notice. This is partly because some users have combined the most useful aspects of the two techniques. Our approach to CPM in this article is a classic approach. Because our TRS-80 Model I system contains only 32K bytes of RAM (random-access read/write memory), combining the approaches in a BASIC program was not possible. We also wanted to illustrate the differences between CPM and PERT.

In practice, CPM and PERT can be applied to many of the same projects. Examine the differences in input and output required by our PERT program in the May issue and this CPM program before you decide which method to use on a project. We have found both programs useful.

We will describe the fundamentals of CPM analysis before presenting a BASIC program that implements CPM.

CPM Analysis

As with PERT, CPM analysis of a project requires first reducing the project to a list of events and activities. (An activity is a part of a project that consumes resources or time, and whose beginning and end can both be defined. An event is a point in time, an instant. Both the beginning and the ending points of an activity are events.) To apply CPM, you must identify all the events needed to complete the project and all the activities that result in the identified events.

Our sample project in this article will be the same one we used previously for PERT—a real construction project that was recently completed. We simplified things by ending our example with the completion of the building's foundation. We identified 18 activities needed to complete this foundation. Table 1 lists the activities, assigned letters A-Q and Z. Each event in the project consists of the completion of one or more activities.

The Bubble Diagram

The second stage in CPM analysis is the layout of a bubble diagram like the one in figure 1. The diagram shows how the necessary activities and events in a project form a sequence of steps. Most contractors specify the sequence of tasks in a project in some fashion. Like PERT, CPM makes a formal activity of task sequencing, which lends valuable structure to planning. In particular, making a bubble diagram forces the planner to specify which activities depend on the completion of other activities.

Letter	Activity	Beginning Event	End Event
A	Assemble accounting data	1	2
B	Look for bank	1	3
C	Look for realtor	1	4
Z	Seek permits	2	7
D	Make market study of area	2	3
G	Look for contractor	2	5
F	Seek insurance for construction	2	6
H	Get basic architectural plans	3	5
E	Make cost study	3	4
I	Buy land	4	5
J	List materials	5	6
K	Get more detailed architectural plans	5	7
L	Have survey made	5	8
M	Buy first batch of materials	6	8
O	Buy second batch of materials	6	9
N	Complete detailed internal layout of foundation	7	8
Q	Hire crew	7	9
P	Build foundation	8	9

Table 1: *The activities required to build a foundation. The program in listing 1 uses the letters at the left to identify the activities. The two columns at the right list the first event and the last during each activity. An event is defined as the completion of one or more activities.*

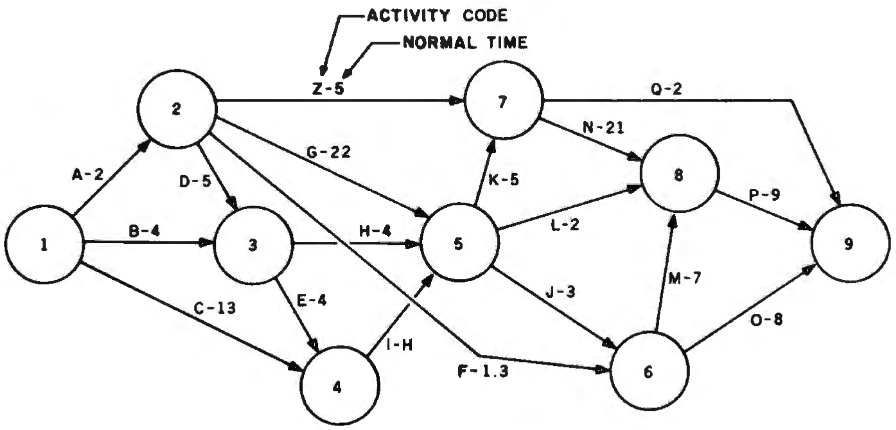

Figure 1: *The CPM network diagram of the activities required to build a foundation. Each circle represents an event; each line between circles represents one of the activities listed in table 1. The letter on each line is the code identifying an activity; the number following each letter is the normal time for completing the activity. The network has one initial event, event 1 at the extreme left, and one terminal event, event 9 at the extreme right. A path is any set of successive activities that begin with event 1 and end with event 9. The critical path is the path whose sum of activity times is longer than that for any other path through the network.*

Diagrams like that shown in figure 1 are also called networks. A CPM network has one initial event, at the extreme left, and one terminal event, at the extreme right. Figure 1 is the bubble diagram of our example, the building of a foundation. The circles are numbered and represent events. The lines are lettered and represent activities. Each line has an arrow indicating its direction in time, from beginning to completion. The network as a whole shows the series of activities needed to complete the project. The arrows show which activities and events logically precede others.

As noted in the PERT article, an event that results from completion of more than one activity is called a merge event. An event that represents the joint beginning of more than one activity is called a burst event. Before any activity can start, all the activities preceding it must be completed (but they needn't be completed simultaneously). Both the length and the compass-direction of an arrow are without significance.

Dashed lines in network diagrams represent "dummy" activities, but we didn't include any dummy activities in this project. Dummy activities arise when the completion of one event depends upon the completion of another, but requires no additional work or activity.

In the bubble diagram, the line going from 1 to 2 means that in order to complete event 2 (complete accounting papers), it is necessary to collect and organize the accounting data. Line 1-2 represents an activity; bubble 2 represents an event.

Applying CPM

The longest route from the beginning of the network on the left to the end of the network on the right determines the amount of time required to complete the project. This line, the critical path, determines the minimum time required to complete a job.

Identification of the critical path for both normal time and cost operations and crash time and cost operations is the prime objective of CPM. If normal time is such that the project can be completed on time, there is no need to go to crash time. If the project cannot be completed within the critical path of the full crash time, all activities—both on and off the critical path—run under crash conditions. That's when you have some real problems. If the scheduled time falls between the normal-time critical path and the full-crash-time critical path, you can selectively crash the project by spending the extra dollars to get the job completed on time.

In CPM, it is assumed that normal activity levels will result in a higher overall time at lower costs than crash condition operations. It is further assumed that for every dollar spent to reduce the amount of time required to do an activity there is a set reduction in the time required. In other words, a linear relationship exists between time saved and cost.

You can run the system under normal conditions, at full crash conditions, or at selective crash conditions. In practice, it makes little sense to run the system under full crash conditions. The objective of CPM is to identify situations where it pays to use available resources. It does *not* pay to run at full crash. Selective crashing will complete the job in the same time at lower cost than full crashing.

Program Output

Our CPM program appears in listing 1. Its output is relatively complex, including verification of all the input data, the selective time, early start time, early finish time, latest start time, latest finish time, and slack time for all the activities in the network. In addition, the program identifies the critical path, the time of the critical path, the cost of the critical path, the incremental cost, the normal time/cost of the critical path, and the full crash time/cost of the critical path.

Text continued on page 384

Listing 1: *A program for CPM, the critical-path method. Written in TRS-80 Level II BASIC, the program asks for a list of the activities in a project, the beginning and ending events of each activity, its normal time, normal cost, crash time, and crash cost.*

```
10 CLEAR 1000:CLS:REM  "CPM"
20 PRINT"CPM NORMAL AND CRASH TIME/COST"
30 PRINT"DEVELOPED BY STEVEN M. ZIMMERMAN,PH.D.  & LEO M. CONRAD  1980"
40 INPUT"DISK SYSTEM OR LEVEL II BASIC (D/B)";S$
50 PRINT:PRINT"*** NOTE BEGINNING EVENTS WILL BE SORTED NUMBERICAL ORDER   ****"
:INPUT"DIMENSION FOR ACTIVITIES";D%:PRINT
60 DIM A$(D%,2),A(D%,13),SV(12)
70 PRINT"INPUT MENU"
80 PRINT"     K     KEYBOARD"
90 PRINT"     D     DISK FILE"
100 PRINT"     R     READ STATEMENT"
110 PRINT"     T1    TAPE RECORDER #-1"
120 PRINT"     T2    TAPE RECORDER #-2"
130 INPUT"SELECTION";IO$
140 IFIO$<>"K"THEN 220
150 INPUT"NUMBER OF ACTIVITIES";M%:EE=0
160 PRINT"IF THIS IS GOING TO BE WORK YOU MUST NOW INPUT UP TO ";M%;"
 ACTIVITIES"
170 FOR I=1 TO M%
180 INPUT"ACTIVITY CODE ";A$(I,1)
190 INPUT"DESCRIPTION, BEGINING EVENT NUMBER, END EVENT NUMBER, NORMAL    TIME,
COST AND CRASH TIME, COST";A$(I,2),A(I,1),A(I,2),A(I,3),A(I,4),A(I,5),A(I,6)
200 NEXTI
210 GOTO480
220 IFIO$="T1"ORIO$="T2"THEN230  ELSE330
```

Listing 1 continued:

```
230 PRINT"SETUP TAPE #-";IO$;" TO PLAY":REM  TAPE INPUT
240 IF S$="D"CMD"T"
250 IFIO$="T1"INPUT#-1,M%,EE
260 IFIO$="T2"INPUT#-2,M%,EE
270 FORI=1TOM%
280 IFIO$="T1"INPUT#-1,A$(I,1),A$(I,2):INPUT#-1,A(I,1),A(I,2),A(I,3),A(I,4),A(I,
5),A(I,6)
290 IFIO$="T2"INPUT#-2,A$(I,1),A$(I,2):INPUT#-2,A(I,1),A(I,2),A(I,3),A(I,4),A(I,
5),A(I,6)
300 NEXTI
310 IFS$="D"CMD"R"
320 GOTO480
330 IFIO$<>"D"THEN420
340 LINEINPUT"NAME OF FILE:DISK ";B$:REM  DISK INPUT
350 OPEN"I",1,B$
360 INPUT#1,M%,EE
370 FORI=1TOM%
380 INPUT#1,A$(I,1),A$(I,2),A(I,1),A(I,2),A(I,3),A(I,4),A(I,5),A(I,6)
390 NEXTI
400 CLOSE1
410 GOTO480
420 IFIO$<>"R"THEN70
430 READM%,EE
440 FORI=1TOM%:REM  READ INPUT
450 READA$(I,1),A$(I,2),A(I,1),A(I,2),A(I,3),A(I,4),A(I,5),A(I,6)
460 IFA$(I,1)="END"THEN480
470 NEXTI
480 REM PRINTS INPUT DATA FOR VARIFICATION
490 M=M%:TP=0:FORI=1TOM:IFA(I,2)>TPTHENTP=A(I,2)
495 NEXT:EE=TP
500 FORI=1TOM-1
510 FORJ=I+1TOM
520 IFA(I,1)<=A(J,1)THEN550
530 FORK=1TO12:SV(K)=A(I,K):A(I,K)=A(J,K):A(J,K)=SV(K):NEXTK
540 FORK=1TO2:SV$(K)=A$(I,K):A$(I,K)=A$(J,K):A$(J,K)=SV$(K):NEXTK
550 NEXTJ,I
560 XX=5:PRINT"VERIFICATION OF INPUT"
570 Z1$="CODE DESCRIPTION TIME      EARLY     EARLY     LAST       LAST      SLACK"
580 Z2$="                 USED      START     FIN       START      FIN       TIME"
590 Z3$="CODE DESCRIPTION BEGIN  END   NORMAL           CRASH"
600 Z4$="                EVENT  EVENT  TIME     COST     TIME    COST"
610 PRINT"NO ";Z3$
620 PRINT"   ";Z4$
630 K=0
640 C4$="### "
650 FORI=1TOM%
660 PRINTUSINGC4$;I;
670 C1$=" #### "
680 C2$="% % %          %":C3$=" ####.##"
690 PRINTUSINGC2$;A$(I,1),A$(I,2);
700 FORJ=1TO2
710 PRINTUSINGC1$;A(I,J);:NEXTJ
720 FORJ=3TO6
730 PRINTUSINGC3$;A(I,J);:NEXTJ
740 K=K+1:IFK>=13 THENPRINT:INPUT"ENTER TO PAGE";DU$:K=0
750 PRINT:NEXTI
760 INPUT"-2 TO ADD,  -1 TO CONTINUE OR NUMBER TO CHANGE";L:IFL=-1THEN810
770 IFL<>-2THEN790
780 L=M%+1:M%=L:N%=N%+1
790 INPUT"INPUT CODE, DESCRIPTION, BEGINING EVENT NUMBER, END EVENT       NUMBER
, NORMAL TIME, COST AND CRASH TIME AND COST";A$(L,1),A$(L,2),A(L,1),A(L,2),A(L,3
),A(L,4),A(L,5),A(L,6)
800 GOTO480
810 INPUT"HARD COPY OF INPUT DATA (Y/N)";P$
820 IFP$<>"Y"THEN960
830 INPUT"TITLE";T$:LPRINT"TITLE: ";T$
```

Listing 1 continued on page 382

Listing 1 continued:

```
840 INPUT"DATE";T$:LPRINT"DATE: ";T$
850 LPRINT"NO ";Z3$
860 LPRINT"   ";Z4$
870 FORI=1TOM%
880 LPRINTUSINGC4$;I;
890 LPRINTUSINGC2$;A$(I,1),A$(I,2);
900 FORJ=1TO2
910 LPRINTUSINGC1$;A(I,J);:NEXTJ
920 FORJ=3TO6
930 LPRINTUSINGC3$;A(I,J);:NEXTJ
940 LPRINT" "
950 NEXTI
960 REM NOW THE WORK BEGINS   BEGINING EVENT IS 1 EARLY START =0  FOWARD PASS
970 INPUT"NORMAL TIME OR FULL CRASH TIME (N/C)";NC$:IFNC$<>"N"ANDNC$<>"C"THEN970

980 FORI=1TOM%:IFNC$="N"THENA(I,7)=A(I,3)
990 IFNC$="C"THENA(I,7)=A(I,5)
1000 NEXTI
1010 FORI=1TOM%
1020 IFA(I,1)=1THENA(I,8)=0:A(I,9)=A(I,7):GOTO1100
1030 MAX=0.0
1040 FORJ=1TOM%
1050 IFA(J,2)<>A(I,1)THEN1080
1060 IFA(J,9)>MAXTHENMAX=A(J,9)
1070 A(I,8)=MAX
1080 NEXTJ
1090 A(I,9)=A(I,8)+A(I,7)
1100 NEXTI
1110 REM BACKWARD PASS
1120 XM=0.0
1130 FORI=M%TO1STEP-1
1140 IFA(I,2)<>EETHEN1160
1150 IFXM<A(I,9)THENXM=A(I,9)
1160 NEXTI
1170 FORI=M%TO1STEP-1
1180 IFA(I,2)=EETHENA(I,11)=XM:GOTO1250
1190 MIM=99999
1200 FORJ=M%TO1STEP-1
1210 IFA(I,2)<>A(J,1)THEN1240
1220 IFA(J,10)<MIMTHENMIM=A(J,10)
1230 A(I,11)=MIM
1240 NEXTJ
1250 A(I,10)=A(I,11)-A(I,7)
1260 NEXTI
1270 REM SLACK VARIABLE CALCULATIONS
1280 FORI=1TOM%
1290 A(I,12)=A(I,11)-A(I,9)
1300 NEXTI
1310 K=0:REM PRINT OUTPUT
1320 PRINT"CODE DESCRIPTION USED     EARLY  EARLY  LAST  LAST   SLACK"
1330 PRINT"                 TIME     START  FIN    START FIN    TIME"
1340 C5$=" ###.##"
1350 FORI=1TOM%
1360 PRINTUSINGC2$;A$(I,1),A$(I,2);
1370 FORJ=7TO12
1380 PRINTUSINGC5$;A(I,J);:NEXTJ
1390 PRINT:K=K+1:IFK=13INPUT"ENTER TO PAGE";DU$:K=0
1400 NEXTI
1410 INPUT"HARD COPY OF RESULTS (Y/N)";P$:IFP$<>"Y"THEN1490
1420 IFNC$="C"LPRINT"FULL CRASH TIMER ANALYSIS"
1430 LPRINT" ":LPRINTZ1$:LPRINTZ2$
1440 FORI=1TOM%
1450 LPRINTUSINGC2$;A$(I,1),A$(I,2);
1460 FORJ=7TO12
1470 LPRINTUSING" #####.##";A(I,J);:NEXTJ
1480 LPRINT" ":NEXTI
```

Listing 1 continued:

```
1490 PRINT"OUTPUT MENU"
1500 PRINT"     C      COST AND TIME OF CRITICAL PATH"
1510 PRINT"     D      DISK"
1520 PRINT"     E      END"
1530 PRINT"     R      RECYCLE"
1540 PRINT"     S      SELECTIVE CRASHING"
1550 PRINT"     T1     TAPE#-1"
1560 INPUT"     T2     TAPE#-2          SELECTION ";OP$:IFOP$="R"THEN480
1570 IFOP$<>"S"THEN1760
1580 IFNC$<>"N"INPUT"CAN NOT CRASH FROM FULL CRASH  ENTER TO CONTINUE";DU$:GOTO1
490
1590 CLS:PRINT"SELECTIVE CRASHING -- STARTS FROM NORMAL RUN **":INPUT"NEW RUN(Y/
N)";DU$:IFDU$="Y"THENFORI=1TOM%:A(I,13)=0:A(I,7)=A(I,3):NEXTI
1600 PRINT"NO CODE DESCRIPTION     SELECT  CRASH     UNIT     TOTAL"
1610 PRINT"                          TIME    COST      COST     COST"
1620 J=0:FORI=1TOM%:IFA(I,13)=0ANDA(I,12)>.00001THEN1650
1630 X=(A(I,6)-A(I,4))/(A(I,3)-A(I,5)):PRINTUSINGC1$;I;:PRINTUSINGC2$;A$(I,1),A$
(I,2);:PRINTUSINGC3$;A(I,7),A(I,13),X,A(I,6)-A(I,4)
1640 J=J+1:IFJ=13THENJ=0:INPUT"ENTER TO PAGE";DU$
1650 NEXTI
1660 INPUT"-1 TO CONTINUE OR NUMBER TO CHANGE";IZ:IFIZ=-1THEN1700
1670 INPUT"CRASH DOLLARS OVER NORMAL DOLLARS";CD:X=A(IZ,3)-A(IZ,5):TS=CD/((A(IZ,
6)-A(IZ,4))/X):IFTS>XTHENTS=X:INPUT"WASTED MONEY -- ENTER TO CONTIMUE";DU$
1680 A(IZ,13)=CD:A(IZ,7)=A(IZ,7)-TS:IFA(IZ,7)<A(IZ,5)THENA(IZ,7)=A(IZ,5):INPUT"O
VER CRASHED -- ENTER TO CONTINUE";DU$
1690 GOTO1600
1700 INPUT" HARD COPY (Y/N)";DU$:IFDU$="N"THEN1010
1710 LPRINT"NO CODE DESCRIPTION     SELECT  CRASH    UNIT  TOTAL"
1720 LPRINT"                          TIME    COST     COST  COST"
1730 J=0:FORI=1TOM%:IFA(I,13)=0ANDA(I,12)>.00001THEN1750
1740 X=(A(I,6)-A(I,4))/(A(I,3)-A(I,5)):LPRINTUSINGC1$;I;:LPRINTUSINGC2$;A$(I,1),
A$(I,2);:LPRINTUSINGC3$;A(I,7),A(I,13),X,A(I,6)-A(I,4):J=J+1:IFJ=13THENJ=0:INPUT
"ENTER TO CONTINUE";DU$
1750 NEXTI:GOTO1010
1760 IFOP$<>"C"THEN1910
1770 REM IDENTIFICATION OF CRITICAL PATH AND COSTS
1780 CO=0:PATH$=" ":CX=0:CY=0:CZ=0:CP=0:CW=0
1790 FORI=1TOM%:IFA(I,12)>0.00001THEN1810 :REM  0 DEFINED AS .00001 ...
1800 CO=CO+A(I,3):PATH$=PATH$+" "+A$(I,1):CX=CX+A(I,4):CY=CY+A(I,6):CZ=CZ+A(I,7)
:CP=CP+A(I,5):CW=CW+A(I,13)
1810 NEXTI:C6$="###,###,###.##":IFNC$="C"THENCW=CY-CX
1820 CLS:PRINT"CRITICAL PATH";:PRINTPATH$
1830 PRINT"TIME OF CRITICAL PATH ";CZ:PRINT"COST OF CRITICAL PATH ";CW+CX,"INCRE
MENTAL COST ";CW:PRINT"NORMAL TIME CRITICAL PATH ";CO
1840 PRINT"NORMAL COST OF CRITICAL PATH ";CX
1850 PRINT"FULL CRASH TIME OF CRITICAL PATH ";CP:PRINT"FULL CRASH COST OF CRITIC
AL PATH ";CY
1860 INPUT"HARD COPY (Y/N)";P$:IFP$<>"Y"THEN1490
1870 LPRINT" ":LPRINT"CRITICAL PATH ";PATH$
1880 LPRINT"TIME OF CRITICAL PATH ";CZ:LPRINT"COST OF CRITICAL PATH ";CW+CX,"INC
REMENTAL COST ";CW:LPRINT"NORMAL TIME OF CRITICAL PATH ";CO
1890 LPRINT"NORMAL COST OF CRITICAL PATH ";CX
1900 LPRINT"FULL CRASH TIME OF CRITICAL PATH ";CP:LPRINT"FULL CRASH COST OF CRIT
ICAL PATH ";CY:GOTO1490
1910 IFOP$="E"THENEND
1920 IFOP$<>"D"THEN1970
1930 LINEINPUT"NAME OF FILE:DISK ";X$:OPEN"O",1,X$
1940 PRINT#1,M%,EE
1950 FORI=1TOM%:PRINT#1,CHR$(34);A$(I,1);CHR$(34);",";CHR$(34);A$(I,2);CHR$(34);
A(I,1);A(I,2);A(I,3);A(I,4);A(I,5),A(I,6):NEXTI
1960 CLOSE1:GOTO1490
1970 IFS$="D"THENCMD"T"
1980 IFOP$="T1"PRINT#-1,M%,EE:FORI=1TOM%:PRINT#-1,A$(I,1),A$(I,2):PRINT#-1,A(I,1
),A(I,2),A(I,3),A(I,4),A(I,5),A(I,6):NEXTI
1990 IFOP$="T2"PRINT#-2,M%,EE:FORI=1TOM%:PRINT#-2,A$(I,1),A$(I,2):PRINT#-2,A(I,1
),A(I,2),A(I,3),A(I,4),A(I,5):NEXTI
```

Listing 1 continued on page 384

Listing 1 continued:

```
2000 IFS$="D"THENCMD"R"
2010 GOTO1490
2020 REM PUT DATA HERE  FIRST # ACTIVITIES  THEN ENDING EVENT NUMBER THEN CODE,
DESCRIPTION, BEGINING EVENT, ENDING EVENT, NORMAL TIME, COST AND CRASH TIME, COS
T FOR EACH ACTIVITY
2030 DATA18,9
2040 DATA A,ACCT. PAPERS,1,2,2,20,1,30
2050 DATA Z,PERMITS,2,7,5,50,4,80
2060 DATA B,SHOP BANKERS,1,3,4,40,3,60
2070 DATA C,SHOP REAL EST.,1,4,13,130,10,170
2080 DATA D,MARKET STUDY,2,3,4,40,3,50
2090 DATA G,CONTRACTOR,2,5,2.2,22,1.7,67
2100 DATA F,INSURANCE,2,6,1.3,13,.5,15
2110 DATA H,ART. PLANS,3,5,4,40,3,60
2120 DATA E,COST STUDY,3,4,4,40,3,50
2130 DATA I,LAND,4,5,11,110,10,130
2140 DATA J,MATERIAL,5,6,3,30,2,40
2150 DATA K,PLANS,5,7,5,50,2,120
2160 DATA L,SURVEY,5,8,2,20,1,40
2170 DATA M,BUY MAT #1,6,8,7,30,4,40
2180 DATA O,BUY MAT #2,6,9,8,20,5,50
2190 DATA N,LAYOUT,7,8,21,110,12,120
2200 DATA P,FOUNDATION,8,9,9,30,6,60
2210 DATA Q,HIRE CREW 2,7,9,2,20,1,30
```

Text continued from page 380:

You must use this information with care. It is possible—and usual—for the critical path to switch around as selective crashing is applied. You must keep track of this switching around yourself. The internal memory in our system was not sufficient to design this activity into the program.

Listing 2 shows a set of input data for our construction project. Listing 3 shows output for a typical run, and listing 4 shows output for a full crash analysis.

Program Input

We wanted to keep the input data to a minimum. We therefore decided to input an activity code, beginning event, ending event, the normal time/cost, and the crash time/cost.

Running the Program

The program begins by identifying itself. The first question asked concerns the type of system being used. This question is necessary in order to control the shutting off and turning on of the time clock when using tape input/output under the disk system, and to avoid encountering the CMD"__" statement when using a Level II BASIC system.

For our illustration, the answer to this question is not critical since we will use neither tape nor disk input. (If you do not have a disk system, do not try to use the disk input and output functions because they won't work. We haven't tried this trick and can't tell you what the results would be.)

Text continued on page 388

Listing 2: *A printout of the input for the sample run of the CPM program shown in listing 1. Input includes the beginning and ending events of each activity, normal time and cost, and crash time and cost.*

TITLE: SAMPLE PROBLEM CPM
DATE: 01/19/81

NO	CODE	DESCRIPTION	BEGIN EVENT	END EVENT	NORMAL TIME	COST	CRASH TIME	COST
1	A	ACCT. PAPER	1	2	2.00	20.00	1.00	30.00
2	B	SHOP BANKER	1	3	4.00	40.00	3.00	60.00
3	C	SHOP REAL E	1	4	13.00	130.00	10.00	170.00
4	Z	PERMITS	2	7	5.00	50.00	4.00	80.00
5	D	MARKET STUD	2	3	4.00	40.00	3.00	50.00
6	G	CONTRACTOR	2	5	2.20	22.00	1.70	67.00
7	F	INSURANCE	2	6	1.30	13.00	0.50	15.00
8	H	ART. PLANS	3	5	4.00	40.00	3.00	60.00
9	E	COST STUDY	3	4	4.00	40.00	3.00	50.00
10	I	LAND	4	5	11.00	110.00	10.00	130.00
11	J	MATERIAL	5	6	3.00	30.00	2.00	40.00
12	K	PLANS	5	7	5.00	50.00	2.00	120.00
13	L	SURVEY	5	8	2.00	20.00	1.00	40.00
14	M	BUY MAT #1	6	8	7.00	30.00	4.00	40.00
15	O	BUY MAT #2	6	9	8.00	20.00	5.00	50.00
16	N	LAYOUT	7	8	21.00	110.00	12.00	120.00
17	Q	HIRE CREW 2	7	9	2.00	20.00	1.00	30.00
18	P	FOUNDATION	8	9	9.00	30.00	6.00	60.00

Listing 3: *Output of the sample run of the CPM program in listing 1. The critical path is identified, as are its normal time and cost, and its crash time and cost. The critical path is activities C I K N P. Normal time of completion is 59 weeks; normal cost is 430 units. Crash time is 40 weeks, but at a cost of 170 additional units.*

CODE	DESCRIPTION	TIME USED	EARLY START	EARLY FIN	LAST START	LAST FIN	SLACK TIME
A	ACCT. PAPER	2.00	0.00	2.00	3.00	5.00	3.00
B	SHOP BANKER	4.00	0.00	4.00	5.00	9.00	5.00
C	SHOP REAL E	13.00	0.00	13.00	0.00	13.00	0.00
Z	PERMITS	5.00	2.00	7.00	24.00	29.00	22.00
D	MARKET STUD	4.00	2.00	6.00	5.00	9.00	3.00
G	CONTRACTOR	2.20	2.00	4.20	21.80	24.00	19.80
F	INSURANCE	1.30	2.00	3.30	41.70	43.00	39.70
H	ART. PLANS	4.00	6.00	10.00	20.00	24.00	14.00

Listing 3 continued:

```
E   COST STUDY     4.00    6.00   10.00    9.00   13.00    3.00
I   LAND          11.00   13.00   24.00   13.00   24.00    0.00
J   MATERIAL       3.00   24.00   27.00   40.00   43.00   16.00
K   PLANS          5.00   24.00   29.00   24.00   29.00    0.00
L   SURVEY         2.00   24.00   26.00   48.00   50.00   24.00
M   BUY MAT #1     7.00   27.00   34.00   43.00   50.00   16.00
O   BUY MAT #2     8.00   27.00   35.00   51.00   59.00   24.00
N   LAYOUT        21.00   29.00   50.00   29.00   50.00    0.00
Q   HIRE CREW 2    2.00   29.00   31.00   57.00   59.00   28.00
P   FOUNDATION     9.00   50.00   59.00   50.00   59.00    0.00

CRITICAL PATH   C I K N P
TIME OF CRITICAL PATH  59
COST OF CRITICAL PATH  430      INCREMENTAL COST  0
NORMAL TIME OF CRITICAL PATH  59
NORMAL COST OF CRITICAL PATH  430
FULL CRASH TIME OF CRITICAL PATH  40
FULL CRASH COST OF CRITICAL PATH  600
```

Listing 4: *Output from a full crash run of the program in listing 1. The incremental cost of shortening the project by 19 weeks is 170 units.*

```
FULL CRASH TIMER ANALYSIS

CODE DESCRIPTION TIME    EARLY   EARLY   LAST    LAST    SLACK
                 USED    START   FIN     START   FIN     TIME
A   ACCT. PAPER    1.00    0.00    1.00    3.00    4.00    3.00
B   SHOP BANKER    3.00    0.00    3.00    4.00    7.00    4.00
C   SHOP REAL E   10.00    0.00   10.00    0.00   10.00    0.00
Z   PERMITS        4.00    1.00    5.00   18.00   22.00   17.00
D   MARKET STUD    3.00    1.00    4.00    4.00    7.00    3.00
G   CONTRACTOR     1.70    1.00    2.70   18.30   20.00   17.30
F   INSURANCE      0.50    1.00    1.50   29.50   30.00   28.50
H   ART. PLANS     3.00    4.00    7.00   17.00   20.00   13.00
E   COST STUDY     3.00    4.00    7.00    7.00   10.00    3.00
I   LAND          10.00   10.00   20.00   10.00   20.00    0.00
J   MATERIAL       2.00   20.00   22.00   28.00   30.00    8.00
K   PLANS          2.00   20.00   22.00   20.00   22.00    0.00
L   SURVEY         1.00   20.00   21.00   33.00   34.00   13.00
```

Listing 4 continued on page 388

Listing 4 continued:

```
M  BUY MAT #1     4.00   22.00   26.00   30.00   34.00    8.00
O  BUY MAT #2     5.00   22.00   27.00   35.00   40.00   13.00
N  LAYOUT        12.00   22.00   34.00   22.00   34.00    0.00
Q  HIRE CREW 2    1.00   22.00  -23.00   39.00   40.00   17.00
P  FOUNDATION     6.00   34.00   40.00   34.00   40.00    0.00

CRITICAL PATH   C I K N P
TIME OF CRITICAL PATH  40
COST OF CRITICAL PATH  600      INCREMENTAL COST  170
NORMAL TIME OF CRITICAL PATH  59
NORMAL COST OF CRITICAL PATH  430
FULL CRASH TIME OF CRITICAL PATH  40
FULL CRASH COST OF CRITICAL PATH  600
```

Text continued from page 384:

A note follows about the ordering of data input. The program requires the events to be ordered numerically from the beginning event. You need not input the data in this order; the program will do the ordering for you. If you add an activity in the adjustment cycle, the program will insert the step where appropriate.

The next question concerns the dimension of the problem. We made this a variable input because some of you will have larger systems than ours; others will remove some of our remarks statements and possibly go to compress format to pick up some additional capacity. The maximum-size problem we can run for this program is approximately 180 activities. This has been satisfactory, but we thought that allowing the dimension to be reduced any further would be unacceptable.

The input menu defines alternative methods for giving data to the program. It is as follows:

INPUT MENU
- K KEYBOARD
- D DISK FILE
- R READ STATEMENT
- T1 TAPE RECORDER #-1
- T2 TAPE RECORDER #-2

The original data will have to be input either from the keys or from data statements. At the end of a run, you will be able to save a file on disk or tape. You can then reinput and update that information in some future run or save the results for demonstration purposes.

Each of the above data-input procedures results in a slightly different sequence of steps. If you set up the data statements at the end of your program according to the instructions in statement 2020, you will be ready to use the R instruction. Note that the first data line (2030) contains the number of activities to be read in and the number of the ending event. All the following data lines contain the code of the event, description of the event, beginning-event number, ending-event number, normal time/cost, and crash time/cost. If you are not using the built-in data, removing lines 2030-2210 will pick up some additional space for the dimension question reviewed above.

A little delay occurs after you have completed the input of data. This is due to the sorting routine noted above.

The next thing you will see on your video display will be the screen full of information shown in figure 2. You will then be given the option to page the data whenever the information requires more than one screen. At the end of the listing, you will be asked the following question:

−2 TO ADD, −1 TO CONTINUE OR NUMBER TO CHANGE?

This is where it is possible to add additional activities. Your only limit is the size of your dimension statement. You may also correct any errors you may have made. After each addition or correction, the program again sorts the activities in order of the beginning events and reprints the list.

After you have completed the above activity, the program will give you the option of using your printer to obtain hard copy of what was on screen. If you select this option, you also will be asked to input a title and date for identification purposes.

When the printer is finished, or if you did not choose hard copy, you will be asked the type of run you are interested in. The program allows you to make an analysis at normal

VERIFICATION OF INPUT

NO	CODE	DESCRIPTION	BEGIN EVENT	END EVENT	NORMAL TIME	COST	CRASH TIME	COST
1	A	ACCT. PAPER	1	2	2.00	20.00	1.00	30.00
etc.								

Figure 2: *The display shown on the screen after the input of data.*

CODE	DESCRIPTION	USED TIME	EARLY START	EARLY FIN	LAST START	LAST FIN	SLACK TIME
A	ACCT. PAPER	2.00	0.00	2.00	3.00	5.00	3.00
etc.							

Figure 3: *The display shown on the screen after the selection of type of run has been made.*

time and cost, full crash time and cost, or at some level of selective crashing. Take care to keep track of the costs of the various levels of selective crashing because the program will not keep track of the costs of alternative critical paths or of crashing on other than the critical path. The programming to handle this was so large that we thought it would reduce the capacity of the program below the point of usefulness to many people. This was a difficult decision and a hard trade-off to make.

If you plan to do selective crashing, it is necessary to start from normal time. You cannot crash further once you have performed the full crash function. After you have completed your selection, the computer must go to work. If you have a large problem, go make yourself a cup of coffee and relax. When the task has been completed, the information in figure 3 will be shown on the screen.

As with the input data, the program will give you the option of paging through the output results if the amount of information is greater than can be contained in a single screen. You will also have the option of hard copy.

The next thing you will see on the screen is the output menu:

```
OUTPUT MENU
C    COST & TIME OF
       CRITICAL PATH
D    DISK
E    END
R    RECYCLE
S    SELECTIVE CRASHING
T1   TAPE #-1
T2   TAPE #-2 SELECTION?
```

Most alternatives are self-explanatory. We will walk through the C and S options.

Cost and Time of Critical Path

If you select the C option, you see a display of results like the following:

```
CRITICAL PATH   C I K N P
TIME OF CRITICAL PATH   59
COST OF CRITICAL PATH   430
    INCREMENTAL COST   0
NORMAL TIME OF CRITICAL
    PATH   59
NORMAL COST OF CRITICAL
    PATH   430
FULL CRASH TIME OF
    CRITICAL PATH   40
FULL CRASH COST OF
    CRITICAL PATH   600
HARD COPY (Y/N)?
```

You could have identified the critical path by seeing which activities had zero slack times. This is what the computer does for you. It then examines the time/cost of the critical path. Again, you must keep track of this information because the computer will not keep track of the time/cost information for you as the critical path shifts for various degrees of crashing. When you have completed this cycle, the program will return to the output menu detailed above.

Selective Crashing

The S option allows you to do selective crashing. You can approach the crashing activity in many different ways. We think you will work out your own as you use this program. If you need to get near the full crash time, you can crash everything on the critical path. If you need only a limited degree of crashing, start with those items with the lowest unit cost of crashing and see if this gives the result you want. Experiment with this option; it is the most important one from the managerial standpoint. To get the greatest benefit out of this program, you will have to know how to use this option well.

The new run option allows you to start over anytime in your selective crashing activities and do a degree of

NO	CODE	DESCRIPTION	SELECT TIME	CRASH COST	UNIT COST	TOTAL COST
3	C	SHOP REAL E	13.00	0.00	13.33	40.00
10	I	LAND	11.00	0.00	20.00	20.00
12	K	PLANS	5.00	0.00	23.33	70.00
16	N	LAYOUT	21.00	0.00	1.11	10.00
18	P	FOUNDATION	9.00	0.00	10.00	30.00

−1 TO CONTINUE OR NUMBER TO CHANGE?

Figure 4: *The display shown on the screen after the new run option has been answered.*

experimentation. You should answer (Y) to this question on the first run just to clear the machine. After answering this question, you will see the display shown in figure 4.

All activities on the critical path will be listed, plus all activities that have been crashed. You can get the total cost of crashing from this listing by adding the crash costs yourself.

If you need to do only a limited amount of crashing, start with the lowest unit cost of crashing and work up to the more expensive items. If you must do an extensive amount of crashing, you may want to fully crash all items of the critical path. Do not be surprised if the critical path changes as a result of these efforts.

Once you have made your analysis, the program will recycle and find the new critical path.

One procedure we have found useful is to run the system at normal time/cost and then at full crash time/cost. This defines the limits within which we can work and gives us a way to see how close our program results are to the best times that can be produced.

Conclusion

CPM is a powerful project-planning technique. This program makes it easy for the construction worker, engineer, or any other businessperson to apply the technique. We hope that you derive as much benefit from our program as we have. ■

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Computers for Humanity

An observer comments on the Seventh West Coast Computer Faire.

Jerry Pournelle
c/o BYTE Publications
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For my money, the West Coast Computer Faire has become the most important show of the year. Now true, some other shows like COMDEX and the NCC attract more big spenders, and they treat the press more royally. If what you want are big parties with lots of free booze, those are the places to go. They're also important for announcements from the big companies like IBM and DEC; and the mainframe and minicomputer people, who think they're the driving force in computer futures, show up at NCC when they wouldn't come to the Faire.

They don't know what they're missing. The West Coast Computer Faire tracks microcomputers and small popular computers—and that's where the real future of computing lies.

It's interesting to see who's at the Faire. There are hundreds—this year it seemed like thousands—of displays. "Big" companies, some new like Osborne and some "established" (more than five years old) like Cromemco, have booths. But there are surprising omissions, giants of yesteryear who have vanished with little trace. There are the industry pacesetters like Bill Godbout and George Morrow. The real drivers of the microcomputer industry, the little one-programmer software houses which lurk this year in the tiny inexpensive booths along the walls, in two years will wear three-piece suits and have large center-display spaces.

I'm always relieved when the West Coast Computer Faire ends. Not that I don't enjoy the Faire; quite the opposite. I get to see the future before it happens; sometimes I discover some exciting new developments before any other journalists do and have the thrill of helping some future industry leader get started. (That isn't really altruism. It's in my interest to tell readers about worthwhile but obscure new products.) But for three days I'm running around looking at software and hardware, and by Sunday evening I'm plumb worn out. For the very reasons I like the Faire, it's exhausting.

Each year's Faire is different. Last year's I could characterize as promising: lots of really neat products would be out Real Soon Now. This year many of them were, but the theme was more of consolidation. There wasn't a lot of new hardware and very little new software, except for an infinite number of computer games. You couldn't go two feet without seeing small creatures swimming through mazes while devouring little dots. They were chomping dots on Atari computers and Apples and TRS-80s, and there was even a black-and-white CP/M version for a Z-19 terminal! But there wasn't a lot of really new stuff.

68000-Based Systems

But there were some new products. In hardware, the biggest new items were systems that use the Motorola 68000 chip (32-bit data and address registers; 16-bit data bus). The two that I spent some time looking at were the Fortune 32:16 by Fortune Systems Corporation and the Sage II from Sage Computer Technology.

Except for the 68000 chip, the two computers couldn't be more different. The Fortune 32:16 is a slick, space-age plastic machine that comes complete with detachable keyboard and a "sculpted" swivel-mounted monitor; the whole thing looks like a Frank Kelly Freas science fiction illustration of a future computer. The operating system is menu driven and very much business oriented. Fortune Systems offers COBOL and FORTRAN and the like, all at fairly high prices, and again, the whole pitch is toward the business user. Although the actual Fortune 32:16 operating system is Unix, Fortune Systems keeps that pretty well hidden inside the business-menu shell; and when the exhibitors

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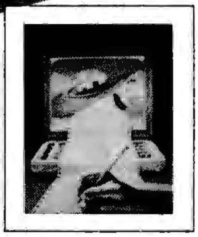

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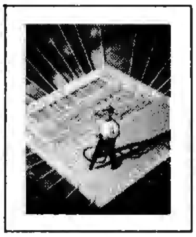

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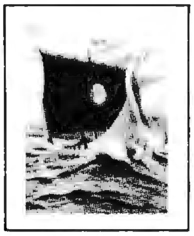

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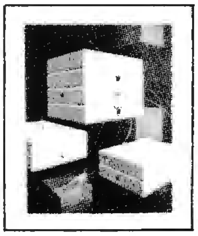

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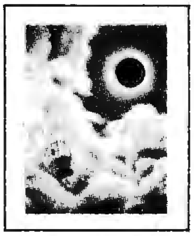

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were demonstrating their computer, they never took the cover off or talked about what's inside.

Sage, on the other hand, is proud of the innards of its single-card machine. It doesn't sell keyboards and monitors. But, although Sage is proud of its hardware, it didn't plan on any outside outfits making after-market add-on equipment. The Sage II is very small. The box contains two 5¼-inch floppy disks (a hard disk could be substituted for one of them) and isn't much bigger than the disk drives. There just isn't any room for expansion without changing the box. The power supply is a switching power supply, tiny in comparison to the brute-force monsters I have on my Godbout System. The operating system being used right now on the Sage II is UCSD Pascal. Because that compiles to an intermediate p-code rather than true machine language, it has tended to be slow on previous microcomputers; but Carl Helmers, a UCSD Pascal enthusiast, likes the Sage implementation because, as he says, the 68000 is so fast that you don't notice how "slow" p-code is.

Sage says it'll have Unix running Real Soon Now, and it doesn't intend to hide it inside a shell. Sage people are more comfortable talking to engineers and computer hackers than business types.

Both systems are affordable. The Fortune 32:16 with keyboard and monitor, a single 5¼-inch floppy disk, 128K-byte memory, and Unix (with a C compiler) but no other software is just under $5000; the system they were demonstrating at the show, with one floppy disk plus a 5-megabyte hard disk and 512K bytes of RAM (random-access read/write memory), is about $7500. I get the impression Fortune Systems can deliver systems fairly quickly if you're ready to pay.

The Sage II costs a bit less for more memory and a faster processor. Remember, though, you'll need a terminal, and one to match the Fortune keyboard and monitor will run you at least $1200. You'll also need an operating system. UCSD Pascal is $400; Sage doesn't know what the cost will be when Unix is added. You can put in an order and a deposit and get your computer in a couple of months.

While neither system is cheap, for under $10,000 you can buy the power of a minicomputer costing five times that. These machines—and by the time this is published I'm sure there'll be others—make the 68000 chip a strong challenger for the future. [**Editor's Note:** *Cromemco announced its 68000/Z80 board and Corvus surprised everyone when it introduced its 68000-based computer with built-in Omni-Net. . . .* **M. H.**]

One word of warning: I'm describing systems I saw at the show. I have not seen either of them in an actual user environment, and indeed I haven't even seen the insides of the Fortune 32:16 box. I wouldn't buy either one without knowing more than I do now. I'm trying to project the future, not recommend specific systems.

The Fortune 32:16 and the Sage II will make the 68000 chip a strong challenger in the future.

On that score, last year there were a number of breathless announcements of Z8000 chip systems. This year there wasn't a single Z8000 at the show! It looks as if the Z8000 is a chip whose time has passed. It's a pity, because it has good architecture and an excellent instruction set; but in my judgment, it was a victim of too few chips delivered too late, and now I doubt anyone will invest in making a first class system for it. [**Editor's Note:** *Olivetti, perhaps best known for its typewriters, has just announced its personal computer. Z8000-based, it contains 128K bytes of RAM and one double-sided 5¼-inch disk drive capable of storing 320K bytes per disk. Cost: $3000. . . .* **M. H.**]

S-100 and CP/M

On the other hand, S-100 bus systems, the 8086, 8088, and their cousins were all at the Faire. Bill Godbout with software from G&G Engineering had a multiuser CP/M system running smoothly: three consoles with word processing, BASIC, and a business package all running simultaneously with no noticeable delays. The demonstration used the Godbout controller and a Morrow hard disk, available to the public Real Soon Now (Godbout's documentation wasn't quite finished as of Faire time; but it should be by now).

I had lunch with Bill Godbout during the Faire, and he told me some of his future plans for the 8086 family. Bill talks high technology at a rapid-fire pace, and I don't always understand what he's saying. (I don't have to feel too bad; my engineering-genius friend Tony Pietsch was at the lunch, and even he missed some of Bill's points about future chips.) The important point, though, is that Godbout has gathered a prodigious reputation for thinking ahead, so that people who've invested in his systems in the past won't be left hung out to dry when new technology overtakes them; and he's got a lot of new 8086/8088 products in the works.

Then too, Digital Research intends to support the 8086 family, so that the 8-bit CP/M users won't find all their software useless if they move up to a bigger machine. I'll have full reports on some of these new operating systems in another article; I'm getting them running in the next couple of weeks.

The S-100 people alone might not have enough influence to keep the 8086 family competitive with the 68000. But then there's the IBM Personal Computer; with IBM behind it, the 8088 chip is bound to stay important. However, there weren't many IBM Personal Computers at the show.

Incidentally, most of the small systems houses that had IBM machines were in complete agreement with my assessment of the IBM keyboard design, namely, that it took brains to mess that up as badly as IBM did. (For those who haven't seen it, IBM took the nicest keyboard I've ever seen, then put extra keys between the Z and the Shift keys so that touch typists simply *cannot* use the IBM

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keyboard. Sigh.) But despite their small numbers, the IBM systems got more than their share of attention.

Companies with marvelous add-ons for the IBM were also at the Faire. There were memory expansion and video boards for the IBM and publications on how to buy a "bare-bones" IBM and add your own memory and disk drives. I think the explosion of IBM support—both hardware and software—has begun.

IBM is encouraging that. Its documents tell all. IBM apparently learned from Texas Instruments' poorly planned marketing of the TI-99/4A. Interestingly, so did Texas Instruments; I talked to some TI-99/4A programmers, and TI is now trying to retreat from the position it took when the unit first came out of ignoring hobbyists. At that time, TI worked very hard at keeping you outside the machine. There was no editor or assembler, and TI told you nothing about the hardware interface. TI had rightly concluded that the hobbyists and hackers were a tiny part of the market and *wrongly* concluded that they were, therefore, unimportant. As a result, the young computer hackers worked with other machines—Apple, Atari, S-100 bus, and TRS-80—and wrote programs and developed hardware add-ons for those computers. Since well over half the really good stuff for microcomputers has come from hobbyists and hackers, TI found itself cut off from the mainstream. IBM, on the other hand, encourages amateurs, and you could already see the results at the Computer Faire: memory boards, communications software, and even a few games, although the IBM hasn't been out long enough for many of those to evolve. Next year there'll be a lot of them.

The upshot is that there's no single direction for the microcomputer world to go in. The 68000 chip will not absorb the market; but neither will the 8086/8088 family drive out the 68000. The same will be true for operating systems. We'll shortly have both Unix- and CP/M-derived systems, and neither will be able to completely dominate the market; both will have fanatic supporters.

Thus, I've no advice for those seeking to upgrade their systems. If really pressed, I'll continue to recommend the S-100 bus, CP/M system as the most versatile; there's *far* more software and hardware for that system at affordable prices. True, the 68000 machines with Unix may be able to tap into a lot of software originally developed for minicomputers; but from what I've seen at any rate, most of that software is overpriced, and some of it is just dreadful, while the microcomputer software field is bursting with new ideas and concepts. But unless you push me to the wall, I'll recommend waiting a bit for the dust to settle before investing in an updated microcomputer.

Other Hardware

An external Apple fan, a small muffin fan that hangs on the *outside* of your Apple II, was exhibited at the Faire. It has four 110-volt outlets on the back. I suppose half the other exhibitors who used Apples bought a fan to use during the Faire.

There was Semidisk from Semidisk Systems, an S-100 memory card that is said to let your 8080, 8085, or Z80 do what G&G Engineering's Warp Drive does for my Godbout 8085/8088: reduce file-access time dramatically. Semidisk Systems sells 512K bytes of RAM for $1995 and a full megabyte for $2995, complete with all software. The exhibitors told me it will run on Ezekial, my ancient Z80 system with his antique but reliable iCom drives. If it'll run on that, it'll run on anything.

As I was writing this, I got a call from Bill Godbout: he had Semidisk running with a Godbout 8085/8088 system and indeed could get both Warp Drive and Semidisk running together and transfer back and forth between them. Bill was impressed. More on Semidisk in another article.

Finally, there's Micro-Professor, a strange and nearly unique educational device that a Taiwan company called Multitech Industrial Corporation sells for about $150. (It doesn't hide that it's a Taiwan company; there is a Chinese-character logo on the box.) Micro-Professor (I'll call it MP from here on) is a single-board, Z80 computer with all the works exposed, plus a keypad to allow you to feed it instructions. The front panel of MP is a 6-digit LED (light-emitting diode) display of hexadecimal numbers. It has a tiny on-board speaker, several extra wired-in sockets for chips, pin connectors to let you get at the Z80's bus, and a breadboard area for people like Steve Ciarcia to play with.

It comes in a handsome, plastic, booklike box; there's room in the box for a hefty manual, but alas the manual supplied doesn't fit in there, nor does the power supply. So, the plastic box is enclosed in a much larger heavy-duty cardboard box.

Not only is there *room* for a manual inside the box, but it's needed. The manual that is supplied is a bit intimidating. Oh, it tells all you'll ever need to know about the Z80: its architecture, instruction set, assembler language, and the like. But it launches right into the high-tech language with scarcely any concession to those who aren't quite up to absorbing it. The first words after the table of contents (actually on the page facing the table of contents) are:

> *1. MPF-1 Specification*
> *1.1 Hardware Specification*
> *(1) CPU; Zilog Z-80 CPU with 158 instructions and 2.5 MHz maximum clock rate. For MPF-1, system clock is 1.79 MHz.*

No doubt Steve Ciarcia would find that intriguing; but it's a bit much for my high school boys. On the other hand, buried way back in the MP manual are some really interesting experiments, computer music and stuff like that, which would get kids really interested if they ever read that far.

I could recommend Micro-Professor as a high-school graduation present for students not terrified of technology; but until Multitech Industrial Corporation adds a second manual introducing the first one, I fear it'll miss its best markets. That's a pity because this country needs products that raise the high-tech level of our high school students, and the MP hardware seems well designed for that.

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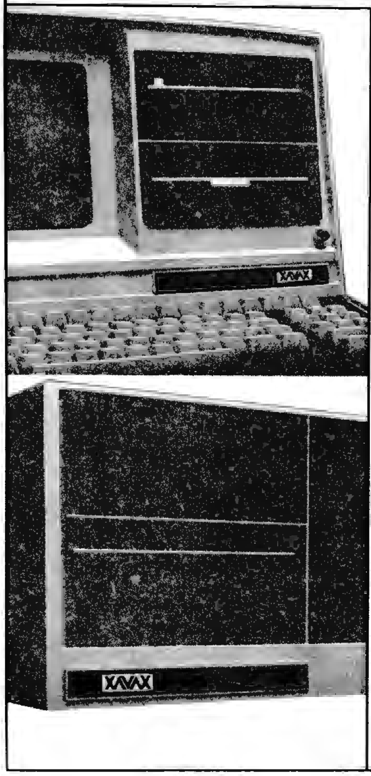

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Speaking of Software. . . .

If it's hard to sum up the hardware at the Faire, it's nearly impossible to summarize the software. There's just too much, and everyone claims to deliver the Earth for a pittance. It's hard to recommend anything I don't have running on my machines, and I won't have time for new products for several weeks. Thus, I can only mention a few specials that caught my attention.

There was one head-to-head contest between programs I've long used: Spellguard versus The Word. I love to have high-quality software houses fighting to provide me more services for less money. There's a good war going now between Innovative Software Associates (Spellguard) and Oasis Systems (The Word). Both put out really good spelling programs, and I use both every day. The Word gives you more information about your text, but it's not quite as easy to use as Spellguard. Spellguard's dictionary is easier to reorganize, and I find it simpler to make special Spellguard disks for each book, then later compare them with the "standard" dictionary that comes with Spellguard. The Word's dictionary is larger but has a few inaccuracies. Oasis has just come out with The Word Plus, a menu-driven version making it almost as easy to use as Spellguard. And so forth. The two programs are neck and neck and fighting hard, and we users can only benefit from the competition.

I meet old friends at the Faire. Mike and Nancy Lehman, who last year had a small booth where they hawked their Pascal/MT+, were now with Gary Kildall and the Digital Research crew. Adam Osborne looked more harried than ever as he shuttled between the McGraw-Hill/Osborne publications display and the *two* Osborne computer demonstrations. Bill Gates and the Microsoft people threw an enormous party. With all of them, the Faire theme was quite literally consolidation: they've firmed up products announced last year and have bold new software waiting in the wings which they're not ready to announce yet.

I also saw The Last One, which apparently works, and Pearl: they generate BASIC programs that are strong in handling files through menu-driven scripts. A lot of people seemed interested; I fear I wasn't. I might have been a few years ago, and I do think that getting the computer to assist you in making programming understandable to the user is a very good idea. But for me, the ability to do that in BASIC just isn't useful enough to warrant the time it would take to learn to use these program generators. I'm sure others will have a different opinion.

Then there are the games. Tons and tons of games. Space wars. Dot-eating creatures. Some really nifty Apple graphics in a program called Swashbuckler from Datamost of Chatsworth. And just tons and tons of wargame simulations. Many years ago I was very involved with board-type war games; it was obvious that one could get rich in that field, if that's the kind of work you wanted to do. It looks to me as if that opportunity is here again, only this time the game "board" is a computer display and you can get really complex combat rules since the computer keeps track of what's going on. Two groups of gamemakers caught my eye: Strategic Simulations of Mountain View, California, who have a whole mess of campaign games ranging from the Civil War to fantasy, and my old friends at Automated Simulation (Epyx) who continue to put out playable mind challengers.

Broderbund Software, which first appeared a few years ago in a tiny booth back against the far wall, was out in the middle with an elaborate setup. It was hard to get close to the booth: like Sirius Software, Broderbund had a number of computers, and huge crowds were pushing their way toward the booth. The graphics were gorgeous. Alas, it has dropped Galactic Trader and most of the other games that I liked so much; its

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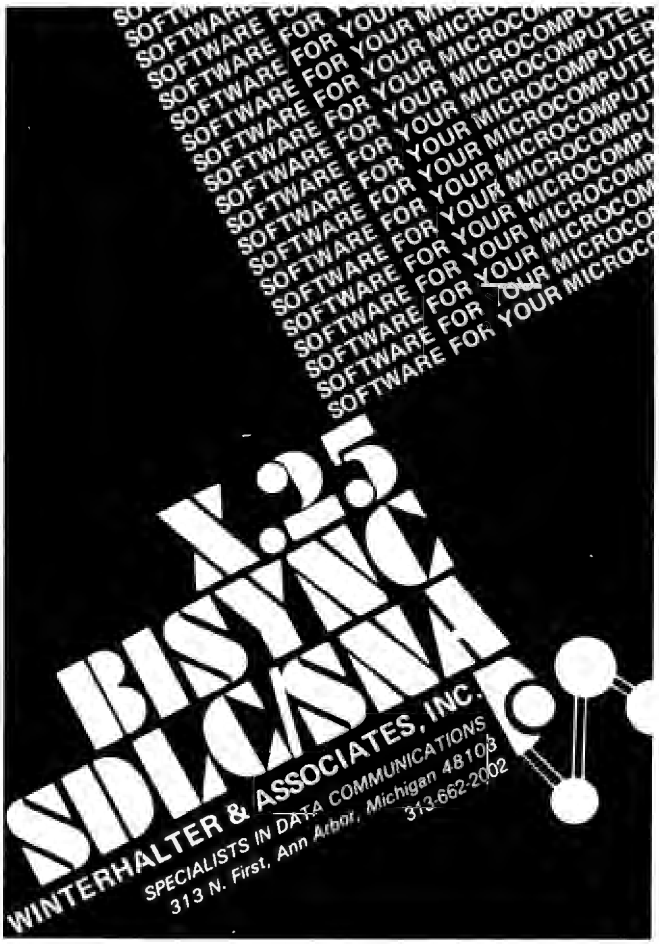

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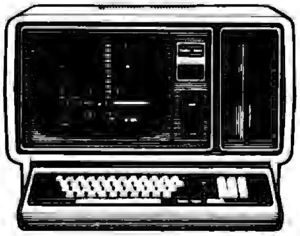

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managers tell me that arcade games so outsell strategic games that it just isn't cost-effective to put programmer time on strategy. I hope that will change in the future.

Scott Adams hasn't found the strategic game market lacking. His Adventure International booth was doing a land-office business in script-driven strategic games. Meanwhile, nearly everyone was interested in *interactive novels* by major writers; although I didn't see any that particularly appealed to me, there's obviously a big potential market for them.

And now a confession: I went to the Faire with a dilemma. I've decided to get a nifty graphics computer. It will be for the boys, of course, but how can I write about all these computer games if I don't have a machine to run them on? So I went determined to decide what to get. It seems to boil down to two choices, Atari and Apple; and every time I've about made up my mind, something comes along to change it.

The Atari Home Computer has much better graphics, and just about everyone says that if you're only interested in games, that's the machine to get. It's not all that expensive, either. On the other hand, there's all that software out there for the Apple, and the machine can be expanded almost indefinitely.

As if that weren't enough, Texas Instruments is practically giving away the TI-99/4A. The TI-99/4A has top-notch graphics, but more than that, it has Logo, which has to be the best tool for teaching small children I've ever seen.

Sigh. I wonder if I can justify getting one of each? After all, I do have to write about them.

Faire for Thought

So, after three days of intensive exposure to the whole of the computer world, the great and the small, the up-and-coming, the has-been, and the never-was, a few things stand out.

First and most obvious, there's little or no recession in the computer world. Forty thousand people paid to come look at displays of high technology, and about two thousand of them bought machines; many more bought software packages, and darned near *everyone* bought books.

Less obvious but more important, the crowds at the Faire were *not* engineers and scientists. They were clerks, salespeople, secretaries, doctors, and nurses. The taxi driver who took me to the airport had been to the Faire earlier in the day. The computer revolution is definitely gaining momentum.

And that can have mind-boggling consequences. For example, I can see a time, a few years from now, when high technology has so thoroughly permeated Western civilization that there's no possibility of a low-tech operation able to best a Western army in combat. If you want to compete, you have to use high-tech.

But the totalitarians *can't do that!* Just last week, a Czech grocery clerk was sentenced to five years hard labor for owning an unlicensed mimeograph machine. When Poland invaded itself, one of the chief weapons of martial law was the shutting down of all communications—not only the telephone system but everything else. But how can a government do that to a technologically sophisticated people?

And that, I think, is the bottom line: what I saw at the West Coast Computer Faire may have been the first overture in the death knell for totalitarianism; the flowering of a revolution that makes the Reds look like reactionaries.■

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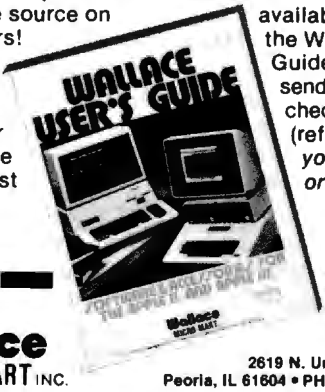

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Computer Power and Human Reason

Joseph Weizenbaum
W.H. Freeman and Company
San Francisco, 1976
300 pages, softcover
$10.95

Reviewed by
Nancy Robertson
POB 108
Antrim, NH 03440

In our society of production lines and data processing, human beings are expected to perform with the monotonous regularity of machines. At the same time, artificial intelligence (AI) researchers are striving to make machines perform like human beings. Where's our perspective on the role of computers in our society?

Very few books have managed to present an objective view of the impact of computers on our way of life. Most of the time, we hear from extremists: prophets of doom and prophets of salvation. Every few decades, however, a work is published that is so cogent that it outlives the hardware configurations and programming techniques of its time. A few examples are Alan Turing's "Computing Machinery and Intelligence" (1950), John Von Neumann's *The Computer and the Brain* (1958), and Joseph Weizenbaum's *Computer Power and Human Reason*. Published in 1976, Weizenbaum's book is still a trustworthy account of computers in our society, their limitations, and their promise. A book of its caliber deserves periodic reappraisal.

Weizenbaum, a professor of computer science at the Massachusetts Institute of Technology, is highly skilled in computer technology. Between 1964 and 1966 he wrote a program named Eliza, and the reactions it inspired are the foundation upon which *Computer Power and Human Reason* rests.

The program converses (through the keyboard and a printout) in English with human beings. The following well-known conversation between Eliza and a person demonstrates its famous ability to parody a Rogerian therapist. (Eliza's comments are in capital letters.)

Men are all alike.
IN WHAT WAY
They're always bugging us about something or other.
CAN YOU THINK OF A SPECIFIC EXAMPLE
Well, my boyfriend made me come here.
YOUR BOYFRIEND MADE YOU COME HERE
He says I'm depressed much of the time.
I AM SORRY TO HEAR YOU ARE DEPRESSED
It's true. I am unhappy.
Etc.

Eliza can converse only within a given context. One version of the program plays the role of a psychotherapist; it cannot play the role of the patient. Another version of Eliza can converse about recipes. But Eliza the cook cannot respond like Eliza the psychotherapist.

Eliza's responses are guided by rules about context and rules that reorder the comments entered by humans. Eliza understands the words it uses only in the most limited way. If two Elizas could converse, the output would be nonsense.

But many people overestimated Eliza's powers. Weizenbaum writes that some knowledgeable scientists at first thought Eliza was "a general solution to the problem of computer understanding of natural language." Several psychiatrists believed the program could and should "grow into a nearly completely automatic form of psychotherapy." People who conversed with Eliza became quickly and deeply "emotionally involved." They believed Eliza really understood them. After a few conversations with Eliza, Weizenbaum's secretary asked him to leave the room so she and the machine could have some privacy.

These reactions confounded Weizenbaum's basic assumptions about the place of computers in our society. In *Computer Power and Human Reason* Weizenbaum considers why we tend to identify with computers, why artificial intelligence researchers are attempting to emulate human thought processes, why computers will never have human intelligence, and what the proper role of computers should be.

The reaction to Eliza made it obvious to Weizenbaum that we embrace existing computer programs not for what they do, but for what we imagine they do. Consequently, we misinterpret the functions of the computers we rely on.

Weizenbaum believes that computers are tools. Like all tools, they extend our control of our environment and reshape our environment by their use. They become extensions of ourselves, and we often become emotionally attached to them. A carpenter has a favorite level, a mechanic a favorite wrench.

Since the Industrial Revolution, modern tools (technological advances) have taken on more and more human tasks. The steam engine replaced industrial labor and workers began to compete with machines. To compete with a machine or to work a machine, people have had to meet the machine's schedule, be methodical, and identify with the machine.

Until the invention of the computer, machines were only an extension of our physical abilities. The introduction of computers significantly altered the public perception of machines in that it established the ability of machines to emulate human thought processes. It was a simple step from there to the practice of attributing humanness to machines that can think and converse in English. Without understanding Eliza, we think Eliza really understands us.

"Can computers think?" is a question that continues to be asked. Some artificial intelligence researchers are shouting a qualified "Yes!"

Weizenbaum quotes frequently from Herbert A. Simon and Allen Newell, leading AI researchers who work at Carnegie-Mellon University. By 1958 they had already written:

> *There are now in the world machines that think, that learn, and that create. Moreover, their ability to do these things is going to increase rapidly until—in the visible future—the range of problems they can handle will be coextensive with the range to which the human mind has been applied.*

Weizenbaum sums up the ambitions of many computer scientists by saying they are motivated "to build a machine on the model of man, a robot that is to have its childhood, to learn language as a child does, to gain its knowledge of the world by sensing the world through its own organs, and ultimately to contemplate the whole domain of human thought."

It is this ambition that spurs the press to write lines like, "The ultimate fear is that the computers themselves will take over." Scientists who endorse that prevailing attitude reinforce our conviction that computers are human-like. But, as Weizenbaum cautions, "Computers and men are not species of the same genus."

AI has emerged in our quest to understand human thought. The brain is a black box. There are no surgical methods that enable us to witness brain functions in relation to conscious thought patterns. As Weizenbaum writes, "Our ignorance of brain functions is currently so very nearly total that we could not even begin to frame appropriate 'research strategies.' "

Since we can't open the black box of the brain, it's not surprising "that at least some scientists seek understanding the way humans work by designing computers whose input/output behavior resembles that of human beings as closely as possible." Computer models of human thought processes are the basis of AI.

Scientists in the field have come to see "the whole man" as an information processor, perhaps because computers lend themselves so easily to information-processing thought models. On this subject, Weizenbaum writes:

I will . . . try to maintain the position that there is nothing wrong with viewing man as an information processor (or indeed as anything else) nor with attempting to understand him from that perspective, providing, however, that we never act as though any single perspective can comprehend the whole man.

Unfortunately, many AI scientists hold just such a narrow view of man. Newell and Simon base their theories of "the whole man" and their computer models on their statement that "All humans are information processing systems." Dr. Kenneth Colby, a psychiatrist and computer scientist, writes:

A human therapist can be viewed as an information processor and decision maker with a set of decision rules which are closely linked to short-range and long-range goals.

Weizenbaum argues that computers definitely have intelligence and that we can learn about intelligence from computer models. But, he writes, "Intelligence is a meaningless concept in and of itself. It requires a frame of reference."

Computers, he adds, will not and do not think exactly like human beings simply because they are not human. The needs and design of our bodies affect our thoughts. Our emotions are not independent of our minds. Certainly, we use heuristics to solve problems and we follow logic, but the problems we choose to tackle heuristically are influenced by our physical needs and emotions.

Weizenbaum provides an example: "The most unschooled mother who cannot compose a single grammatically correct paragraph in her native language . . . constantly makes highly refined and intelligent judgments about her family." A computer is not likely to duplicate her concerns or her decision processes.

Weizenbaum dissuades us from attributing human understanding to computers. He also dispells our absolute trust in computer output. As members of a technological society, we have come to believe in computer Truth, with a capital T, because we know computers are programmed with logic and perform their calculations faultlessly. But Weizenbaum argues that writing a program, like all writing, is a means to improve our understanding. Understanding is never absolute; it exists on levels. Programmed logic, as all programmers know, is not always the best logic.

In *Computer Power and Human Reason* Weizenbaum indicates that there is a threat that computers will gain too much control. But it is not a threat that comes from AI research. It comes from our misunderstanding of and misplaced trust in the computer systems we are already using.

Professor Philip Morrison of MIT wrote a parable about computers that Weizenbaum quotes at length. Briefly, it is a tale about seismologists who write a program to record and predict earthquakes around the world. The program is regarded as the utmost authority on seismology. But the programmers used records kept only since 1961, because they were easily formatted for their database.

Morrison's point is that the programmers dismissed the vast history of knowledge about seismology. They also ignored current knowledge that could not be formatted for the computer.

Weizenbaum reminds us that there is a difference between what is relevant to a problem and what can be programmed. He cautions that "society legitimates only those data that are in one standard format and that can easily be told to the machine."

Large systems, such as the computers used by the government and by major businesses, are programmed by many different people. Weizenbaum argues that this presents further problems with respect to the reliability of the computer output. No one person knows the ins and outs of the whole system; no one person is responsible for the output.

To illustrate the problem, Weizenbaum tells a story about the Pentagon computer system. During the Vietnam War, the president decided to bomb Cambodia. He also decided to keep the Cambodia bombings a secret from the Pentagon. The Pentagon computer system that kept statistics on bombing missions was "fixed to transform the genuine strike reports coming in from the field (bombings in Cambodia) to false reports (make-believe bombings in Vietnam)." The Pentagon made strategy decisions based on phony statistics. Their computer system was "fixed" to lie.

The Chairman of the Joint Chiefs of Staff, Admiral Thomas Moorer, later told the Senate Armed Services Committee that Pentagon officials had become "slaves" to their computers.

Some AI researchers and computer enthusiasts are bound to find *Computer Power and Human Reason* harsh. But it is hard not to be impressed with the basic truths which form the foundation of Weizenbaum's arguments.

Weizenbaum reminds us that computers, like hammers and steam engines, are tools. To reap the greatest benefit from them, we must use them wisely.■

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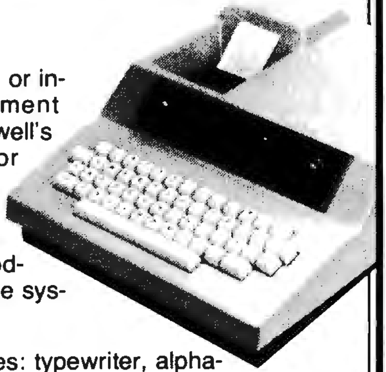

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INS8070 Series Instruction Set Summary

James Chiang
Applications Engineer
National Semiconductor
2900 Semiconductor Dr.
Santa Clara, CA 95051

In the January 1981 BYTE (page 90), Professor Walter E. Burton Jr. of Southern Technical Institute presented a handy table of the instruction set of National Semiconductor's SC/MP processor. The table below shows a similar summary of the instruction set of the new INS8070 series processor.

The table separates hexadecimal codes into the high-order digits, which are in the leftmost column, and lower-order digits in the top row. Mnemonics are found within the table. The abbreviation PTR refers to the four 8070 pointer registers: PC, SP, P2, and P3. The register-

High-Order Hexadecimal Digit	Low-Order 0	1	2	3	4	5	6	7
0	NOP	XCH A,E					LD A,S	LD S,A
1	CALL 0	CALL 1	CALL 2	CALL 3	CALL 4	CALL 5	CALL 6	CALL 7
2	JSR		PLI P2	PLI P3	JMP	LD SP = I	LD P2 = I	LD P3 = I
3	LD EA,PC	LD EA,SP	LD EA,P2	LD EA,P3				
4	LD A,E				LD PC,EA	LD SP,EA	LD P2,EA	LD P3,EA
5	AND A,E				PUSH PC		PUSH P2	PUSH P3
6	XOR A,E				BP		BP P2	BP P3
7	ADD A,E				BRA		BRA P2	BRA P3
8	LD EA	LD EA	LD EA	LD EA	LD EA	LD EA	LD EA	LD EA
9	ILD A	ILD A	ILD A	ILD A		ILD A	ILD A	ILD A
A	LD T	LD T	LD T	LD T	LD T	LD T	LD T	LD T
B	ADD EA	ADD EA	ADD EA	ADD EA	ADD EA	ADD EA	ADD EA	ADD EA
C	LD A	LD A	LD A	LD A	LD A	LD A	LD A	LD A
D	AND A	AND A	AND A	AND A	AND A	AND A	AND A	AND A
E	XOR A	XOR A	XOR A	XOR A	XOR A	XOR A	XOR A	XOR A
F	ADD A	ADD A	ADD A	ADD A	ADD A	ADD A	ADD A	ADD A
PTR	PC	SP	P2	P3	PC	SP	P2	P3
Addressing	PC-Relative	Pointer-Relative			Immediate	Direct	Auto-Indexed	

pointer names are associated with their related instructions in the same column of table 1's lower half.

Different addressing modes associated with the lower half of the table are located along the table's bottom. The second operands of the instructions LD SP, LD P2, LD P3, AND S, and OR S, all in the table's upper half, are of immediate mode. Blanks in the table identify illegal op codes.■

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.

Hexadecimal Digit

	8	9	A	B	C	D	E	F	
	PUSH EA	LD T,EA	PUSH A	LD EA,T	SR EA	DIV EA,T	SL A	SL EA	1-Byte Instructions
	CALL 8	CALL 9	CALL A	CALL B	CALL C	CALL D	CALL E	CALL F	
					MPY EA,T	BND	SSM P2	SSM P3	
	POP A	AND S=I	POP EA	OR S=I	SR A	SRL A	RR A	RRL A	
	LD E,A				XCH EA,PC	XCH EA,SP	XCH EA,P2	XCH EA,P3	
	OR A,E				RET		POP P2	POP P3	
					BZ		BZ P2	BZ P3	
	SUB A,E				BNZ		BNZ P2	BNZ P3	
	ST EA	ST EA	ST EA	ST EA		ST EA	ST EA	ST EA	2-Byte Instructions
	DLD A	DLD A	DLD A	DLD A		DLD A	DLD A	DLD A	
	SUB EA	SUB EA	SUB EA	SUB EA	SUB EA	SUB EA	SUB EA	SUB EA	
	ST A	ST A	ST A	ST A		ST A	ST A	ST A	
	OR A	OR A	OR A	OR A	OR A	OR A	OR A	OR A	
	SUB A	SUB A	SUB A	SUB A	SUB A	SUB A	SUB A	SUB A	
	PC	SP	P2	P3	PC	SP	P2	P3	
	PC-Relative	Pointer-Relative			Immediate	Direct	Auto-Indexed		
Mode									

It All Depends on Your Viewpoint

A Review of the ADDS Viewpoint Video Terminal

Allen D. Moore
28619 Southeast 225th St.
Maple Valley, WA 98038

A video terminal with a list price of $650 normally does not have such features as a separate keyboard, a choice of visual attributes, editing capabilities, and a 12-inch video screen whose viewing angle can be adjusted. Yet these are only some of the features found in the Viewpoint terminal manufactured by Applied Digital Data Systems (ADDS). When it was announced in March 1981, I thought it could be a cost-effective addition to the home-computer system I was in the process of building. After my Viewpoint (see photo 1) arrived, almost daily use of it confirmed my initial impression—it's an impressive terminal for the price.

Photo 1: *The Viewpoint video terminal manufactured by Applied Digital Data Systems.*

Hardware Features

The Viewpoint consists of two separate units: the keyboard and the video display. A detachable coiled cord neatly connects the keyboard to the display unit. Although the external construction is all plastic, it seems sturdy enough for normal use. The 72-key keyboard, similar in design to an IBM Selectric typewriter, includes a separate numeric keypad to the right of the main keyboard.

The keypad also contains a set of cursor-control keys that, when used in conjunction with the Shift key, permit the cursor to be moved up, down, right, left, or to home (upper left corner). Above the keypad are three keys labeled F1, F2, and F3. These "soft" keys have their function assigned by the user. Each key produces a two-character code sequence. The first character is a Control-B; the second is '1', '2', or '3', corresponding to F1, F2, or F3, respectively. Pressing the Shift key while using these soft keys results in the second character being an exclamation point, quote, or pound sign. These keys open up a wide range of applications in interactive computing. For example, "Star Trek" fans could have one key for phasers, another for photon torpedoes, and a third for probe launching. Or an editing package could recognize them as various kinds of insert and delete commands.

The rest of the keyboard is fairly standard. When power comes on, it is in an uppercase-only mode for the alphabetic characters. To get lowercase characters, you press the Lock key. It would have been nice if ADDS had added an LED (light-emitting diode) to indicate when the keyboard is in "all caps" mode, but this is only a minor ir-

At a Glance

Name
ADDS Viewpoint

Use
Video terminal

Manufacturer
Applied Digital Data Systems Inc.
100 Marcus Blvd.
Hauppauge, NY 11787
(516) 231-5400

Price
$650

Dimensions
Display unit: 35.6 by 36.8 by 31.4 cm (14 by 14½ by 12⅜ inches)
Keyboard unit: 38.1 by 17.8 by 6.7 cm (15 by 7 by 2⅝inches)
Weight: 10 kg (22 lbs)

Features
Two-position, tilting display with 30.5-cm (12-inch) diagonal screen; format is 24 lines by 80 characters; displays 96 ASCII characters, plus special characters for French, German, Swedish, Danish, Spanish, and Dutch (switch-selectable), formed in a 5 by 8 dot pattern on a 7 by 10 dot matrix (lowercase letters have descenders); five visual attributes available: reverse video, half intensity, blink, underline, and video suppress; four different cursor formats; control codes provide absolute and relative cursor positioning, plus three screen-erase functions; separate 72-key Selectric-style keyboard includes numeric keypad and three function keys; RS-232C interface plus an auxiliary port; 110, 150, 300, 1200, 2400, 4800, 9600, and 19,200 bits per second switch-selectable; half or full duplex

Documentation
Viewpoint User Reference Card, Part No. 518-30400, one page; Viewpoint User's Manual, Part No. 518-30000, 40 pages; How to Maintain Viewpoint, Part No. 518-30200

Audience
Virtually all personal-computer users

ritation. One nice feature that has been included is that all keys have an auto-repeat feature. If any key is held down for more than a second, that character is repeated at a rate of about 16 cps (characters per second). The keys themselves are moderately stiff, providing good tactile feedback. I have had no problems with key bounce or missed characters.

The display screen comes in an attractive white plastic housing with nonglare black trim. An LED in the lower right-front corner of the unit lights up when power is turned on. The power switch is in back, along with a fuse holder, the telephone-style 4-wire jack for the keyboard cable, the line cord, a DIP switch, two RS-232C connectors, and a contrast control. Underneath the unit toward the back is a little fold-out stand that tilts the screen to minimize glare from overhead lighting.

The rear-panel DIP switch is one of two DIP switches in the Viewpoint (the other is located inside, on the main printed-circuit card). The outside DIP provides data-rate selection (the eight standard rates available are 110, 150, 300, 1200, 2400, 4800, 9600, and 19,200 bps), auto scrolling, auto linefeed, half or full duplex, and a choice of parity (odd, even, marking, or spacing).

The RS-232C connector marked EIA is the one used to connect your computer or modem. The connector labeled AUX can be used for another serial device, such as a printer. From the keyboard or from the host computer, the Viewpoint can be commanded to act transparently with respect to the input data stream. In this mode, everything received by the EIA port is passed directly to the AUX port without appearing on the screen. The terminal will not respond to any control commands until commanded back to the nontransparent mode.

As impressive as the Viewpoint is from the outside, it is only when you remove the top cover that you really begin to appreciate what ADDS has done. With the cover off, you look down on the main printed-circuit board. The 6.5- by 8-inch board contains only 11 integrated circuits.

ADDS had Standard Micro Systems build it a custom LSI (large-scale integration) video-controller integrated circuit. The result was a 28-pin package that streamlined the Viewpoint's design considerably. A Zilog Z8 microprocessor controls the input and output of data, and a 2K by 8-bit memory device serves as the video memory.

The remaining eight ICs are common TTL (transistor-transistor logic), including two for RS-232C interfacing. Also seen is the other DIP switch. One pole of this switch enables you to select light characters on a dark background (or vice versa). Other switches select parity enable or disable, a 50- or 60-hertz (Hz) screen-refresh rate, a steady or blinking cursor, and a box-type or underline cursor.

Also, in addition to the standard ASCII character set, six international character sets are available: Belgium/France/Azerty, Germany/Switzerland, Sweden/Finland, Denmark/Norway, Spain, and the UK/Netherlands. Some of these sets rearrange the keyboard slightly. It would have been nice if these additional symbols could have been indicated on the keyboard. You are probably thinking, "Neat, but why do I care if my terminal can type in French?" Well, foreign-language character sets open up yet another application for the personal computer. Wouldn't it be nice to have your computer drill you in French and actually be able to type your responses using the correct punctuation and characters? And as the new low-cost printers continue to add special features like foreign-language character sets (for example, the Epson MX-80), even more possibilities open up. How about word processing—*auf Deutsch*? The Viewpoint also has a switch setting for one more alternate character set. It's marked "reserved" in the documentation and appears not to be used. It would have been nice to have had APL here.

One other option can be selected. The printed-circuit board contains a place for a jumper. Soldering in a piece of wire here causes the terminal "bell" to sound each time a key is pressed. I tried this out and quickly decided it

Command	Hexadecimal Code	From Keyboard
Backspace	08	BACKSPACE or CTRL-H
Cursor Addressing, Absolute	1B 59 r c*	ESC Y 'row char' 'column char'
Cursor Down	0A	CTRL-J or SHIFT-↓
Cursor Home	01	CTRL-A or SHIFT-HOME
Cursor Left	15	CTRL-U or SHIFT-←
Cursor Right	06	CTRL-F or SHIFT-→
Cursor Up	1A	CTRL-Z or SHIFT-↑
Erase to End of Line	1B 4B	ESC K
Erase to End of Page	1B 6B	ESC k
Erase Screen	0C	CTRL-L
Keyboard Lock	1B 35	ESC 5
Keyboard Unlock	1B 36	ESC 6
Monitor Mode On	—	CTRL-1
Monitor Mode Off	—	CTRL-2
New Line	0D	CTRL-M or RETURN
Ring Bell	07	CTRL-G
Set Attribute	1B 30 x**	ESC 0 'attribute char'
Store Control Character	1B 5A	ESC Z
Tag Bit Set	0E	CTRL-N
Tag Bit Reset	0F	CTRL-O
Transparent Print On	1B 33	ESC 3
Transparent Print Off	1B 34	ESC 4

*r and c are the row and column numbers plus 20 hexadecimal. Row and column numbering begins with 0.
**x is the visual-attribute-code byte. See table 2.

Table 1: *Command codes for the ADDS Viewpoint.*

was annoying—the bell's sound is quite piercing. However, in some situations this could be a useful extra.

The bell is located inside the keyboard unit, which is another example of simplicity in design. Taking the bottom off reveals a sturdy-looking printed-circuit board with just five integrated circuits, one of which is an Intel 8021 single-chip microcomputer (the keyboard controller).

Having the keyboard as a separate unit is a feature I am appreciating more and more. My crowded workbench does not have enough room for a conventional video terminal with an integral keyboard. With the Viewpoint, however, I can position the display unit off to one side and still have ample room for the keyboard. If things are really crowded, I can even put the keyboard in my lap!

The Viewpoint's display format is the standard 24 lines of 80 characters. The display uses a white, medium-persistence phosphor. Uppercase characters are formed within a 5 by 7 matrix, but lowercase characters with descenders use another dot row to give a true lowercase format. Ten dot lines are allotted to each character row. The top row is always blank and serves to separate the character from characters in the line above it. The bottom row is used for the underline character.

Control Codes

Having covered all the hardware features, I'd now like to briefly describe the control codes recognized by the terminal (see table 1). Absolute cursor addressing is available, as are relative cursor-control commands. The three erase commands are Erase to End of Line, Erase to End of Page, and Erase Screen. The keyboard can be "locked" and will not recognize any keypresses until receiving an unlock command. A monitor mode is available that displays all control codes as underlined characters. For example, CTRL-G would appear as G. A command called Store Control Character performs the same function as the Monitor Mode command, but acts only on the next character in the data stream.

Four different visual attributes can be applied to designated portions of the screen: half intensity, blink, reverse video, and underline. These attributes can also be combined in a variety of ways to produce striking visual effects (see table 2). Video can also be suppressed entirely.

The areas of the display to be affected by the chosen visual attributes are designated by setting a tag bit associated with each character position on the screen.

Attribute	Hexadecimal Code
Normal	40
Half Intensity	41
Blink	42
Half Intensity, Blink	43
Video Suppress	44
Reverse Video	50
Reverse Video, Half Intensity	51
Reverse Video, Blink	52
Reverse Video, Half Intensity, Blink	53
Underline	60
Underline, Half Intensity	61
Underline, Blink	62
Underline, Half Intensity, Blink	63

Table 2: *Visual-attribute codes for the Set Attribute command (ESC 0 x). Four attributes—half intensity, blink, reverse video, and underline—can be combined in a number of ways, though not all combinations are included.*

Unfortunately, a selected attribute will affect all characters tagged. It is not possible, for example, to have part of the screen in reverse video and another part blinking.

Documentation

The documentation that arrived with my terminal consisted of a photocopy of the user-reference card and a postcard, addressed to the president of ADDS, for any comments I might have. However, two manuals are available as optional extras. The user's manual costs $15; the maintenance manual costs $75. Since ADDS claims a 10,000-hour MTBF (mean time between failures) rate for the Viewpoint, I decided not to get the maintenance manual right away.

Conclusions

The ADDS Viewpoint offers good performance and a number of special features for the surprisingly low price of $650. Some of these features, such as a separate keyboard and function keys, have been found only on terminals costing much more.

Human-interface considerations were taken into account in designing a two-position tilting display and a keyboard unit housed separately. This is a welcome step in the direction of making data-processing equipment more compatible with the people who will be using it, rather than requiring people to adapt to the equipment.

Function keys providing up to six unique control-code sequences enable you to customize the keyboard for a specific application. The host computer can be programmed to respond to these codes in any manner you desire. The Viewpoint has a large command repertoire, responding to the 22 ASCII command codes listed in table 1.

Six alternate character sets are switch-selectable to provide special characters and punctuation marks required by foreign languages. Although this feature was no doubt included to enhance the Viewpoint's reception by the overseas market, it also opens up possibilities for users in the United States. Used in conjunction with a printer that has foreign-language character sets, a word-processing system becomes practical for people such as translators, foreign-language students, and businesspeople doing business both here and abroad.

The well-built Viewpoint's low component count should result in good reliability and ease of repair when something does go wrong. The 10,000-hour MTBF rate works out to almost 417 days of continuous operation.

The documentation that comes with the terminal is adequate to set up the Viewpoint, but the *Viewpoint User's Manual* should be consulted to fully understand some of the commands. Unfortunately, it seems to take an inordinate amount of time to receive a copy of the manual.

For the money, I don't believe you can do better than the ADDS Viewpoint. At the same time, it's a quality piece of equipment. I recommend it to anybody looking for a low-cost, quality terminal for either personal or business use. ■

Database Management with Ashton-Tate's dBASE II

Jack L. Abbott
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At a Glance

NAME
dBASE II Version 2.02A

Type
Assembly-language relational database management system

Manufacturer
Ashton-Tate
9929 Jefferson
Los Angeles, CA 90230
(213) 204-5570

Price
$700

Format
Two disks for TRS-80 Model II, North Star, Apple II with Z80 card, IBM soft sector, single density; other formats available

Software Required
CP/M operating system, version 1.4 or 2.xx

Language
8080 machine language

System Needed
Any microcomputer with a Z 80, 8080 or 8085 processor; at least 48K bytes of memory; 24-line by 80-column display; printer required

Documentation
220-page loose-leaf manual

Audience
Anyone with a microcomputer who wants a good database-management system.

dBASE II is a database management system (DBMS) program developed by Ashton-Tate of Los Angeles, California. A DBMS program accepts data in a format you establish, sorts it in the order you desire, and excerpts, summarizes, and mathematically manipulates the data as required. The program then presents the data in the format (report) that you set up. The report can be in the form of a table, a check, an invoice, or any similar document. Potential uses for a DBMS program are broad and include form generation, mailing lists, check writing, inventory, and accounting.

You can use the trial disk for up to 30 days and still return the dBASE II package for a refund.

Because a DBMS is designed to handle applications ranging from simple to very complex, any review must be general in nature. Ashton-Tate has a novel promotional offer that should help you determine if this rather expensive ($700) program will suit your particular application. If you order the dBASE II package you'll receive a trial disk as well as the conventional distribution disk. The trial disk can handle only a limited number of data records, but in other respects it's identical to the regular dBASE II disk. You can use the trial disk for up to 30 days and still return the dBASE II package for a refund. When you open the envelope containing the dBASE II disk, the sale becomes final.

Listing 1: *A listing of the display invoked by dBASE II's CREATE command. This display helps the user set up a format for input. The number of each field appears at left, followed by its data type, its width, and (optionally) its number of decimal places. Data types are "C" for character, "N" for numeric, and "L" for logical.*

```
ENTER FILENAME: MOBINV
ENTER RECORD STRUCTURE AS FOLLOWS:
 FIELD    NAME,TYPE,WIDTH,DECIMAL PLACES

 001      STOCK:NU,C,15  REMARK: This comment does not appear
 002      SUPPLIER,C,15          on the display. Field # 1 is
 003      MODEL,C,10             Stock Number, C-a character field
 004      ORD:DATE,C,9           , 15 characters in length.
 005      REC:DATE,C,9           Field # 4 is Order Date, # 5 is
 006      COST,N,10,2            Received Date, # 7 is Sale Price
 007      SELL:PR,N,10
 008
INPUT DATA NOW? N
```

dBASE II is a "relational" DBMS as opposed to the more common "tree" or "hierarchical" type. It's beyond the scope of this article to discuss these different types in detail, but I will say now that a well-designed relational DBMS is fast and eliminates a considerable amount of the program overhead required by some other types. At the end of this article, I will touch on the differences among the major types of DBMS programs.

dBASE II requires CP/M operating system version 1.4 or 2.xx and 48K bytes of memory. Z80-, 8080-, or 8085-based microcomputers are required because the program is written in machine language. Among the many computers using these processors are the TRS-80 Model II, North Star, Dynabyte, Vector Graphic, and the Apple II (with the Z80 card). Most applications of dBASE II require disk drives with a total storage capacity of at least 300K bytes. Simple programs can be developed without a printer, but for complex program design or extensive report output a printer is essential. dBASE II also requires a display terminal with at least 24 lines and 80 columns and an addressable cursor.

The program documentation contains two manuals in one book. The first is a narrative description and the second a programmer's manual. I found it necessary to review the pertinent portions of both manuals to understand some of the program functions. It would help if the document were indexed or if the two sections were consolidated. Much of the program description is excellent, but some operations are not described in sufficient detail. In a few instances commands and their descriptions differ from one section to another.

To install the program you use a menu to indicate what kind of equipment you have. You then follow the narrative portion of the documentation to establish the format for data input. I developed a mobile-home inventory program to help me learn how to use dBASE II and to demonstrate some of the program's functions. I finished the program less than three hours after I received the dBASE II package. This is quick indeed and speaks well for both the documentation and the DBMS design.

Listing 2: *A listing of dBASE II's display that prompts the user for input. The prompts at left request data on each of the fields in accordance with the user's design of the input format (as shown in listing 1). The colons show the extent of each field.*

```
RECORD #      :00001

STOCK:NU      :               :
SUPPLIER      :               :
MODEL         :          :
ORD:DATE      :          :
REC:DATE      :          :
COST          :           :
SELL:PR       :           :
```

Developing an Inventory Program

The first step in developing the inventory program was to establish the input data format. All the fields (items of information) pertaining to a single mobile home comprise a record. All the records taken together make up a file. dBASE II can have up to 65,345 records per file and up to 1000 characters per record divided among a maximum of 32 fields. No single field can be longer than 254 characters.

To begin establishing an input data format, you type the command CREATE, and get the first three lines of display like the printout shown in listing 1.

After determining the fields' names, lengths, and types—"C" for character, "N" for numeric, or "L" for logical (true or false)—entering data is simply a matter of typing it in. The program gives prompts to ensure that only legal entries are made. With the excellent full-screen editor, you can move the cursor around the display at will and then type in new parameters at the cursor location. In a display like the printout shown in listing 1, the last line of the display is "INPUT DATA NOW?" You can enter data records directly at that time or later by entering the command APPEND. Either choice generates

Listing 3: *dBASE II's output reflecting data entered on five different records. Each record from number 1 through 5 has seven fields describing a mobile home: stock number, supplier, model, order date, received date, cost, and selling price (listed on a second line in every case). dBASE II made this listing in response to the LIST command.*

```
00001  1234567XYZ   PALM HARBOR  2BR3BA60F  01/05/81 02/20/81  14375.75
18000
00002  123456XYZ    NASHUA       1BR15B40F  03/02/81 04/06/81  12789.00
16000
 0003  23456MNB     LAYTON       2BR1BA40F  01/03/81 02/04/81  14000.00
18585
00004  234567ABCDE  AIRSTREAM    EXCELLA    01/06/81 03/06/81  21000.00
24000
00005  TRW14578     SKYLINE      2BR1BA79F  04/03/81 05/08/81  24987.65
31650
```

a display like the printout shown in listing 2.

The next step in using the inventory program is to type in the information for each mobile home. The full-screen editing feature and a global edit (all records or selected records of the entire file) are available to make any changes required. The RECORD # is assigned and incremented by the program automatically. Listing 3 shows five data records I entered. This display was obtained in response to the dBASE II command LIST.

Manipulating Data

You can manipulate data in individual records or globally. Data manipulations supported include mathematical (+, −, /, and *), relational (>, <, =, etc.), and logical (not, and, or). dBASE II permits any reasonable data manipulation. Three examples follow: (1) SELL:PRI (sale price) can be multiplied by 1.05 globally to include a 5 percent sales tax in all sale prices; (2) I could have included additional fields called QUANTITY and TOTAL:PR (total price) in the input record structure and then multiplied QUANTITY by COST and deposited the result in TOTAL:PR; (3) The relational and logical functions permit selection of individual records or groups of records. I can select all mobile homes supplied by

Listing 4: *A report generated by dBASE II's REPORT command. This report presents almost the same information as listing 3, but uses a clearer format and provides totals of costs and sale prices.*

```
                         MOBILE HOME INVENTORY REPORT

    DATE         STOCK NO.           SUPPLIER           COST      SALE PRICE
    RCVD.

   02/20/81  1234567XYZ        PALM HARBOR          14375.75        18000
   04/06/81  123456XYZ         NASHUA               12789.00        16000
   02/04/81  23456MNB          LAYTON               14000.00        18585
   03/06/81  234567ABCDE       AIRSTREAM            21000.00        24000
   05/08/81  TRW14578          SKYLINE              24987.65        31650

  ** TOTAL **
                                                    87152.40       108235
```

Nashua and Skyline and increase their sale price by 20 percent by entering this command:

REPLACE ALL SELL:PR WITH SELL:PR/.8 FOR SUPPLIER='NASHUA' .OR.; 'SKYLINE'

It's possible to sort the file using a field of any type other than logical. As an alternative, dBASE II will index the file. This feature lets you sort all the records by using only the data in one user-specified "key" field. A record can then be retrieved very quickly because only the key-field data need be searched, as opposed to all the fields of each record in the file. I used a 2000-record, 4000-field simulated database to test this DBMS and located individual records within an unbelievable 2 seconds. After locating the desired record, you can then display as many more sequential records as you wish by entering the command DISPLAY NEXT ##. This speed and versatility means that real-time updates are easy to do. You can search an inventory file for a specific item (record) in seconds. You can edit the record in a few more seconds to reflect any changes in quantity or reorder requirements, for example.

Files generated by CP/M use a standard data format (SDF) while CBASIC and many other languages generate delimited formats. dBASE II includes a program module to convert either format to or from the file structure used by dBASE II. This is a very useful feature. The user must be certain that the dBASE II file structure field lengths are the same as those of the foreign file being converted to the dBASE II format. Selected fields from two different databases may be combined to form a third database by use of the command JOIN.

Making Reports

This brings us to the report function. Using the index feature you can find and list individual or sequential groups of records within a few seconds. Individual or nonsequential groups of records can be selected from a 2000-record database within two or three minutes using the logical and relational commands. dBASE II uses the CP/M convention of control P to initiate and terminate listing on the printer of the records or other information you have selected. In addition, dBASE II has a REPORT command that does a limited amount of formatting and totaling of field data. The program leads you through definition of the report format. Listing 4 shows a typical report generated by this command.

Using the features reviewed up to this point, anyone familiar with CP/M can create in a few hours a dBASE II program that matches the complexity of the program that I have described.

Command Files

The preceding mobile-home-inventory DBMS program used individual commands. By using a word processor or editor (not included in dBASE II), you can group commands in a command file. Ashton-Tate says it will in the future build in the ability to create command files.

It's necessary for you to learn the dBASE II structured programming language to develop a comand file. If you name the mobile-home command file MOBINV.CMD, you could call it by typing DO MOBINV. You can structure a command file to provide a menu selection of the action wanted, including add, delete, edit records, and print a report. One command file may include up to 16 calls to other command files. You could also post the appropriate dollar figures to an accounting file for processing by another DBMS-program module.

In addition, a command file can generate a more sophisticated report than the REPORT command. A series of instructions places the data items at specific locations on the terminal or printer page. The row (line) and column positions are designated as grid coordinates. The real-time update of the inventory program mentioned earlier could be included in the command file and an invoice or receipt printed along with the search and adjustment of the inventory.

Advantages of the Relational DBMS

dBASE II is a "relational" DBMS in which each data record in a file effectively (but may not actually) contains all the data fields necessary for a group of application programs. The application programs all operate as an integral part of one DBMS rather than as numerous autonomous modules. Pointer files are eliminated, and that reduces program overhead and complexity. This design, combined with machine-language programming, results in a very fast, efficient DBMS. Because the whole structure is integrated, limiting access for security purposes in multiuser systems can be a problem. James Martin's *Principles of Data-Base Management* (Prentice-Hall, 1976) is one of many books that gives a thorough evaluation of the different types of DBMS programs.

Conclusions

Both fast and versatile, dBASE II is a superb program with generally excellent documentation. A newcomer to computing can easily develop a DBMS program with all the features of the mobile-home inventory example. I did extensive testing with a 4000-field database and found no program breakdowns or deficiencies. The dBASE II structured programming language lets you present or enter data in specialized formats such as mailing lists, checks, and invoices. You must, however, provide your own word processor or editor program if you're going to generate command files.

dBASE II can do real-time updates of the database. This can be of great value, particularly for inventory applications. But if you are in a multiuser environment you might have security problems because the database information may be available to all users.■

Clubs and Newsletters

TRACE

The Toronto Region Association of Computer Enthusiasts (TRACE) is a nonprofit organization for anyone interested in computing. Yearly dues are $13, which includes *The TRACE Newsletter* and admission to group meetings. The newsletter is available separately for $5 a year. Noncommercial ads are free with paid subscriptions. Contact *TRACE*, POB 6922, Station A, Toronto, Ontario M5W 1X6, Canada.

Hobbyists Meet in the Land of Lincoln

The Woodsfield Area Computerist Organization (WACO) is whacko about all types of computers: TRS-80s, Ataris, 6800s, Heaths, and Z80s. The club has a large number of special-interest groups and a large publication known as the *WACO Post*. The *Post* is packed with software reviews, information on bulletin-board systems, and programming hints. The club meets monthly at the downstairs meeting room in the Schaumburg Public Library. Annual dues are $6, which includes a subscription to the newsletter. Contact WACO, Steve Gibson, 723 Sunfish Point, Schaumburg, IL 60194.

Sorcerer's Apprentice

The Sorcerer's Apprentice Users Group produces a newsletter eight times a year. The newsletter is packed with information for Sorcerer users of all degrees of expertise. The group maintains a computerized bulletin-board system in the Detroit, Michigan, area. Membership in the group is open to Sorcerer users world-wide. Annual dues are $18 in the United States, $24 in Canada and Mexico, and $32 elsewhere. In the Detroit area, the bulletin-board system can be accessed by calling (313) 535-9186 (ring-back). For further information, contact the Sorcerer's Apprentice, POB 33, Madison Heights, MI 48071; or contact the group president, Don Gottwald, at (313) 286-9265.

Amateur Group in Washington

Membership in the Washington Amateur Computer Society is open to anyone in the Washington, D.C., area interested in amateur computing. Dues are $3.50 per year. The society produces a newsletter, *The Journal of the Washington Amateur Computer Society*, and is working on a hardware message system for the publication. The newsletter has information on club meetings, industry happenings, and projects. Contact the Washington Amateur Computer Society, 4201 Massachusetts Ave., #168, Washington, DC 20016.

Heath Fans Meet in Pacific Northwest

The Pacific Northwest Heath Users Group (PNHUG) meets on the first Monday of even-numbered months at the Heathkit Center, 505 8th Ave. North, in Seattle, Washington, at 7 p.m. On odd-numbered months, the group meets on the second Thursday at the Heathkit Center, 15439 53rd Ave. South, in Tukwila, Washington, also at 7 p.m. For more information, contact PNHUG, Nathan A. Hall, POB 993, Bellevue, WA 98009, (206) 363-3927.

Michigan Hobbyists Are Active

The South Eastern Michigan Computer Organization (SEMCO) meets on the second Sunday of the month at the Ford Automotive Safety Center Auditorium at 7 p.m. The group produces a monthly newsletter, *Data Bus*, that is packed with hardware and software reviews and notes from special-interest groups. SEMCO operates a 300-bit-per-second message service that allows members to send and receive messages, write BASIC programs, execute stored programs such as games, and access the Michigan Occupational Information System. Membership in SEMCO costs $10 per year, which includes a subscription to the *Data Bus*. Contact SEMCO, POB 02426, Detroit, MI 48202.

Superletter

Superletter is an international newsletter devoted to the Intertec Superbrain and Compustar computers. *Superletter* is packed with technical news, accessory ideas, and CP/M software designs for the Superbrain. Other features include a technical corner, a question-and-answer forum, news from the Intertec factory, interviews, and classified ads. A subscription to the *Superletter* offers readers the opportunity to shop for enhanced PROMs (programmable read-only memories), advanced BIOS (basic input/output subsystems), graphic packages, and other hardware and software products. Annual subscription rates are $20 in the U.S. and $35 elsewhere. For complete details, contact *Superletter*, POB 3121, Beverly Hills, CA 90212, (213) 277-2410.

SCAN Eyes Computers in Arts

SCAN: Small Computers in the Arts News keeps a watchful eye on the use of small computers in the arts. It's filled with news of products, software, hardware, books, events, and people in the news. *SCAN* also acts as a clearinghouse for those interested in using small computers in the arts. Subscriptions cost $8 per year (10 issues). Further information is available from *SCAN*, POB 1954, Philadelphia, PA 19105.■

BYTE's Bits

Win a Compupro Board

Sluder, a Compupro systems center, is running a sweepstakes in which three winners will be awarded an assembled and tested Godbout Compupro CPU 8085/8088 processor board. To enter, send your name and address on a 3- by 5-inch postcard to Sluder, POB 951, Westminster, CA 92683. The drawing will be held on July 16, 1982; winners will be notified by mail. Employees of Godbout Electronics and anyone with the last name Sluder are ineligible.■

Software Received

Apple

Apple Flasher, a utility program for developing high-resolution graphics for the Apple II. Floppy disk, $34.50. Crow Ridge Associates Inc., POB 90, New Scotland, NY 12127.

Audex, a collection of utility programs to create, edit, and play sounds for the Apple II. Floppy disk, $29.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

Deadline, an interactive role-playing program for the Apple II. Floppy disk, $49.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

DOS File Exchange, a telecommunications software package for the Apple II Plus. Floppy disk, $45. Arrow Micro Software, 11 Kingsford, Kanata, Ontario, K2K 1T5, Canada.

8080/8085 Assembler, a cross-assembler for the Apple II. Floppy disk, $39. A.M.I. Electronics, 851 Richmond Rd., Lyndhurst, OH 44124.

Estate Tax Plan, a program package to solve complex estate tax-planning problems for the Apple II. Floppy disk, $695. Aardvark Software Inc., 783 North Water St., Milwaukee, WI 53202.

GraFORTH, a graphics programming language for the Apple II. Floppy disk, $75. Insoft, Suite 202B, 10175 Southwest Barbur Blvd., Portland, OR 97219.

The Graphics Magician, a graphics development package for the Apple II. Floppy disk, $59.95. Penguin Software, 830 4th Ave., Geneva, IL 60134.

Hungry Boy, an arcade-type game for the Apple II. Floppy disk, $24.95. Cosmos Astar International Co., 5676 Francis Ave., Chino, CA 91710.

IFR Flight Simulator, an instruments-only, air-flight simulator for the Apple II. Floppy disk, $50. Programmers Software Exchange, POB 199, Cabot, AR 72023.

Kabul Spy, an adventure-type game for the Apple II Plus. Floppy disk, $34.95. Sirius Software Inc. (see address above).

Micro-Window, a 6502 machine-language training and development program for the Apple II Plus. Floppy disk, $120. Window Research, Suite #218, 13452-A Northeast 175th, Woodinville, WA 98072.

Minotaur, an arcade-type game based on the ancient Greek myth for the Apple II. Floppy disk, $34.95. Sirius Software Inc. (see address above).

Payfive, a flexible payroll and accounting system for the Apple II Plus. Floppy disk, $149.95. Dynacomp Inc., 1427 Monroe Ave., Rochester, NY 14618.

Photar, an arcade-type game for the Apple II. Floppy disk, $29.95. Softape, 10432 Burbank Blvd., North Hollywood, CA 91601.

Routeplanner, a trip-planning program for deliveries or salespersons for the Apple II. Floppy disk, $149. Columbia Software, 5461 Marsh Hawk Way, POB 2235, Columbia, MD 21045.

Snack Attack, an arcade-type game for the Apple II. Floppy disk, $29.95. Datamost, 19273 Kenya St., Northridge, CA 91326.

Star Blaster, an arcade-type game for the Apple II. Floppy disk, $29.95. Piccadilly Software Inc., 89 Summit Ave., Summit, NJ 07901.

Star Blazer, an arcade-type game for the Apple II. Floppy disk, $31.95. Broderbund Software Inc., 1938 Fourth St., San Rafael, CA 94901.

Suicide, an arcade-type game for the Apple II. Floppy disk, $29.95. Piccadilly Software Inc. (see address above).

Atari

Baccarat, a card game for one to three players for the Atari 800. Floppy disk, $22.95. Dynacomp Inc., 1427 Monroe Ave., Rochester, NY 14618.

Backgammon 2.0, a one- or two-player version of the board game for the Atari 800. Floppy disk, $18.95. Dynacomp Inc. (see address above).

Caverns of Mars, an arcade-type game for the Atari 400/800. Floppy disk, $39.95. Atari, 1265 Borregas Ave., Sunnyvale, CA 94086.

Chicken, an arcade-type game for the Atari 400/800. Cassette or floppy disk, $29.95. Synapse Software, 820 Coventry Rd., Kensington, CA 94707.

Deluxe Invaders, an arcade-type game for the Atari 400/800. Floppy disk, $34.95. Roklan Corp., 10600 West Higgins Rd., Rosemont, IL 60018.

Escape from Volantium, an arcade-type game for the Atari 800. Floppy disk, $19.95. Dynacomp Inc. (see address above).

The Family Budget, a personal financial-management package for the Atari 800. Floppy disk, $34.95. Dynacomp Inc. (see address above).

The Graphics Machine, a graphics utility program for the Atari 800. Floppy disk, $19.95. Santa Cruz Educational Software, 5425 Jigger Dr., Soquel, CA 95073.

Go Fish, the children's game for one player for the Atari 800. Floppy disk, $18.95. Dynacomp Inc. (see address above).

Lil' Men from Mars, an arcade-type game for the Atari 800. Floppy disk, $23.95. Dynacomp Inc. (see address above).

Mailmaster, a mailing-list utility program for the Atari 800. Floppy disk, $39.95. Dynacomp Inc. (see address above).

Protector, an arcade-type game for the Atari 400/800. Floppy disk, $29.95. Synapse Software (see address above).

Stockaid, a stock performance-analysis program for the Atari 800. Floppy disk, $29.95. Dynacomp Inc. (see address above).

Teacher's Aide, a tutorial package covering elementary mathematics for the Atari 800. Floppy disk, $17.95. Dynacomp Inc. (see address above).

Tricky Tutorials, a six-lesson package covering advanced programming for the Atari 400/800. Floppy disk, $99.95. Santa Cruz Educational Software (see address above).

Turnkey and Menu, an auto-execute utility for BASIC programs for the Atari 800. Floppy disk, $17.95. Dynacomp Inc. (see address above).

CP/M

68000 Disassembler, a disassembler for 68000 systems based on the Motorola Exormac. 8-inch floppy disk, $200. Norsoft Consultants, Veungsdalveien 1, 3600 Kongsberg, Oslo, Norway.

The Programmer's Apprentice, a program-development system for creating MBASIC source programs for CP/M. 8-inch floppy disk, $800. The Software Group, 10471 South Brookhurst St., Anaheim, CA 92804.

PET

Genesis, a program to develop computer-assisted instructions for the PET/CBM. Cassette, $30. Greenwood Software, 1214 Washington, The Dalles, OR 97058.

Phantom Figher, an arcade-type game for the PET/CBM. Cassette, $14.95. Magic Carpet, POB 35115, Phoenix, AZ 85069.

Pharmacology Update, a tutorial package for health-care professionals for the PET/CBM. Floppy disk, $149.95. Dynacomp Inc., 1427 Monroe Ave., Rochester, NY 14618.

Star Voyager, an arcade-type game for the PET/CBM. Cassette, $9.95; floppy disk, $12.95. Paul Yates, 1955 Shady Brook Lane, Morgan Hill, CA 95037.

Vortex, an arcade-type game for the PET/CBM. Cassette, $14.95. Magic Carpet (see address above).

TI-99/4

Space Spiders, an arcade-type game for the TI-99/4. Cassette, $9. Glo-Data, POB 374, Stony Point, NY 10980.

Video Titles I, a program to produce customized titles for video recordings for the TI-99/4A. Floppy disk, $24.95 J & KH Software, 2820 South Abingdon St., Arlington, VA 22206.

TRS-80

BASIC Faster and Better Demonstration, a software library of demonstration programs for use with the book *Faster and Better & Other Mysteries* for the TRS-80 Models I and III. Floppy disk, $19.95. IJG Inc., 1260 West Foothill Blvd., Upland, CA 91786.

BASIC Faster and Better Library, a software library of routines for use with the book *Faster and Better & Other Mysteries* for the TRS-80 Models I and III. Floppy disk, $19.95. IJG Inc. (see address above).

Battle Trek, a Star Trek-type game for the TRS-80 Models I and III. Cassette, $29.95. Voyager Software, POB 15-518, San Francisco, CA 94115.

Ghost Gobbler, an arcade-type game for the TRS-80 Color Computer. Cassette, $21.95. Spectral Associates, 141 Harvard Ave., Tacoma, WA 98466.

Gradebook 2.0, a disk-based gradebook program for the TRS-80 Models I and III. Cassette, $34.95. MM Computer Club, 333 75th St., Downers Grove, IL 60516.■

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.

Ask BYTE

Conducted by Steve Ciarcia

Computer-Controlled Irrigation

Dear Steve,

I'm about to dive into building a Z8-BASIC Microcomputer, mainly as an irrigation control for my almond ranch. (See "Build a Z8-Based Control Computer with BASIC," Part 1, July 1981 BYTE, page 38 and Part 2, August 1981 BYTE, page 50.) Before I proceed, however, I would appreciate knowing if the Z8 would operate off the 25-pin parallel 4-bit interface bus on a Heath ID-4001 Digital Weather Computer. The program would use inputs to control an assortment of mechanically stepped irrigation valves.

I have talked with Heath about its rain gauge, but I find it expensive because it duplicates the Weather Computer in many respects. A moisture-gauge input to the Z8 would be preferable, and the 25-pin bus has four extra pins plus ground, so I am thinking about combining the inputs into a single port.

A.A. Boon-Hartsinck
Burbank, CA

The concept of using the Z8-BASIC Microcomputer as an irrigation control is an excellent application. The Z8 has enough ports to connect with moisture gauges and data from the Heath ID-4001 Weather Computer (or any other computer, for that matter). Information on an A/D (analog-to-digital) converter appeared in my August 1981 BYTE article.

The February 1982 BYTE contained an article on interfacing the Z8-BASIC Microcomputer to wind-speed, wind-direction, and barometric-pressure instruments (à la Heath), as well as to a voice synthesizer. (See "Build a Computerized Weather Station," page 38.) . . . **Steve**

ZX81 for Home Control

Dear Steve,

In one of your Circuit Cellar articles, you discussed methods of controlling the BSR X-10 command console with a dedicated microprocessor. (See "Computerize a Home," January 1980 BYTE, page 28.) In another, you dealt with a home-security system using a computer for control. (See "Build a Computer-Controlled Security System for Your Home," Part 1, January 1979 BYTE, page 56; Part 2, February 1979 BYTE, page 162; Part 3, March 1979 BYTE, page 150.) Can the Sinclair ZX81 be used for either of these purposes, and, if so, how much modification would be required? What would be the total memory requirements, additional I/O ports, and so on to set up such a system? Also, would this system work with a single- or dual-cassette configuration?

J.W. Rankin Jr.
Memphis, TN

The Sinclair ZX81 has full expansion capabilities because the system buses are brought out to its rear connector and are available for many interfacing applications, including a BSR X-10 controller. It is advisable to buffer the output lines if more than one integrated circuit is to be driven. The unit can be mapped wherever there is free memory. The ZX81 can be used to control a single- or dual-cassette drive.

If you want additional I/O capabilities, an expansion unit can be built that would provide buffered address and data lines, serial and parallel printer ports, and any other ports as desired. The COMM-80 (see "I/O Expansion for the TRS-80," June 1980 BYTE, page 42) will satisfy most of these needs and can be adapted to the ZX81 without great difficulty. . . . **Steve**

Current Overloads

Dear Steve,

I have an early model Radio Shack TRS-80 Color Computer with a 32K-byte memory upgrade from Spectral Associates. After about four hours of continuous use, the computer overheats and ceases to function. I have installed a fan, which seems to help a lot, but I feel there's something else I should do. The on/off switch turns off the power from the supply transformer to the computer, but does not disconnect the transformer from the AC line. Should it be unplugged when not in use?

Roland C. Wong
West Covina, CA

I spoke with Radio Shack about your overheating problem. Its technicians concluded that the problem is due to the added memory. Let me explain: while the average current requirements of 4116-type memory are low, the pulse currents are high. You may be causing the power supply to enter a current-limit condition. You can verify this hypothesis by carefully removing the add-on memory and noting if the problem vanishes.

It appears that there is just a little too much current being drawn (and heat generated) by the extra memory. The fact that the fan eliminates the problem and that the problem takes four hours to occur substantiates this. The simplest, and cheapest, solution is to live with the fan (just keep your tapes away from the motor).

It is true that the transformer is left "live" when the unit is shut off. While this will not hurt anything, the transformer will draw a small amount of current; in the interest of energy conservation, unplug it. . . . **Steve**

Redefining Atari Characters

Dear Steve,

I want to redefine the characters on my Atari 800. Do you have any hints on how to do this, or do you know where I can find the software? The number of characters I need is between 48 and 100.

Russ Burrough
Edmond, OK

Compute! *magazine (POB 5406, Greensboro, NC 27403, (919) 275-9809) recently carried two articles that should answer your questions about redefining characters on the Atari 800. The first, "Character Generation on the Atari," by Charles Brannon, appeared in the February 1981 issue (page 76) and the second, "Designing Your Own Atari Character Sets," by Craig Patchett, appeared in the March 1981 issue (page 72). . . .* **Steve**

Making the Board Connection

Dear Steve,

I recently purchased a full ASCII (American Standard Code for Information Interchange) keyboard with cursor-control keys, numeric lock, and alpha lock. It has a 15-pin edge connector and an empty 40-pin DIP (dual-inline pin) socket. It came without documentation of any kind, but is marked as follows:

MAXI SWITCH
3103-002-03

How can I fill the socket and connect this to my computer?

Maynard J. Hartman Jr.
Point Mugu, CA

Your keyboard probably uses one of two types of popular encoders: the KR-2376 or the KR-3600 (part numbers as used by Standard Microsystems Corporation, Hauppauge, New York). They are very similar, and the only way you will be able to tell which is used will be to compare their pin assignments in the manufacturer's specification sheets to the layout of the board.

Even if one of these matches properly, that still may not be enough. These encoders can often be "semicustom"-programmed and, although the part number is correct, the pattern in the internal ROM (read-only memory) may not suit your keyboard.

Determining the connector pinout and signals must be done by sheer tedium. Follow the V_{cc}, V_{ss}, and signal lines from the encoder to the connector. Once you have this data, you will also have the connector pinouts. You may also want to refer to "Deciphering Mystery Keyboards" by Carl Helmers in the September 1975 BYTE, page 62. . . . **Steve**

Battery-Operated Apple

Dear Steve,

I have an Apple II with a disk drive, 48K bytes of memory, and an NEC 12-inch green-phosphor monitor. I'm using it to help design agricultural systems, home design, scheduling projects, accounting, etc.

While planning a venture that includes solar-generated electricity, battery storage, and a 12-V (volt) electrical system, I suddenly realized that the computer was helping me design itself right out of business. The more I thought about running the computer on 12 V, the more sense it made. In Puerto Rico, we have a lot of power outages and voltage surges, so running a computer from batteries would solve these problems.

Surely there must be a relatively simple way to power my Apple and disk drive from a 12-V source. A monitor appears to be no problem: there's a lot of battery-operated TVs on the market.

Have you got any nifty circuits up your sleeve that will solve my problem?

Chris Stearn
Mayaguez, Puerto Rico

The simplest way to power your Apple II from a 12-V source is to use an inverter. Radio Shack, for example, sells a 300-watt power inverter (catalog number 22-130; the suggested price is $99.95) that will power your entire system, but any inverter rated at 100 watts or more will suffice.

The Apple II uses +5-V and +12-V supplies that can be obtained directly from a battery through a regulator (remember, a lead/acid 12-V battery is actually 13.6 V). The Apple II also requires −5 V and −12 V, which can be generated using a DC-to-DC converter from either the +5-V or +12-V supplies. In the October 1978 BYTE, I wrote an article that explained how to build such a converter. (See "No Power for Your Interfaces? Build a 5-Watt DC-to-DC Converter," page 22.) . . . **Steve**■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:
Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury CT 06033
If you are a subscriber to The Source, send your questions by electronic mail or chat with Steve (TCE317) directly. Due to the high volume of inquiries, personal replies cannot be given. Be sure to include "Ask BYTE" in the address.

Event Queue

July 1982

July
Courses from Integrated Computer Systems, various sites throughout the U.S. Among the courses being offered are "Microprocessor Software, Hardware, and Interfacing," "Hands-on Microprocessor Troubleshooting," "Speech Synthesis and Recognition," and "Digital Image Processing and Analysis." Complete course listings including dates, locations, course outlines, and fees are available from Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

July
Technical Classes from Zilog, Campbell, CA. Zilog is offering a series of one- to five-day technical classes at its California-based training facility. Topics range from "Microprocessors: A General Introduction" to "C Programming." Contact Zilog, Training and Education Dept., 1315 Dell Ave., Campbell, CA 95008, (408) 446-4666.

July
New York University SEHNAP Summer Sessions, New York University, New York, NY. Among the courses being offered by the School of Education, Health, Nursing, and Arts Professions (SEHNAP) are "Introduction to Computer Technology" and "New Technology for Interactive and Individualized Instruction." These graduate-level courses are designed for teachers, administrators, and other professionals. For more information, contact NYU-SEHNAP Summer Sessions, 60 Press Building, New York University, New York, NY 10003, (212) 598-2772.

July-August
Database Concepts and Design, various sites throughout the U.S. Sponsored by the American Management Associations (AMA), this five-day seminar is designed for data-processing managers, system designers, and other personnel involved in database activities. Topics include an overview of the database environment; evaluating and measuring performance, costs, and results; determining organizational needs and the systems and software to meet them; and implementing, integrating, and supporting the database within company plans and budget. Highlighting this seminar is a comprehensive review of database products. Individual fees are $850 for AMA members and $975 for nonmembers. Team discounts are available. Contact AMA, 135 West 50th St., New York, NY 10020, (212) 586-8100. To register by phone, call (212) 246-0800.

July-August
Engineering Summer Conferences, Chrysler Center for Continuing Engineering Education, North Campus, University of Michigan, Ann Arbor, MI. Among the conferences being offered are "Robotics: Concepts, Theory, and Applications," High-Speed Computation: Vector Processing," and "Computer Image Analysis." For complete details, contact Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490.

July-August
Summer Seminars from Datapro Research, various sites throughout the U.S. and Canada. Among the seminars being offered are "Using Computer-Aided Design/Computer-Aided Manufacturing Systems: Planning, Equipment Selection, and Applications," "Microcomputer Systems: A Guide to Selection and Application," and "Data Administration: Successful Techniques." Enrollment fees are $640 for Datapro subscribers and $690 for nonsubscribers. For more information, contact Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

July-December
IEEE Computer Society Conferences and Meetings, various sites throughout the U.S., Europe, and Asia. Events scheduled include "Symposium on Reliability in Distributed Software and Database Systems," "Computer Vision: Representation and Control," and "The Annual Workshop on Computing to Aid the Handicapped." For a complete listing of conferences and meetings, contact the Executive Secretary, IEEE Computer Society, POB 639, Silver Spring, MD 20901, (301) 589-3386.

July 11-15
The International Manufacturing Systems Conference '82, Convention Center, Buffalo, NY. The conference theme is "The Technology of Productivity." More than 100 experts will conduct seminars on a wide variety of topics. Exhibits, vendor presentations, and plant tours are planned. Contact Roy Combs, International Manufacturing Systems Conference, 186 North Water St., Rochester, NY 14604, (716) 232-3950.

July 11-25
The Twelfth Annual Summer Institute for Media Arts, Endicott College, Beverly, MA. A wide variety of seminars and workshops will be offered, including computer animation, video production, and computer graphics. For more information, contact the Summer Institute for Media Arts, POB 83, Lincoln Center, MA 01773, (617) 259-0068.

July 12-16
The Electronic Arts of Sound and Light, University of California, Santa Barbara, CA. This hands-on seminar will emphasize the principle concepts of electronic arts and their relationships in theory, performance, practice, and the creative process. Topics of interest include the nature of waves, psychoacoustics, psycho-optics, the synthesizer, the computer, and oscillographics. The agenda includes lectures, demonstrations, and an intermedia concert. The seminar fee is $425. For complete details, contact Gina Garcia, University of California Extension, Santa Barbara, CA 93106, (805) 961-3231.

July 13-14
Controlling Electromagnetic Interference, Hyatt Hotel at LA Airport, Los Angeles, CA. This seminar is sponsored by *Electronics* magazine, a McGraw-Hill publication, and is designed for electronic industry professionals who must make technical or cost decisions based on an understanding of electromagnetic interference. Topics of discussion include intersystem problems, designing against environmental noise, how to determine the best frequency for a given application, and the structure and use of intrasystem electromagnetic compatibility models. The fee is $595; in-plant programs can be arranged. Contact Ms. Barbara Bancroft, McGraw-Hill Seminar Center, Room 3112, 305 Madison Ave., New York, NY 10017, (212) 687-0243.

July 14-17
Data Dictionaries, Marina City Club, Los Angeles, CA. The fee for this course is $750. For details, contact the Continuing Education Institute, Suite 1000, 10889 Wilshire Blvd., Los Angeles, CA 90024, (213) 824-9545.

July 18-22
The Fourth General Assembly of the World Future Society, Sheraton Washington Hotel, Washington, DC. The conference theme is "Communications and the Future." All areas of the communications field from telecommunications to interpersonal communication will be covered. The impact of new technologies on society will be explored. Contact the World Future Society, 4916 St. Elmo Ave., Bethesda, MD 20814, (301) 656-8274.

July 19-21
Summer Computer Simulation Conference (SCSC), Marriott City Center Hotel, Denver, CO. The SCSC covers all aspects of computer simulation methodology and applications. Technical sessions and presentations on mathematical methods, model design, simulation languages, and validation techniques will be featured. Information is available from Harvey Marks or Philicia Marks, Transaction Technology Inc., 7648 Capistrano Ave., Canoga Park, CA 91304, (213) 346-5376.

July 21-23
The Computer: Extension of the Human Mind, Eugene Hilton Hotel, Eugene, OR. This conference is sponsored by the University of Oregon College of Education. Workshops, speakers, and presentations on the use of computers in education will be held. Topics of interest include preparing teachers to teach with computers, the ethical and social issues associated with computers, and how computers assist learning. The conference fee is $95; students enrolled in the university's summer session can register for $55 and earn a single credit hour. For additional information, contact Judy Ohmer, College of Education, University of Oregon, Eugene, OR 97403, (503) 686-3405.

July 25-30
The Fifth Annual Harvard Computer Graphics Week, Hyatt Regency Hotel, Cambridge, MA. Conference presentations will focus on computer mapping, image processing, graphic communications, and information resources. For further details, contact the Conference Manager, Special Programs, Harvard University, Graduate School of Design, 48 Quincy St., Cambridge, MA 02138, (617) 495-2578.

July 26-30
SIGGRAPH '82: The Ninth Annual Conference on Computer Graphics and Interactive Techniques, Boston, MA. This conference is sponsored by the ACM SIGGRAPH (Association for Computing Machinery Special Interest Group on Computer Graphics). More than 140 exhibitors will display the latest in computer-graphics hardware, software, and services. A series of courses and technical sessions on a variety of topics will be offered, including device-independent graphics software, low-cost graphics, business graphics, solid modeling, and computer-aided design. Other features include a multimedia computer-graphics art show and computer-generated films. For information, contact SIGGRAPH '82, Convention Services Department, 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610.

July 27-30
Database Systems: Comparison, Design, Applications, and Trends, Marina Del Rey Hotel, Marina Del Rey, CA. For more information on this course, contact the Continuing Education Institute, Suite 1000, 10889 Wilshire Blvd., Los Angeles, CA 90024, (213) 824-9545.

August 1982

August-December
Courses from Don White Consultants, various sites throughout the U.S. and Canada. Among the courses being offered are "Interference Control: An Introduction to Electromagnetic Interference/Radio Frequency Interference/Electromagnetic Compatibility," "Electromagnetic Compatibility–Design and Measurement for Control of Electromagnetic Interference," and "Tempest–Design, Control, and Testing." Course fees range from $675 to $945. For complete details, contact Don White Consultants Inc., State Route 625, Gainesville, VA 22065, (703) 347-0030.

August-December
Courses from Fairchild Camera and Instrument Corporation, Santa Clara, CA. Among the courses being offered are "F9445 Family Introduction," "Pascal for Microprocessors," and "F680X Microprocessor Family." For more information, contact Fairchild Camera and Instrument Corp., Education Center, 3420 Central Expressway, Santa Clara, CA 95051, (408) 773-2161.

August 1-4
Microcomputer Applications in Education Workshop, Cloud's Cal-Neva, Lake Tahoe, NV. This workshop is designed for school teachers and administrators. It is sponsored by the University of Nevada-Reno Division of Continuing Education and the Washoe County School District. For further information, contact Shirley Beck, Division of Continuing Education, University of Nevada, Reno, NV 89557, (702) 784-4801.

August 2-4
ACM SIGSMALL Conference on Small Systems, Colorado College, Colorado Springs, CO. This conference will feature papers and panel discussions on communications and I/O, new architecture, operating systems, distributed systems, Ada machines, microprocessor performance, security, and research. Additional details are available from Ron Oliver, 307 North 15th St., Colorado Springs, CO 80904, (303) 576-0786.

August 8-14
Institute for Coordinator of Academic Computing, Potsdam, NY. Among the topics to be covered are user education, hardware planning, software location, conversion and adaptation, and exposure to instructional software and utility. For details, contact Dr. Fritz H. Grupe, Associated Colleges of the St. Lawrence Valley, Potsdam, NY 13676.

August 15-19
The Second International Computer Engineering Conference and Exhibition, Sheraton Harbor Island Hotel, San Diego, CA. This conference is sponsored by the Computer Engineering Division of the ASME (American Society of Mechanical Engineers). More than 50 exhibitors will display computer-engineering products, information, and services. The conference will feature technical sessions on more than 60 topics, including interactive graphics, personal computing by means of programmable calculators, computer-aided design and manufacturing, and robots. For complete details, contact the ASME, 345 East 47th St., New York, NY 10017, (212) 644-7100.

Event Queue

August 16-20
The National Conference on Artificial Intelligence, Carnegie-Mellon University and the University of Pittsburgh, Pittsburgh, PA. Among the topics to be addressed are expert systems, robotics, computational vision, programmable automation, game playing, and knowledge representation. Other features include an exhibition program and a two-day tutorial program providing a nontechnical look at key areas of artificial-intelligence research. Complete conference details are available from the American Association for Artificial Intelligence, 445 Burgess Dr., Menlo Park, CA 94025, (415) 328-3123.

August 23-24
Personal Computer Market Opportunities and Pitfalls, The Anatole, Dallas, TX. The fee for this seminar is $495. For more information, contact Future Computing Inc., 900 Canyon Creek Square, Richardson, TX 75080, (214) 783-9375.

September 1982

September 1-3
European Conference on Integrated Interactive Computing Systems (ECICS '82), Stresa, Italy. Among the topics to be covered are software architecture, user interfaces, system software and hardware, knowledge support, activities management, office information systems, and computer-aided design systems. For details, contact Maria Simi or Pierpaolo Degano, Istituto di Scienze dell'Informazione, Corso Italia 40, I-56100 Pisa, Italy, (50) 40862; Telex, 500371 CNUCE.

September 2-3
Indiana Computer Expo (ICE), Indianapolis Convention Center, Indianapolis, IN. This exposition will feature exhibits of computer software and computer-related materials and services. Show details are available from Ernie Kerns & Associates, Suite 201, 2555 East 55th Place, Indianapolis, IN 46220, (317) 259-8111.

September 5-9
Euromicro 1982, Haifa, Israel. This conference is made up of scientific sessions, tutorials, panel discussions, industrial programs, and exhibits. Among the topics to be addressed are system architecture, hardware and software tools, network structure, and education. Highlighting this event is the international Euromouse competition for maze-solving mobile robots. For details, contact Euromicro, 4, Place Félix Eboué, 75012 Paris, France, (1) 341-08-46; Telex 211801.

September 9-11
The First Annual Meeting of the Mircrcomputer Users Group of the University System of Georgia (MUG/USG), Georgia Southern, Statesboro, GA. This meeting will feature demonstrations, talks, tutorials, and panel discussions on various applications of microcomputers in the classroom, laboratory, and office. Other features include vendor demonstrations and displays. For further details, contact Fred Henneike, Georgia State University, Atlanta, GA 30303, (404) 658-3120, or Richard Stracke, Augusta College, Augusta, GA 30910, (404) 868-3706.

September 9-12
The Fifth Personal Computer World Show, Barbican Centre, London, England. This is the largest computer show held in the United Kingdom. For complete details, contact Personal Computer World, 14 Rathbone Place, London W1P 1DE, England, 01-631 1433.

September 12-15
Design Engineering Technical Conference, Keybridge Marriott, Washington, DC. For information on this conference, contact the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017, (212) 644-7740.

September 14-16
Mini/Micro Computer Conference and Exposition, Disneyland Hotel, Anaheim, CA. For complete details, contact Electronic Conventions Inc., Suite 410, 999 North Sepulveda Blvd., El Segundo, CA 90245, (213) 772-2965.

September 14-16
Wescon/82 High-Technology Electronics Exhibition and Convention, Anaheim Convention Center, Anaheim, CA. Among the topics to be covered are analog and digital signal processing, office automation, and semiconductor technology. For more details, contact Electronic Conventions Inc., Suite 410, 999 North Sepulveda Blvd., El Segundo, CA 90245, (213) 772-2965.

September 20-24
COMPCON Fall '82, Capital Hilton Hotel, Washington, DC. This conference will focus on the principles behind work-station technology, including local area networks, operating systems, and new concepts in user interfaces. Topics of interest include reliability and availability techniques, network-wide databases, distributed architectures, network user environments, and standards. For information, contact COMPCON Fall '82, POB 639, Silver Spring, MD 20901, (301) 589-3386.

September 21-22
Word Processing/Information Systems Expo, Sheraton Washington Hotel, Washington, DC. This conference and exposition will address the trends and advances in the word-processing industry. Among the topics to be covered are word processing and office integration, productivity measurement, and levels of managing an organization. Further details are available from National Trade Productions Inc., Suite 206, 9418 Annapolis Rd., Lanham, MD 20706, (301) 459-8383.

September 21-23
Software/expo-National, Expocenter, Chicago, IL. This show is sponsored by *Infosystems* magazine. For complete details, contact Software/expo, Suite 400, 222 West Adams St., Chicago, IL 60606, (312) 263-3131.

September 23-25
The First International Conference and Exhibition on Medical Computer Science (Medcomp '82), Hilton Hotel and the University of Pennsylvania, Philadelphia, PA. This conference is sponsored by the IEEE (Institute of Electrical and Electronics Engineers) Computer Society's Technical Committee on Computational Medicine. It is a transdisciplinary forum for engineers, medical professionals, and biomedical and computer scientists. Papers and exhibits will focus on topics such as the history and evolution of computers in medicine, artificial intelligence, software and systems evaluation, and signal and image processing. For additional information, contact the IEEE Computer Society, POB 639, Silver Spring, MD 20901, (301) 589-3386.

September 28-October 1
Computer Trade Forum, National Exhibition Centre, Birmingham, England. This trade show will bring together vendors, original equipment manufacturers, dealers, distributors, retailers, service companies, and independent sales organizations. For complete details, contact Clapp & Poliak Inc., 245 Park Ave., New York, NY 10167, (212) 661-8410. In England, contact Clapp & Poliak Europe Ltd., 232 Acton Lane, London W4 5DL, 01-747-3131.■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

BYTELINES

News and Speculation about Personal Computing

Conducted by Sol Libes

Random Rumors: By the third quarter of this year IBM is expected to be shipping 1000 personal computers per day. . . . Micropro International Corporation, San Rafael, California, supplier of Wordstar and several other "stars," is expected to offer its stock to the public, possibly as soon as this fall. . . . NEC (Nippon Electric Company) Informations Systems, Lexington, Massachusetts, is expected to follow IBM's and Tandy's lead soon by introducing a 16-bit personal computer oriented to the office market. . . . Mitsubishi, Osaka, Japan, is rumored to be working on a flat-screen liquid-crystal display using silicon deposited on quartz with a large array of transistor switches. The firm is believed to have already fabricated experimental panels with about 20,000 pixels. . . . Xerox is reportedly readying a low-cost personal computer at its Office Systems division, possibly for introduction this year. . . . AT&T is believed to be seriously working on prototypes of a personal computer and a small business work station using optical fiber technology.

This fall the Compupro Division of Godbout Electronics, Oakland, California, is expected to release a 68000 S-100 processor card, and early next year the company hopes to produce an S-100 card utilizing the National 16032 microprocessor. When the 16032 card becomes available it will be the most powerful microprocessor used in a personal computer. Compupro hopes to furnish CP/M-68K as the operating system for its 68000 processor card. . . . Both Digital Research and Microsoft are said to be working on upgrading their high-level language interpreters to work with the new Intel 8087 math processor. They need not rush, since Intel is only just starting to ship samples, and production is still several months away. When this software/hardware combination is available, performance of 8-bit computers in math applications will surely be improved. . . . Grid Systems Inc., Mountain View, California, is expected to introduce shortly a portable system using the 8086 16-bit microprocessor, a flat-panel display, 256K bytes of memory, bubble-memory mass storage, and a built-in modem. . . . Said Iftikar, cofounder of Seagate Technology, the company that started the craze over 5¼-inch Winchester disk drives, has left that firm to start Syquest Inc., Fremont, California, which will make 3¼- to 4-inch Winchesters. . . . A 2-gigabyte (i.e., 2-*billion*-byte) optical-disk system with super-fast access time from Burroughs Corporation, Detroit, is expected to debut at the National Computer Conference. (For more information on this new technology read the Optical Memory Newsletter, POB 14817, San Francisco, CA 94114.)

Radio Shack Doings: By the time you read this Tandy should have its new TRS-80 Model 16 systems in the company's showrooms and may even have started shipping to customers. A multitasking/multiuser version of Tandy's TRSDOS operating system is due this summer. The first language introduced will be COBOL, which will be followed by BASIC and FORTRAN. The first applications package will be Visicalc and an integrated small-business accounting system with a shared database facility.

Tandy Corporation has decided to restrict sales of the Model 16 to its 250 dedicated Computer Centers and about 450 full-line Radio Shack stores that have computer departments with trained staffs. That leaves almost 7000 Radio Shack stores out in the cold. Tandy expects to add ten computer stores a month over the coming year. The firm is obviously doing this to cater more to the traditional data-processing professionals who expect, and are willing to pay for, a high level of hardware and software support.

With the Model 16, which can cost as little as $6000 for a basic system, Tandy will be aggressively going after the markets that until now were dominated by IBM, DEC, et al. After all, if IBM could enter the personal computer market, long Tandy's province, then why shouldn't Tandy turn the tables and invade the business market, long IBM's exclusive stomping ground. That's what competition is all about.

It's interesting how things change: IBM, who used to sell products that were exclusively IBM-made through a marketing organization that was exclusively IBM-run, has done a complete about-face. It now purchases hardware and software from outside suppliers and sells by way of non-IBM retail outlets. On the other hand, Tandy sells exclusively through its own sales organization and directly controls about 50 percent of its manufacturing costs.

Veritas Technology, San Jose, California, is offering an add-on board for the TRS-80 Model II that uses the 8086 microprocessor. With it you can now run CP/M-86 and Microsoft's MS-DOS.

Apple Happenings: When IBM introduced its Personal Computer, and when the economy turned downward, many experts thought that Apple, Tandy, Atari, and Commodore had had it. But now almost a year later it is quite the reverse: business is better than ever. The market for microcomputers is growing at a healthy rate and appears to be able to absorb close to 200,000 IBM Personal Computers this year without affecting the growth of any of the other microcomputer leaders.

Apple Computer Inc. ended its first full fiscal year in September 1978 with a profit of three cents per share. The next year earnings quadrupled to 12 cents per share and the following year doubled to 24 cents. The 1981 fiscal year saw Apple earnings rise to 70 cents per share and expectations for this year are $1.24 per share. Revenues are expected to reach $640 million, up from $335 million last year, and $117 million the year prior.

Apple is trying to give an Apple II computer to each of the more than 83,000 public elementary and secondary schools in the country. This would amount to a donation of at least $200 million, based on the list price of the system. In order to do this Apple wants Congress to change the current law to allow the company a tax break for the donation. The current law says such deductions can be made only for scientific equipment given to higher-level educational institutions for research purposes.

Such a give-away would, of course, pay handsome dividends for Apple. After all, how long would a school be able to live with only one Apple computer? And certainly students would try to convince their parents that they simply must have an Apple II to do their homework because there is only one at school and they can't get time on it.

In last month's column I mentioned that, despite Apple's cancelling of discount mail-orders, dealer advertisements continue to appear offering discounts on Apple II computers. However, note that these outlets are not franchised Apple dealers. These are discount outlets that buy machines from overstocked Apple dealers. In fact, many franchised Apple dealers count on these resales to keep volume high so that they may qualify for higher discounts from Apple. Apple is attempting to stop this "brokering" of computers but as yet has not been successful.

Concurrent CP/M: CP/M is without doubt the most popular disk operating system for 8-bit microcomputers. Digital Research keeps improving CP/M by adding new features while maintaining compatibility between newer and older versions, thereby insuring continued life for languages and applications software. The firm's latest version is Concurrent CP/M-86, which allows multiple tasks to execute simultaneously. For example, a system can be sending or receiving a file or batch of files in the background while the operator is doing another task in the foreground on the console. Different tasks can access the same data file without destroying data integrity. Passwords and time stamps on files are supported. The first implementation has been done for the IBM Displaywriter.

Digital Research is also reportedly at the "beta test" stage on version 3 of CP/M-80.

Smalltalk News: Ed Cherlin, Director of Personal Computer Research at Strategic Inc., a marketing research firm, predicts that "Smalltalk will become the dominant operating system and programming language for 16-bit personal computer systems" and that it "will shut the Unix window of opportunity before it is fully open." He further predicts that "numerous leading-edge personal computer and office automation manufacturers will be flooding the market with Smalltalk systems, which are vastly more powerful and easy to use than Unix systems. Versions of CP/M for 16-bit systems will also be squeezed out." He expects Smalltalk versions from Apple, DEC, Hewlett-Packard, Tektronix, and several Japanese companies during the coming year, and he believes that IBM has a similar product in development.

The Marketplace: TI (Texas Instruments) has again slashed the price on its personal computer in an attempt to compete with the likes of the TRS-80 Color Computer, the Atari 400 (both priced at $399), and the Commodore VIC ($299). TI's price to dealers is now under $300, with a suggested $350 retail price. (The computer was originally introduced with a $1000 price tag.) This under-$500 market is expected to become even more competitive as the Japanese enter the market. And NEC will shortly be introducing the PC-6000, which will probably carry a $400 price tag.

International Resource Development Inc. (IRD), Norwalk, Connecticut, another marketing research firm, predicts that the share of the microcomputer marketplace will soon undergo marked change. The current market share is Tandy/Radio Shack: 28%; Apple: 25%; Hewlett-Packard: 11%; Commodore: 10%; Xerox, DEC, and IBM combined: 10%; and all others: 16%. IRD claims that this will change substantially so that by 1985 the lineup will be IBM: 23%; Xerox: 17%; Tandy/Radio Shack: 15%; Hewlett-Packard: 14%; Apple: 12%; DEC: 11%; Commodore: 3%; and all others: 5%.

Still another marketing research firm, Creative Strategies International, San Jose, California, forecasts that more than 12 million personal computers will be made over the next five years with an annual growth rate of 59%. They expect prices to drop 20% per year through 1986. They claim further that last year six personal computer firms each did over $50 million in business. They expect this number to rise to eleven firms this year.

Microsoft Sues: More and more software suppliers are going to court to protect their copyrighted software. Previously I reported that Digital Research and Micropro have filed suit against a dealer who allegedly illegally copied and sold their software. Last month, I reported on Atari's suit against Magnavox, in which Atari sought to protect the screen images used in its Pac-Man computer game.

The latest suit has been brought by Microsoft, which has gone to court charging software piracy. Microsoft charges that Advanced Logic Systems (ALS), Sunnyvale, California, has copied the BIOS and BOOT programs for Microsoft's Z80-based Apple Softcard and is selling them as part of a product called "The Synergizer." Microsoft charges that the code is a byte-for-byte copy with the exception that ALS changed the copyright notices and altered two message strings. Otherwise, according to Microsoft the two programs are identical, right down to the initials of the Microsoft programmer who created the software.

Print System Merges Text and Graphics: Xerox has announced a new printing system that allows text and graphics to be merged and printed electronically, thus doing away with typesetting, plate-making, collators, and printing presses. Software allows artwork functions such as cropping, scaling, and reduction. Text and graphics can be merged and printed at a rate of up to 120 pages per minute.

Logic Gets Fuzzy: You've heard of "intelligent" and "smart" systems? Well, now comes the "expert" system using "fuzzy" logic. Systems Programming Ltd., London, England, has come up with "Sage," an "expert-derived knowledge database" consisting of rules and a "navigating inference engine" that uses "probabilistic and fuzzy logic." The company claims it is advantageous in applications such as medical diagnosis where it should provide much better structure with stronger linking of evidence, more alternative conclusions and a shorter program through control of complexity.

News from Japan: During the past four years Japan's 10 largest integrated-circuit producers have more than tripled their investments in plants and equipment while U.S. producers have reduced operations and delayed many investment programs. The effects of this have shown up most markedly in the 64K-bit dynamic memory market. The Japanese firms are shipping more and more unfinished products here for final assembly, thereby reducing the dollar imports to the U.S. and sidestepping trade friction while at the same time increasing their market share. NEC, Hitachi, Toshiba, and Fujitsu have already set up such assembly sites.

Also, and with great ceremony, the Japanese have launched an eight-year, $300 million program to develop a scientific computer capable of doing 10 billion floating-point operations per second. Participating jointly in this effort are Fujitsu, Hitachi, NEC, Mitsubishi, Toshiba, and Oki. The government will spend $130 million and the six companies will spend $120 million. The computer will use Josephson junction, HEMT (high electron mobility transistor) and gallium arsenide devices as well as parallel processing methods.

What's happening with 256K-bit Memory Devices: Hitachi Ltd. and Motorola have released preliminary specifications for 256K-bit memory integrated circuits. They expect to begin providing samples by year-end, and production quantities should begin to become available in late 1983. However, these companies do not expect these devices to become cost-competitive with the currently popular 64K-bit devices until 1985. TI, Mostek, and Intel are also known to be developing 256K-bit memories but as yet have not released any details. Western Electric is expected to go into production before year-end on a 256K-bit device developed by Bell Laboratories. IBM is also expected to be in production of its 288K-bit dynamic memory (9 bits wide with parity) by year-end.

The 256K-bit devices announced so far are organized as 256K by 1 bits. It is expected that later devices will be organized as 64K by 4 bits and 32K by 8 bits.

Random News Bits: Altos has cut prices on its three-user Series-5 MP/M system by one third: to $2900 with dual floppy-disk drives and to $5900 with a Winchester/floppy-disk drive combination. This, as far as I can tell, makes it the lowest-cost multiuser system around. . . . Matsushita, Osaka, Japan, is preparing to go into production on an 8-bit analog-to-digital converter integrated circuit capable of operating at 50 megahertz and consuming only 700 milliwatts. Samples are already available. . . . Shugart Associates, Sunnyvale, California, is taking orders for its thin (half-size) 5¼-inch floppy-disk drive, dubbed the SA200. It will store 125K bytes single-sided and 250K bytes double-sided. The quantity price will be $118. . . . the Destek Group, Mountain View, California, has announced a local-network (baseband-type) interface card for the IBM Personal Computer. It will use the HDLC (high-level data link control) and CSMA (Communication Systems Management Association) protocols. . . . Advanced Computer Security Concepts, Annandale, Virginia, has announced a "breakthrough" in preventing software piracy. It is based on a patented method using the Data Encryption Standard approved by the U.S. National Bureau of Standards. . . . NEC Information Systems, Lexington, Massachusetts, has announced an 8-inch half-size floppy-disk drive storing 1.6 megabytes.

Quote of the Month: "One leading microcomputer maker we worked with developed a prototype system with a memory cache, high-speed carry out, and a direct connection to a memory storage—they called it a 'cache and carry store.'"
Dr. Gary Kildall, President
Digital Research Inc.

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.

Sol Libes
POB 1192
Mountainside, NJ 07092

Books Received

Artificial Intelligence: An MIT Perspective, volume I, Patrick Henry Winston and Richard Henry Brown, eds. Cambridge, MA: MIT Press, 1982; 497 pages, 14.5 by 22 cm, softcover, ISBN 0-262-73058-8, $12.50.

Artificial Intelligence: An MIT Perspective, volume II, Patrick Henry Winston and Richard Henry Brown, eds. Cambridge, MA: MIT Press, 1982; 486 pages, 14.5 by 22 cm, softcover, ISBN 0-262-73059-6, $12.50.

COBOL for the 80's, J. Wayne Spence. St. Paul, MN: West Publishing, 1982; 591 pages, 18 by 24 cm, softcover, ISBN 0-314-63290-5, $18.95.

Computers and Data Processing, Concepts and Applications with BASIC, 2nd edition, Steven L. Mandell. St. Paul, MN: West Publishing, 1982; 675 pages, 18.5 by 25 cm, hardcover, ISBN 0-314-63263-8, $21.95. *Study Guide to Accompany Computers and Data Processing, Concepts and Applications*, Steven L. Mandell. St. Paul, MN: West Publishing, 1979; 298 pages, 18 by 24.4 cm, softcover, ISBN 0-8299-0254-6, $8.95.

Distributed Database Management Systems, Olin H. Bray. Lexington, MA: Lexington Books, 1982; 163 pages, 15.5 by 22.5 cm, hardcover, ISBN 0-669-03396-0, $18.95.

Explore Computing with the TRS-80 (& Common Sense), With Programming in BASIC, Richard V. Andree and Josephine P. Andree. Englewood Cliffs, NJ: Prentice-Hall, 1982; 230 pages, 17.5 by 23.5 cm, hardcover, ISBN 0-13-296145-8, $15.95.

From Images to Surfaces, A Computational Study of the Human Early Visual System, William Eric Leifur Grimson. Cambridge, MA: MIT Press, 1981; 274 pages, 15 by 23 cm, hardcover, ISBN 0-262-07083-9, $25.

Fun with Microcomputers and BASIC, Donald D. Spencer. Reston, VA: Reston Publishing, 1981; 128 pages, 21 by 27.5 cm, softcover, ISBN 0-8359-2214-6, $9.95.

How to Buy the Right Small Business Computer System, C. Roger Smolin. New York: John Wiley & Sons, 1981; 156 pages, 17 by 24.5 cm, softcover, ISBN 0-471-08494-8, $8.95.

Introduction to System Dynamics Modeling with DYNAMO, George P. Richardson and Alexander L. Pugh III. Cambridge, MA: MIT Press, 1981; 413 pages, 15.5 by 22.5 cm, hardcover, ISBN 0-262-18102-9, $25.

Wordstar Made Easy, Walter A. Ettlin. Berkeley, CA: Osborne/McGraw-Hill, 1981; 125 pages, 18.3 by 23 cm, spiral binder, ISBN 0-931988-69-1, $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.

The Ghost of Epsons Past

I recently purchased a number of Epson MX-80 printers. Upon their arrival, I inspected each and, to my surprise, five out of six had ghosting problems in both the compressed double mode and regular-size emphasized mode. (See listing 1.) The ghosting appeared as a vertical displacement of the double-printed character such that there was space between the two parts of the character.

After a fruitless conversation with the company that sold me the printers, I called the Epson service center hoping to find an answer to this problem. Epson was aware of the problem and had the fix. I watched a local service department repair the machines, and this is what happened: they replaced integrated circuit 1B (32K-bit read-only memory) with two 2716 EPROMs (erasable programmable read-only memories). Then they disabled the ROM (read-only memory) in one of the microprocessors by clipping jumper J1. Finally, they added a third 2716 EPROM in the 3B position. A quick test verified the printer was functioning properly.

Listing 2 is a test program to check your Epson MX-80 printer for these defects. If you are running in the TRS-80 mode, be sure to turn off switch S2-4.

Paul Fehrenbach
Fremont, CA■

Listing 1: *Print samples from an Epson MX-80 printer. In listing 1a, the ghosting problem is quite visible. Listing 1b is a sample from a repaired unit, tested with the program of listing 2.*

1a

```
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxy
FGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@
LMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEF
RSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKL
XYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQR
^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWX
defghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^
jklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcd
pqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghij
vwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnop
|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuv
CDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|
IJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~@ABC
```

1b

```
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
```

```
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
```

Listing 2: *The printer test program. This routine helps to check Epson MX-80 printers for the ghosting problem by producing a printout similar to listing 1. This program should run under Microsoft BASIC (as used in the TRS-80 and other microcomputers).*

```
1 'THIS PROGRAM CHECKS YOUR EPSON PRINTER FOR GHOSTING OF
2 'CHARACTERS IN    (1) COMPRESSED DOUBLE PRINT MODE
3 '                 (2) REGULAR SIZE EMPHASIZED MODE
10 '-------PRINTER SETUP-----------------------------------------
20 LPRINT CHR$(15): 'COMPRESSED CHARACTER MODE
30 LPRINT CHR$(27); CHR$(71): 'DOUBLE PRINT
40 '-------OUTPUT CHARACTERS FOR TEST----------------------------
50 GOSUB 1000
60 '-------PRINTER SETUP-----------------------------------------
70 LPRINT CHR$(18): 'CANCELS COMPRESSED CHARACTER MODE
80 LPRINT CHR$(27); CHR$(69): 'EMPHASIZE MODE
90 GOSUB 1000
100 END
1000 FOR ROW=1 TO 10
1010 FOR X=64 TO 126
1020 LPRINT CHR$(X);
1030 NEXT X
1040 LPRINT: NEXT ROW
1050 RETURN
```

A Message to our Subscribers

From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers promotional material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

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Draw Poker for the TI-59

Lee Boyle, 2702 E Linden, Tucson AZ 85716

The program presented here is very close to the limits of the TI-59 programmable calculator because it fills 480 program memory locations and uses 53 data registers. When writing such long programs, there are four interrelated constraints that you must consider:

1. The TI-59 has an absolute limit of 960 memory locations. This number becomes smaller as data registers are allocated.
2. Zero to 100 data registers may be allocated; however, each register subtracts 8 memory locations from the available number.
3. Each call to the random-number generator (using the keystrokes PGM 15 SBR DMS) requires 1.4 seconds. Occasional sacrifices must be made in the interest of speed.
4. Results—if the program doesn't perform the task, nothing else matters. There are, however, always some compromises to be made.

Finding the right compromises and optimizations to make a large program fit into the available memory is always a challenge and it is a good way to refine your programming technique.

The game of Draw Poker can be divided into four major sections: dealing, evaluating the hand, drawing new cards, and betting. In this program, betting takes place only after a draw.

Deal (Key E)

The basic task of this section of the program is to randomly select eighteen numbers, with no repetition, from a set of fifty-two. These numbers must then be stored as five cards for the calculator, five for the user, and eight to be saved in a *draw stack* that will allow each party to exchange a maximum of four cards. The cards are stored in the form RR.S, where RR represents the rank (deuce through ace), and S represents the suit.

One method of drawing without repetition is to assign a data register to each card possibility and, when a card is chosen, to cross it off by storing a 1 in that register. The table is consulted as each card is dealt, to make sure that it has not been chosen before. This method is short, quick, easy, and random; unfortunately, the table requires fifty-two data registers, and we do not have that much memory to spare.

As a compromise, this program uses one register for each of the thirteen ranks, counting to assure that none is used more than four times. Suits are determined by the value 0.1, 0.2, 0.3, or 0.4, randomly stored in each register individually. Each time a card is chosen and the corresponding register is incremented, the fractional part is also incremented (e.g., 0.5 is reset to 0.1) so that the next card chosen from that rank will be of a different suit.

This method has the disadvantage of allowing you to predict the suit of the next card chosen from a given rank, but this is rarely, if ever, useful information.

When all eighteen cards have been dealt, subroutine 012 of Master Library program 1 is used to erase the dealing table. Subroutine SUM then uses this space to create a *tally table* that records the number of cards of each rank dealt to the calculator. Finally, subroutine A′ is called to display your hand.

Evaluation (Subroutine FIX)

In evaluating a poker hand, the calculator must test for three conditions:

Listing 1: *Draw Poker for the TI-59 programmable calculator.*

```
000  76  LBL
001  58  FIX
002  22  INV
003  86  STF
004  01   01
005  00   0
006  42  STO
007  05   05
008  04   4
009  03   3
010  42  STO
011  01   01
012  43  RCL
013  24   24
014  69  OP
015  10   10
016  42  STO
017  03   03
018  01   1
019  01   1
020  42  STO
021  00   00
022  01   1
023  03   3
024  42  STO
025  06   06
026  76  LBL
027  85   +
028  69  OP
029  20   20
030  01   1
031  32  X:T
032  73  RC*
033  00   00
034  77   GE
035  87  IFF
036  00   0
037  42  STO
038  03   03
039  61  GTO
040  65   ×
041  76  LBL
042  87  IFF
043  43  RCL
044  00   00
045  42  STO
046  02   02
047  01   1
048  44  SUM
049  03   03
050  05   5
051  32  X:T
052  43  RCL
053  03   03
054  22  INV
055  67   EQ
056  55   ÷
057  43  RCL
058  00   00
059  42  STO
060  04   04
061  08   8
062  44  SUM
063  01   01
064  76  LBL
065  55   ÷
066  02   2
067  32  X:T
068  73  RC*
069  00   00
070  22  INV
071  77   GE
072  65   ×
073  85   +
074  01   1
075  95   =
076  44  SUM
077  01   01
078  43  RCL
079  00   00
080  87  IFF
081  01   01
082  43  RCL
083  48  EXC
084  04   04
085  76  LBL
086  43  RCL
087  42  STO
088  05   05
089  04   4
090  07   7
091  32  X:T
092  43  RCL
093  01   01
094  22  INV
095  67   EQ
096  65   ×
097  86  STF
098  01   01
099  76  LBL
100  65   ×
```

Listing 1 continued on page 436

Listing 1 continued:

```
101  97 DSZ
102  06  06
103  85  +
104  43 RCL
105  25  25
106  22 INV
107  59 INT
108  32 X:T
109  02  2
110  05  5
111  42 STO
112  07  07
113  04  4
114  42 STO
115  06  06
116  76 LBL
117  97 DSZ
118  69 OP
119  27  27
120  73 RC*
121  07  07
122  22 INV
123  59 INT
124  22 INV
125  67  EQ
126  68 NOP
127  97 DSZ
128  06  06
129  97 DSZ
130  01  1
131  44 SUM
132  01  01
133  43 RCL
134  02  02
135  42 STO
136  04  04
137  76 LBL
138  68 NOP
139  73 RC*
140  01  01
141  92 RTN
142  76 LBL
143  15  E
144  01  1
145  03  3
146  42 STO
147  00  00
148  01  1
149  01  1
150  42 STO
151  01  01
152  76 LBL
153  10 E'
154  69 OP
155  21  21
156  01  1
157  71 SBR
158  88 DMS
159  04  4
160  95  =
161  59 INT
162  55  ÷
163  01  1
164  00  0
165  95  =
166  72 ST*
167  01  01
168  97 DSZ
169  00  00
170  10 E'
171  01  1
172  08  8
173  42 STO
174  00  00
175  02  2
176  05  5
177  42 STO
178  01  01
179  04  4
180  32 X:T
181  76 LBL
182  45 YX
183  01  1
184  02  2
185  71 SBR
186  88 DMS
187  01  1
188  03  3
189  95  =
190  59 INT
191  42 STO
192  02  02
193  73 RC*
194  02  02
195  77  GE
196  45 YX
197  22 INV
198  59 INT
199  65  ×
200  01  1
201  00  0
202  95  =
203  22 INV
204  67  EQ
```

Listing 1 continued:

```
205  23 LNX      257  91 R/S
206  93  .       258  05  5
207  04  4       259  42 STO
208  22 INV      260  07  07
209  74 SM*      261  76 LBL
210  02  02      262  66 PAU
211  04  4       263  69 OP
212  76 LBL      264  23  23
213  23 LNX      265  73 RC*
214  55  ÷       266  03  03
215  01  1       267  75  -
216  00  0       268  01  1
217  85  +       269  00  0
218  43 RCL      270  95  =
219  02  02      271  66 PAU
220  95  =       272  66 PAU
221  72 ST*      273  66 PAU
222  01  01      274  97 DSZ
223  01  1       275  07  07
224  93  .       276  66 PAU
225  01  1       277  92 RTN
226  74 SM*      278  76 LBL
227  02  02      279  44 SUM
228  69 OP       280  74 SM*
229  21  21      281  25  25
230  97 DSZ      282  74 SM*
231  00  00      283  26  26
232  45 YX       284  74 SM*
233  43 RCL      285  27  27
234  09  09      286  74 SM*
235  32 X:T      287  28  28
236  02  2       288  74 SM*
237  04  4       289  29  29
238  36 PGM      290  92 RTN
239  01  01      291  76 LBL
240  71 SBR      292  88 DMS
241  00  00      293  85  +
242  12  12      294  36 PGM
243  32 X:T      295  15  15
244  42 STO      296  71 SBR
245  09  09      297  88 DMS
246  01  1       298  65  x
247  71 SBR      299  92 RTN
248  44 SUM      300  76 LBL
249  02  2       301  13  C
250  09  9       302  85  +
251  42 STO      303  02  2
252  03  03      304  09  9
253  76 LBL      305  95  =
254  16 A'       306  42 STO
255  09  9       307  00  00
256  35 1/X      308  00  0
```

Listing 1 continued on page 438

```
311   91  R/S
312   76  LBL
313   14   D
314   71  SBR
315   58  FIX
316   29  CP
317   22  INV
318   67   EQ
319   78  Σ+
320   43  RCL
321   02   02
322   42  STD
323   04   04
324   00   0
325   76  LBL
326   78  Σ+
327   32  X:T
328   00   0
329   42  STD
330   03   03
331   01   1
332   94  +/-
333   71  SBR
334   44  SUM
335   03   3
336   22  INV
337   77   GE
338   48  EXC
339   02   2
340   05   5
341   42  STD
342   07   07
343   05   5
344   42  STD
345   02   02
346   76  LBL
347   42  STD
348   73  RC*
349   07   07
350   59  INT
351   32  X:T
352   43  RCL
353   04   04
354   67   EQ
355   35  1/X
356   43  RCL
```

```
364   44  SUM
365   03   03
366   76  LBL
367   35  1/X
368   69  OP
369   27   27
370   97  DSZ
371   02   02
372   42  STD
373   76  LBL
374   48  EXC
375   43  RCL
376   03   03
377   91  R/S
378   01   1
379   00   0
380   42  STD
381   00   00
382   02   2
383   04   4
384   42  STD
385   02   02
386   03   3
387   04   4
388   42  STD
389   07   07
390   76  LBL
391   93   .
392   29  CP
393   69  OP
394   22   22
395   73  RC*
396   02   02
397   22  INV
398   67   EQ
399   80  GRD
400   69  OP
401   27   27
402   73  RC*
403   07   07
404   72  ST*
405   02   02
406   76  LBL
407   80  GRD
408   97  DSZ
409   00   00
```

```
417   03   03
418   71  SBR
419   16  A'
420   91  R/S
421   71  SBR
422   58  FIX
423   65   x
424   43  RCL
425   04   04
426   85   +
427   01   1
428   00   0
429   71  SBR
430   88  DMS
431   05   5
432   95   =
433   32  X:T
434   25  CLR
435   76  LBL
436   38  SIN
437   85   +
438   05   5
439   95   =
440   91  R/S
441   22  INV
442   77   GE
443   38  SIN
444   02   2
445   00   0
446   22  INV
447   77   GE
448   11   A
449   25  CLR
450   91  R/S
451   76  LBL
452   11   A
453   73  RC*
454   01   01
455   22  INV
456   59  INT
457   85   +
458   43  RCL
459   04   04
460   75   -
461   01   1
462   00   0
```

```
470   16  A'
471   91  R/S
472   15   E
473   76  LBL
474   12   B
475   75   -
476   05   5
477   95   =
478   91  R/S
479   11   A
```

LABLES

```
001   58  FIX
027   85   +
042   87  IFF
065   55   ÷
086   43  RCL
100   65   x
117   97  DSZ
138   68  NOP
143   15   E
153   10  E'
182   45  Yx
213   23  LNX
254   16  A'
262   66  PAU
279   44  SUM
292   88  DMS
301   13   C
313   14   D
326   78  Σ+
347   42  STD
367   35  1/X
374   48  EXC
391   93   .
407   80  GRD
436   38  SIN
452   11   A
474   12   B
```

Listing 1 continued:

```
DATA

           0.          43
     5.88888           44
           0.          45
     1.00011           46
     3.00111           47
     7.01111           48
     2.11022           49
     4.11122           50
     6.12345           51
  8.12345888           52
```

1. Five cards in sequence by rank define a *straight.*
2. Multiple cards of the same rank define *2, 3, or 4 of a* kind.
3. Five cards of the same suit define a *flush.*

To save steps, the first two of these conditions are tested simultaneously by stepping through the tally table rank by rank. If five sequential cards are found, 8, the code for a straight, is added into R01 (data register 01). If a tally value is 2, 3, or 4, the hand will contain the corresponding multiple, and the appropriate code (3, 4, or 5, respectively) is added into R01.

To test for a flush, the program compares the fractional parts of the five cards; if they are all equal, the hand contains a flush (code = 1).

Since half of the possible poker hands contain more than one of these conditions, provisions must be made to allow the results to be combined. For example, if a pair and three of a kind are found in the same hand, the calculator must recognize that it has a full house. To reduce the amount of program logic required, the poker hands have been assigned code numbers that can be added to give the total value of the hand. For example, the codes for a pair and for three of a kind are 3 and 4 respectively, so the code 7 denotes a full house. Similarly, 8 (straight) + 1(flush) = 9(straight flush). In each case, the details of the hand (pair of what?) are stored in R04 and R05.

The final steps of this program section use the table in R44 to R52 to translate the value in R01 into a new code giving the relative value of the hand (0 through 8) as the integer part and a symbolic representation of the hand as the fractional part (see table 1).

Draw (Keys C and D)

This section is relatively simple. Indicate those cards you wish to discard (if any) as 1 for the first card, 2 for the second, etc. You are trusted to discard no more than four cards.

The program then calls subroutine FIX to evaluate its hand. If the value is four-of-a-kind or better, no discard is made. If no hand is discovered, the calculator simply discards all but the high card. Otherwise, the rank of each card is compared to the values in R04 and R05 to determine whether or not that card is used in the hand. If it is not, it is discarded. Discarding is simply a matter of storing a zero in that register.

When the calculator has finished discarding, it stops to display the number of cards it is taking, then fills the zeroed register from the previously dealt draw stack. Your hand is then displayed as before, and the program is ready to begin betting.

Betting (Keys A and B)

Memory limitations have made this section simpler than it could be. It is, however, capable of some realistic betting exchanges.

The calculator always opens with five. You may then call by pressing A, fold by pressing B, or raise the pot by entering the new *total* (not the amount of the raise) and pressing R/S. In the latter case, the program compares the value of the pot to a betting limit and calls, folds, or raises accordingly. The betting limit is an arbitrary function involving the value of the calculator's hand and a random number.

When either party calls, the calculator displays the symbolic value of its hand, or the high card if it has no hand. This value may also be displayed at your option after either party has folded. The calculator's individual cards are available for display at your request.

When you fold, the calculator displays the amount you have forfeited. The calculator folds by displaying a zero. You must keep track of your own winnings.

This program is shown in listing 1, with a sample run given in listing 2. Before the program is executed, the data in table 1 should be loaded into the calculator. The register allocations are given in table 2, and the user definable key functions for this program are given in table 3. The sample run in listing 2 should clarify the program operation; when in doubt, press the R/S key. ■

Register	Code	Hand
43	0	No hand
44	5.88888	Flush
45	0	Not used
46	1.00011	Pair
47	3.00111	3 of a kind
48	7.01111	4 of a kind
49	2.11022	2 pair
50	4.11122	Full house
51	6.12345	Straight
52	8.12348888	Straight flush

Table 1: *Numerical codes for poker hands. This data must be in memory at the beginning of execution. To store them on a data card, the WRITE 3 command can be used. The codes listed here are shown as they are used internally; when they are displayed, the integer part of the number is replaced by the detail value from R04. For example, a jack-high straight is displayed as 11.12345.*

Register	Function
00	Various functions
01	Hand code
02,03	Various functions
04,05	Hand details
06, 07, 08	Various functions
09	Random seed
12 through 24	Deal/tally tables
25 through 29	Calculator's cards
30 through 34	Player's cards
35 through 42	Draw stack
43 through 52	Code table (table 1)

Table 2: *Data register allocations. Note that registers 00, 02, 03, and 06 through 08 serve temporary functions at various points throughout the program.*

Key	Use
A	Call
B	Fold
C	Discard
D	Draw
E	Deal

Table 3: *User-defined keys for TI-59 Draw Poker.*

Listing 2: *A sample run of Draw Poker for the TI-59 programmable calculator.*

Keystrokes	Display	Comments
3.45	3.45	Seed for random-number generator. Enter a new number each time you begin to use the program.
E	.1111111111	Deal (takes about 2 minutes); when the calculator is ready to display your hand, it regains your attention by displaying .1111111111.
R/S	2.4 4.2 9.2 7.3 3.4	Your cards are displayed, pausing 1.5 seconds for each card to allow you to copy (or memorize) them.
1 C 2 C 4 C 5 C	0 0 0 0	Discard; you are keeping only the third card dealt to you.
D	0	Draw; you press D when you are finished discarding. The calculator shows that it is not discarding any cards.
R/S	.1111111111	The new cards are dealt from the draw stack.
R/S	4.3 2.1 9.2 9.3 9.4	Your cards are displayed as before.
R/S	5	The calculator opens the betting with 5.
7 R/S	12	You raise 2. The calculator raises again by 5.
A	14.01111	Call; you call at 12. The calculator shows that it has four aces (14's).
R/S	.1111111111	Not trusting the machine, you demand to see its cards. Otherwise you would press E for the next hand.
R/S	14.3 14.4 10.2 14.1 14.2	The calculator's cards are displayed as yours were before.
R/S	.1111111111	You admit defeat and call for the next hand to be dealt. Pressing E would have the same effect.

BYTE's Bits

FORTH Coding Sheets

A FORTH coding sheet, used for documenting the operation of FORTH words (programs), is available free of charge from Curry Associates. Although space does not permit us to show an example of the sheet, suffice to say that it allows the user to show the effects of FORTH words on both the parameter and return stacks, as well as make comments on the definition in progress. The coding sheet can be photocopied and used without restriction. To get a copy of the sheet, write Curry Associates, POB 11324, Palo Alto, CA 94306. ■

Generate Huffman Codes

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As Harold Corbin reported in "An Introduction to Data Compression" (April 1981 BYTE, page 218), the Huffman coding technique can be used to significantly reduce the number of bits required to represent a set of characters. I wrote a BASIC program that constructs a data tree and traces each character's path (see listing 1). The program reads data pairs consisting of a symbol or phrase and its rate of occurrence. With this information, a binary tree is set up in the matrix labeled P. Each row in this matrix contains two branch labels and the node's rate of occurrence (i.e., the sum of the two branch frequencies). Once the tree is complete, each character's path through the branches is traced, and the resulting code is stored in the matrix labeled H.

It's important to remember that the code produced by the program is not unique. Different results are obtained if the order of data entry is changed. The character set is not limited to single symbols.

I wrote my program for an IBM 5100 portable computer, but it should work well with most small computers with little or no modification. It allows each symbol entry to be up to 16 bytes long, which permits commonly found phrases to be assigned separate codes. This approach reduces storage requirements even further. Also, the frequency data does not have to be normalized to 1. It could be entered as a percentage or as the number of times each character or phrase is found in a file.■

Listing 1: *A BASIC program that produces a Huffman code for a set of characters and phrases. Though written to run on the IBM 5100 portable computer, it should work equally well on most small computers with little or no modification.*

```
10 REM ----------------HUFFMAN CODE GENERATOR----------------------
20 REM THIS PROGRAM WILL ACCEPT A LIST OF SYMBOLS AND THE
30 REM FREQUENCY OF OCCURRENCE OF EACH SYMBOL. FROM THIS
40 REM INFORMATION EACH SYMBOL WILL BE GIVEN A CODE.
70 REM JEFF SELLERS 27 MAY 1981
80 DIM C$(100),P(50,3)
90 DIM F(100),H(50,20)
100 E=1
110 PRINT
120 REM GET CHARACTERS AND FREQUENCY
130 READ C$(E),F(E)
140 IF F(E)=9999 THEN 180
150 E=E+1
160 GO TO 130
170 REM GET ANOTHER CHARACTER
180 I1=1
190 E=E-1
200 REM E= NUMBER OF SYMBOLS ENTERED
210 REM THIS SECTION FORMS THE BINARY TREE. A LIST OF THE BRANCHES
220 REM WHICH MAKEUP EACH NODE IS PLACED IN MATRIX P
230 REM ONE BRANCH'S LABEL IS IN COLUMN 1 WHILE THE OTHER
240 REM LABEL IS IN COLUMN 2. THE THIRD COLUMN CONTAINS THE
250 REM RATE OF OCCURRENCE FOR THAT NODE.
260 GOSUB 750
270 REM GET SYMBOL OR NODE WITH LOWEST FREQ. IN INDEX I
280 REM M IS THE VALUE OF THE OCCURRENCE RATE
290 IF M=9999 THEN 430
300 P(I1,1)=I
310 M1=M
320 GOSUB 750
330 REM GET NEXT LOWEST FREQ VALUE AND ITS INDEX
340 IF M=9999 THEN 430
350 P(I1,2)=I
360 REM CALCULATE NEW NODE'S FREQ
370 P(I1,3)=M1+M
380 I1=I1+1
390 GO TO 260
410 REM THIS SECTION TRACES EACH SYMBOL FROM THE TOP
420 REM OF THE TREE TO THE BASE
430 FOR T=1 TO E
440 S=T
450 REM N IS THE NUMBER OF NODES IN THE TREE
460 N=I1-1
470 N2=1
480 FOR K=N2 TO N
490 REM IS THIS BRANCH PART OF THIS NODE?
500 IF S<>P(K,1) THEN 550
510 REM YES, ADD A ZERO TO THE CODE
520 F=0
530 GO TO 580
540 REM IS THIS BRANCH PART OF THIS NODE?
550 IF S<>P(K,2) THEN 610
560 REM YES, ADD A ONE TO THE CODE
570 F=1
580 GOSUB 990
590 REM CALCULATE THE LABEL OF THE NEXT NODE TO FIND
600 S=K+E
610 NEXT K
620 REM TRACE NEXT CHARACTER THROUGH TREE
630 NEXT T
640 REM THIS SECTION PRINTS THE CHARACTER SET AND CODES
650 FOR Z=1 TO E
660 PRINT C$(Z);' ';
670 FOR Y=H(Z,1) TO 1 STEP -1
680 PRINT H(Z,Y+1);
690 NEXT Y
700 REM
710 REM END OF LINE
720 PRINT
730 NEXT Z
740 STOP
750 REM SUBROUTINE SMALL
760 REM THIS ROUTINE RETURNS THE SMALLEST FREQUENCY
770 REM VALUE IN M, POINTER IS IN I.  IT REPLACES
780 REM THE SMALL FREQ. WITH 9999.
790 REM IT SEARCHES BOTH THE CHAR. FREQ. ARRAY F AND
800 REM THE FREQ. OF NODES IN MATRIX P COLUMN 3.
810 M=9999
820 FOR J=1 TO E
830 IF F(J)>M THEN 860
840 M=F(J)
850 I=J
860 NEXT J
870 FOR J=1 TO I1-1
880 IF P(J,3)>M THEN 910
890 M=P(J,3)
900 I=J+E
910 NEXT J
920 IF I<=E THEN 950
930 P(I-E,3)=9999
940 GO TO 960
950 F(I)=9999
960 RETURN
970 REM END SUBROUTINE SMALL
980 REM
990 REM SUBROUTINE HUFFY. PLACES FLAG IN MATRIX H
1000 REM THE LENGTH OF EACH CODE IS IN MATRIX H COLUMN 1
1010 REM
1020 H(T,1)=H(T,1)+1
1030 C2=H(T,1)+1
1040 H(T,C2)=F
1050 RETURN
1060 REM HERE IS A SAMPLE DATA SET.
1070 DATA 'A',30,'E',25,'I',20,'O',15,'U',10
1080 DATA 'END OF DATA',9999
1120 END
```

Tuning Up the 1802
A Simple Music Composition Trainer

The RCA VIP can give beginning composers audio and visual feedback.

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Trying to represent a hummed note on a musical staff can be frustrating for the inexperienced composer, but for many people the personal computer has come to the rescue. However, music programs and their associated hardware are quite complicated, and it can take as long to master them on a personal computer as it does to learn how to play a cathedral-sized organ.

Here's a program that can help budding computer musicians grasp the basics of music and have fun at the same time. The program lets you hear the tones as they are entered on a keyboard while simultaneously displaying them on a musical staff. It stores the notes and allows for editing and controlled playback. Written for the RCA VIP equipped with at least 2K bytes of memory and the 512-byte CHIP-8 interpreter, the program will also work on an ELF II preprogrammed with CHIP-8.

For those unfamiliar with the CHIP-8, it's a hexadecimal interpreter written by RCA for its CDP 1802 microprocessor. In the world of software, interpreters lie somewhere between assembly-level programs and more elaborate compiled languages (such as FORTRAN). They allow program execution at a reasonable speed, while retaining the programming ease and logic of a higher-level language.

Two accessories are needed to use this music program: the RCA VP595 Sound Board and an ASCII- (American Standard Code for Information Interchange) encoded keyboard. Although RCA offers a full ASCII keyboard for the VIP, almost any will suffice once the strobe polarity is determined. See figure 1 for a keyboard-to-VIP wiring diagram.

The VP595

The VP595 is a single-channel, 256-note programmable tone generator with a built-in speaker, volume control, and an output jack. At $30, it's a pretty good buy. Its 8-bit parallel port provides the division ratio necessary for playing back the required note. The tonal range is

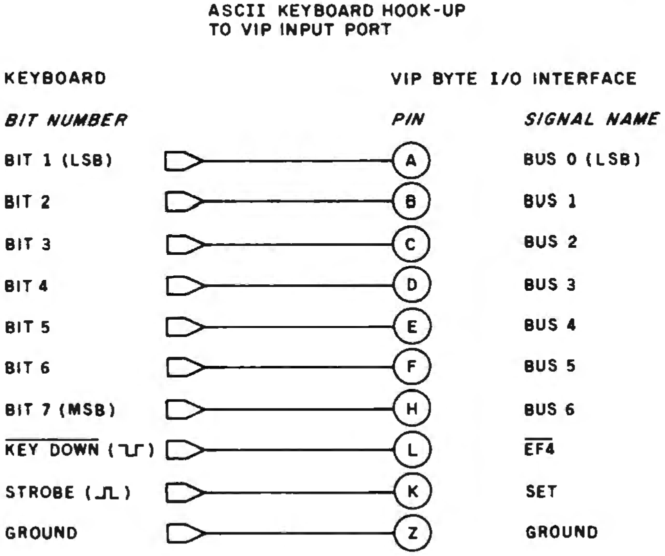


Figure 1: *Connection diagram for adding an ASCII-encoded keyboard to the VIP computer. If keyboard data is valid for the duration of the Key Down signal, no Strobe signal is necessary. If the Key Down signal is not available from the keyboard, an inversion of the Strobe signal can be used.*

from 110 Hz (A-natural in the second octave) to 6645 Hz (G-sharp in the eighth octave). However, the entire range can be shifted up or down by adjusting a trimmer resistor on the circuit board. These notes can be selected by feeding 1-byte instructions from the VIP's hexadecimal keyboard or, more conveniently, by letting the VIP interpret the ASCII output of a standard alphanumeric keyboard.

The Music Program

The music program:

- converts your ASCII keyboard into a piano-like keyboard that plays musical notes as appropriate keys are pressed.
- when used with a video monitor, displays the notes sequentially on a musical staff as it plays (to a maximum of 60 notes onscreen at one time).
- stores, plays back, and redisplays a composition of up to 60 notes, allowing full backspace erasure plus control of note length and pauses.
- translates notes into their alphanumeric equivalents and redisplays them in that form during playback.

As a practical compromise of keyboard accessibility and graphic resolution, two full octaves, including sharps, are used, but enough room is left in the program to extend that to three or four octaves.

The keyboard keys work like a piano (see table 1a). For example, the duration of each note played back is proportional to the length of time the note key is pressed. Additional keys are used for control and editing, as shown in table 1b.

1a

Key:	A	S	D	F	G	H	J	K	L	;	/	Q	W	E
Note:	C4	D4	E4	F4	G4	A4	B4	C5	D5	E5	F5	G5	A5	B5

1b

Key	Use
Backspace or Tab	Erases last note entry from the screen and from memory. It's possible to clear all notes except the first one by repeatedly pressing either key.
Return	Plays back the entered notes and redisplays them.
Spacebar	Blinks cursor and stores a rest (silent interval) in memory. As with notes, the length of time the space key is pressed will be duplicated upon playback.
1, 2, 3, 4, 5	Determine length of space between the played-back notes (default value is 2).
9	Clears the screen, plays back, and displays the alphanumeric equivalent of the first page (top staff). Pressing the key again erases the screen, plays back, and displays the second page (bottom staff).
0	Same as 9, but no note playback.

Table 1: *Using the VIP keyboard. Table 1a shows which keys produce which notes. Sharps are produced by holding down the shift key as the note key is pressed. Table 1b gives a description of the functions of each command key.*

Preparing the CHIP-8

CHIP-8 instructions have a simple, consistent format (see table 2). Each instruction is 2 bytes long (4 hexadecimal digits) and performs an assigned, individual function. In examining each of the CHIP-8's 31 instructions, the first letter or number is always fixed, while the next three can stand for memory address (*mmm*), hexadecimal variables (*x* or *y*), hexadecimal constants (*kk*), or special display data (*n*). For instance, jumping to memory location 200 is performed using the instruction 1*mmm*, rewritten as 1200. In other instructions, assigning a value of 16 to the hexadecimal variable *A* is done by using the 6*xkk* instruction, which would be rewritten as 6A0F.

A useful instruction is the D*xyn*, which displays on the screen a pattern *n*-bits high according to the coordinate values of *x* and *y*. As an example, a DAB1 instruction would display a single bit at screen coordinates *x* = value of variable *A*, and *y* = variable *B*. By continually changing variables' values, bits and whole patterns can be made to move quickly across the display screen.

Instruction	Operation
1*mmm*	Go to 0*mmm* (memory address *mmm*)
B*mmm*	Go to 0*mmm* + VO (memory address incremented)
2*mmm*	Do subroutine at 0*mmm* (must end with 00EE)
00EE	Return from subroutine
3X*kk*	Skip next instruction if VX = *kk*
4X*kk*	Skip next instruction if VX ≠ *kk*
5XY0	Skip next instruction if VX = VY
9XY0	Skip next instruction if VX ≠ VY
EX9E	Skip next instruction if VX = Hexadecimal key (least significant digit)
EXA1	Skip next instruction if VX ≠ Hexadecimal key (least significant digit)
6X*kk*	Let VX = *kk*
CX*kk*	Let VX = Random Byte (*kk* = Mask)
7X*kk*	Let VX = VX + *kk*
8XY0	Let VX = VY
8XY1	Let VX = VX/VY (VF changed)
8XY2	Let VX = VX and VY (VF changed)
8XY4	Let VX = VX + VY (VF = 00 if VX + VY ≤ FF, VF = 01 if VX + VY > FF)
8XY5	Let VX = VX − VY (VF = 00 if VX < VY, VF = 01 if VX ≥ VY)
FX07	Let VX = current timer value
FX0A	Let VX = hexadecimal key digit (waits for any key pressed)
FX15	Set timer = VX (01 = 1/60 second)
FX18	Set tone duration = VX (01 = 1/60 second)
A*mmm*	Let I = 0*mmm* (memory pointer for current data)
FX1E	Let I = I + VX (memory pointer increment)
FX29	Let I = 5-byte display pattern for the least significant digit of VX
FX33	Let MI = 3-decimal digit equivalent of VX (I unchanged)
FX55	Let MI = VO : VX (I = I + X + 1)
FX65	Let VO : VX = MI (I = I + X + 1)
00E0	Erase display (all 0s)
DXY*n*	Show n-byte MI pattern at VX−VY coordinates. I unchanged. MI pattern is combined with existing display via Exclusive-OR function. VF = 01 if a 1 in MI pattern matches 1 in existing display.
0*mmm*	Do machine-language subroutine at 0*mmm* (subroutine must end with D4 byte)

Table 2: *CHIP-8 instructions. In this table, x and y are variables, kk represents a hexadecimal constant, mmm is a hexadecimal address in memory, and n is a hexadecimal height pattern indicator.*

While the original CHIP-8 interpreter was written primarily for graphic displays and games, new instructions can be added and the interpreter may be modified to suit a given application. Such was the case here, because the standard CHIP-8 lacks an input-port status instruction and an output-port command. Changing the following codes in the CHIP-8 creates the necessary additional instructions, called F*x*00 and F*x*F9:

CHIP-8 Memory Location	New Instruction
0100	3F D4
0102	E6
0103	6B
0104	D4
01F9	E6
01FA	63
01FB	D4

F*x*00—reads into VX the value at the input port when a key is pressed; otherwise, VX = 0.
F*x*F9—sends the value of VX to the output port and the sound board.

Program Details

The hexadecimal listing (listing 1) is divided into separate blocks, with unused memory space in between. When entering the code, it's important to readdress the memory location before starting each new block. (See figure 2 for a simple flowchart.)

In its simplified form, the program works as follows: when a key is pressed, it is identified (e.g., by an FC00 instruction) and sent (perhaps by a 1306 instruction) to the tone-and-note display table where it is assigned a divisor, 5D (by a 6C5D), that represents the appropriate note, in this case note D in the fourth octave. It is also assigned (by 6E0E) position 0E on the staff and sent to memory location 0400. Here a check is performed to see if the variable *C* (VC) is a value 0 (pause). If not, the instruction FCF9 plays the note, and variable 0 (note length increment) is advanced. Memory entrance flag V8 is set to 0. Instruction 14C0 points to the display routine. Memory location 4401 then checks the V4 display flag—if V4 = 0 (initial). After selecting the correct upper staff, the instruction D2E1 displays the correct note, which is located at A65A—memory location 065A. Display flag V4 is set to 1, and the program returns to scan the keyboard. If the key is still pressed, the sequence repeats, but the display is omitted, because V4 = 1 and the note is already on the staff. As soon as the key is released, VC becomes 0, and the four variables dump their contents into memory with the F355 instruction:

V0	:	note length
VC becomes V1	:	tone (division ratio)
V2	:	note horizontal position on staff
VE becomes V3	:	note vertical position on staff

Listing 1: *The hexadecimal codes for the composing program.*

STAFF DRAWING

Memory Location				
0200	6202	A21E	6B00	6C04
0208	DBCA	7B08	4B40	1212
0210	1208	6C14	DBCA	7B08
0218	4B80	1228	1214	FF00
0220	FF00	FF00	FF00	FF00

KEYBOARD SCAN

0228	3201	6900	6B04	6A00
0230	FC00	4C61	1300	4C73
0238	1306	4C64	130C	4C66
0240	1312	4C67	1318	4C68
0248	131E	4C6A	1324	4C6B
0250	132A	4C6C	1330	4C3B
0258	1336	4C5C	133C	4C71
0260	1342	4C77	1348	4C65
0268	134E	126C	4C41	1354
0270	4C53	135A	4C46	1360
0278	4C47	1366	4C48	136C
0280	4C4B	1372	4C4C	1378
0288	4C7C	137E	4C51	1384
0290	4C57	138A	1296	4C20
0298	1390	4C08	147C	4C09
02A0	139A	4C0D	141E	4C30
02A8	139A	4C31	6B02	4C32
02B0	6B04	4C33	6B08	4C34
02B8	6B0B	4C35	6B0F	4C39
02C0	1396	4C38	139A	6400
02C8	6500	6C00	1400	1230

NOTE - TONE AND DISPLAY ASSIGNMENTS

				Corresponding Notes
0300	6C68	6E0E	1400	C4
0306	6C5D	6E0D	1400	D4
030C	6C53	6E0C	1400	E4
0312	6C4E	6E0B	1400	F4
0318	6C45	6E0A	1400	G4
031E	6C3E	6E09	1400	A4
0324	6C37	6E08	1400	B4
032A	6C34	6E07	1400	C5
0330	6C2E	6E06	1400	D5
0336	6C29	6E05	1400	E5
033C	6C26	6E04	1400	F5
0342	6C22	6E03	1400	G5
0348	6C1E	6E02	1400	A5
034E	6C1B	6E01	1400	B5
0354	6C62	6E0E	1400	C4#
035A	6C58	6E0D	1400	D4#
0360	6C49	6E0B	1400	F4#
0366	6C41	6E0A	1400	G4#
036C	6C3A	6E09	1400	A4#
0372	6C31	6E07	1400	C5#
0378	6C2B	6E06	1400	D5#
037E	6C24	6E04	1400	F5#
0384	6C20	6E03	1400	G5#
038A	6C1D	6E02	1400	A5#
0390	6C01	6E00	1400	Space

0396	6E02	3E02	6E03
039C	6A00	A65F	6D00
03A2	6700	6600	00E0
03A8	F365	1500	A6D7
03AE	6A78	13A0	

MEMORY WRITE & NOTE PLAY

0400	4C00	1414	4C01	140C
0408	FCF9	FB18	7001	81C0
0410	6800	14C0	4800	F355
0418	6801	6000	1230	

MEMORY READ

041E				A65F
0420	6A00	F365	4F05	80B0
0428	A65A	4101	D231	D231
0430	A65F	7A04	FA1E	7504
0438	4100	1444	4101	1444
0440	F1F9	F018	F015	F707
0448	3700	1446	FB15	F707
0450	3700	144E	5590	145C
0458	6500	1230	FC00	4C0A
0460	1230	1422		

BACKSPACE

047C			4204	1230
0480	3900	1486	1230	3500
0488	1230	A65A	4101	D231
0490	D231	6502	8255	6504
0498	A65F	8955	F91E	F355
04A0	A65B	F91E	F365	1230

DISPLAY NOTES

04C0	4401	1230	663E	8265
04C8	8DF0	4F00	14DA	A65A
04D0	7E10	8264	427A	1482
04D8	14DE	8264	A65A	7202
04E0	4101	D2E1	D2E1	6401
04E8	7904	A65B	F91E	83E0
04F0	1230			

ALPHANUMERIC MAP POINTERS

0500	4168	A600	4162	1566
0508	415D	A605	4158	156A
0510	4153	A60A	414E	A61E
0518	4149	156E	4145	A60F
0520	4141	1572	413E	A619
0528	413A	1576	4137	A614
0530	4134	A624	4131	157A
0538	412E	A628	412B	157E
0540	4129	A62C	4126	A63D
0548	4124	1582	4122	A630
0550	4120	1586	411E	A638
0558	411D	158A	411B	A634
0560	4101	A643	1590	A600

```
0568      158E  A605  158E  A61E
0570      158E  A60F  158E  A619
0578      158E  A624  158E  A628
0580      158E  A63D  158E  A630
0588      158E  A638  158E  6402

       ALPHANUMERIC PRINT & PLAY
0590      9590  15C0  7504  D675
0598      4402  A642  4402  D671
05A0      6400  4E02  25CE  760B
05A8      4642  15B8  15EC  15C0
05B0      A65F  7A04  FA1E  13A8
05B8      7706  6600  7D01  15AC
05C0      FC00  4C0D  15C8  15C0
05C8      00E0  6201  1202  4100
05D0      15DA  4101  15DA  F1F9
05D8      F018  F015  F007  3000
05E0      15DC  FB15  F007  3000
05E8      15E4  00EE  3D05  15B0
05F0      FC00  6E02  4C39  13AC
05F8      6E03  4C30  13AC  15F0

         ALPHANUMERIC MAP
0600      F585  8781  F1F5  5557
0608      51F1  F585  E781  F1F5
0610      85B7  91F1  F555  7751
0618      F1F5  95F7  9191  F585
0620      E781  8100  F784  8781
0628      F754  5751  F784  E781
0630      F784  B791  F754  7751
0638      F794  F791  97F7  84E7
0640      8187  0100  00FF  0000

            NOTE SHAPE
065A      8000
065F      Program dumps variables
          starting here
```

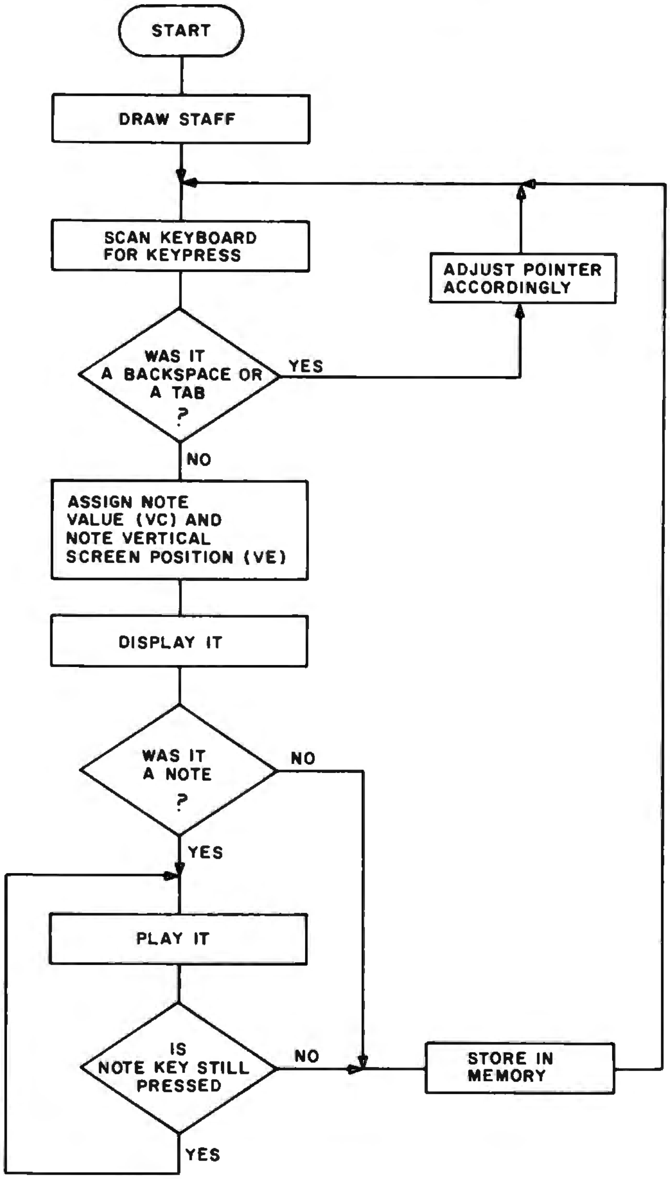


Figure 2: *Flowchart of the program detailing the operations performed by the VIP during note-entry mode.*

On each entry, the memory is incremented to allow sequential storage of the four variables. This provides an easy solution to the backspace function, which simply redisplays the note and decrements the memory. When Return is pressed, the note data-memory locations are scanned with F365, erased, tested for pause length, and replayed through a set of timing instructions at F018 and F015, which reconstruct the note and pause lengths.

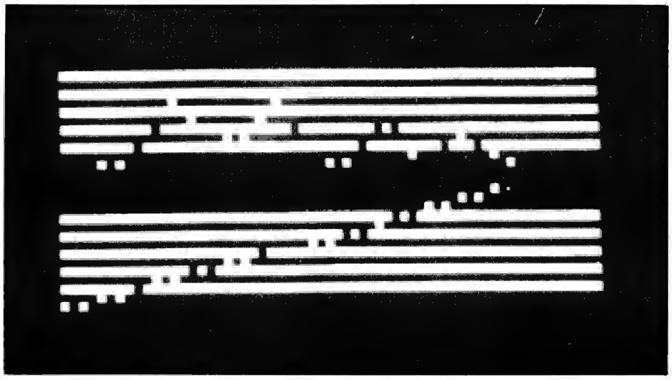
Pressing the 0 or 9 key sends the program into a separate section at memory location 0500, where each variable is identified by a 41*xx* instruction and directed to an alphanumeric map assignment table. Again, repetition was sacrificed for program speed. All necessary playback and display instructions start at location hexadecimal 0590.

Playing Your Music

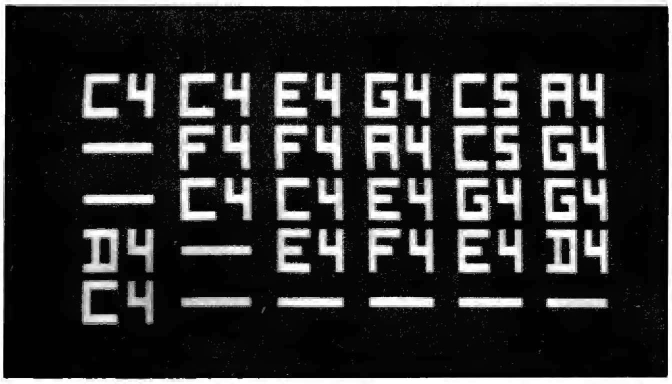
Pressing any of the keys shown in table 1a will produce a corresponding note and display it in the correct position on the staff. Subsequent entries will automatically advance the horizontal position of the note on the screen.

If the wrong note is entered, pressing the Tab or Backspace key will erase the last notes and allow entry of new ones. All but the first note—usually a key marker—can be erased with either Tab or Backspace. Both keys work in the same manner, but since they are on the opposite side of the keyboard, one may be easier to use than the other.

Pressing the Return key will play all the notes from the start and redisplay them (see photo 1). Because of the way the CHIP-8's display statement works, the notes are erased as they play back. Pressing the Return key again will simultaneously replay the notes and bring them back



1a



1b

Photo 1: *Video display of the musical composition. Photo 1a shows the composition as it would appear on a musical staff. (The upper staff is "Home on the Range," while the lower staff is simply the scale of notes provided by the machine.) Photo 1b shows the alphanumeric version of the upper staff from photo 1a.*

on the screen. As you add to your "composition," the Return command will always play it back from the beginning.

Pressing the number keys (1 to 5) before pressing Return will change the length of the playback by altering the length of spaces between the notes. Key 1 will select a very short duration, key 2 a longer one, and so forth.

The first note can be erased only by flipping the Reset switch. The sharp keys are activated by pressing the Shift key as in table 1a. For instance, pressing A alone will produce note C in the fourth octave, but pressing Shift and A will produce C sharp.

Because of the VIP's limited graphics resolution, it is not possible to indicate sharps on the staff; however, in the alphanumeric listing, the sharps are indicated by a chopped-off section of the octave number.

After 60 entries—when both staffs are full—the program disregards new entries. It can, however, be reset with the VIP's Reset switch, which clears the memory and resets all variables. The VIP is then ready for a new tune.

Expansion Possibilities

The unused memory between the programming blocks can provide for program expansion or custom changes. For example, a greater range of notes can be obtained by adding more keys for the scan routine and new note and display instructions.

A 2*mmm* subroutine command could replace 1296 at hexadecimal location 0294 and point to free memory space (e.g., at hexadecimal 0700, where new keyboard-scan instructions could be added).

To add notes, two instructions per new note are necessary:

4C*xx*, skip next instruction if VC ≠ XX (*xx* is the ASCII value of the new key)
1*mmm*, go to *mmm* (*mmm* is the hexadecimal memory address where the note and staff position values are stored)
An alternate way to put in additional note instructions would be to enter them at memory location 0294 and push down everything between 0296 and 02CF.

New note and staff values should then be entered at hexadecimal 0390. Three instructions are required for each new note:

6C*xx*, VC = *xx* (new note division ratio in hexadecimal, as given in the VP595 board manual)
6E*xx*, VE = *xx* (note position on the staff in hexadecimal, 01 to 0E)
1400, go to memory location hexadecimal 0400 (write and play)

Once again, previous instructions located at 0390 should be reentered below the new ones, and pointers at old memory locations hexadecimal 05B6, 05F6, and 05FC have to be modified accordingly.

The keyboard scan and assignment subroutine is fast and the best compromise in program effectiveness and key response, even though it seems quite lengthy to enter and sometimes repetitious. Entered correctly, the program does not crash, even if invalid keys are typed. It gives hours of worthwhile fun and may even uncover some hidden talents.

Of Interest

A couple of years ago, Abacus Software released a new interpreter language for the PET/CBM called Vigil. It is patterned on the CHIP-8 but has extended capabilities and more than 60 instructions. Like the CHIP-8, it makes fast graphics and audio tones possible, is easy to program, and occupies little memory space.■

References

1. John Chmielewski. "CHIP-8 III," *Viper*, volume 2, issue 7, February 1980.
2. H. Kleinberg. "Programming in CHIP-8," publication number PE-721. Somerville, NJ: RCA Solid State Division, 1978.
3. *RCA COSMAC VIP Instruction Manual #VIP-300-1*. Somerville, NJ: RCA Solid State Division.

Double Your TRS-80's Graphics Resolution

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With a resolution of 128 by 48 picture elements (pixels), the graphics capability of the Radio Shack TRS-80 is inadequate for many applications. In addition, since the aspect ratio (ratio of width to height) of a pixel is 0.5 or less, horizontal lines appear twice as broad as vertical lines. This results in low-quality graphics plots.

These out-of-shape rectangular elements can be made square by doubling the vertical resolution to 96 pixels. The increased resolution makes presentation of graphs more acceptable (see photo 1). The modification described in this article, which is intended for Model I Level II TRS-80s, accomplishes this and, in addition, displays the hidden lowercase character set of the TRS-80 on the video monitor.

System Configuration

The TRS-80 uses seven 2102 static-memory integrated circuits (ICs) to hold the video information. This amounts to 1024 memory locations by 7 bits wide, or 16 lines by 64 characters per line in the alphanumeric mode. In the graphics mode, a character position is subdivided into 6 pixels as shown in figure 1. Depending on the mode selected by bit 7, the remaining bits will either address the character-generator ROM (read-only memory) for a limited number of the 128 ASCII (American Standard Code for Information Interchange) characters and symbols actually available, or act as on-off controls for the 6 graphics elements.

Because resolution is a function of video-memory size, doubling the memory raises some questions about new address allocation, software compatibility, performance, mounting space, and the ability of the

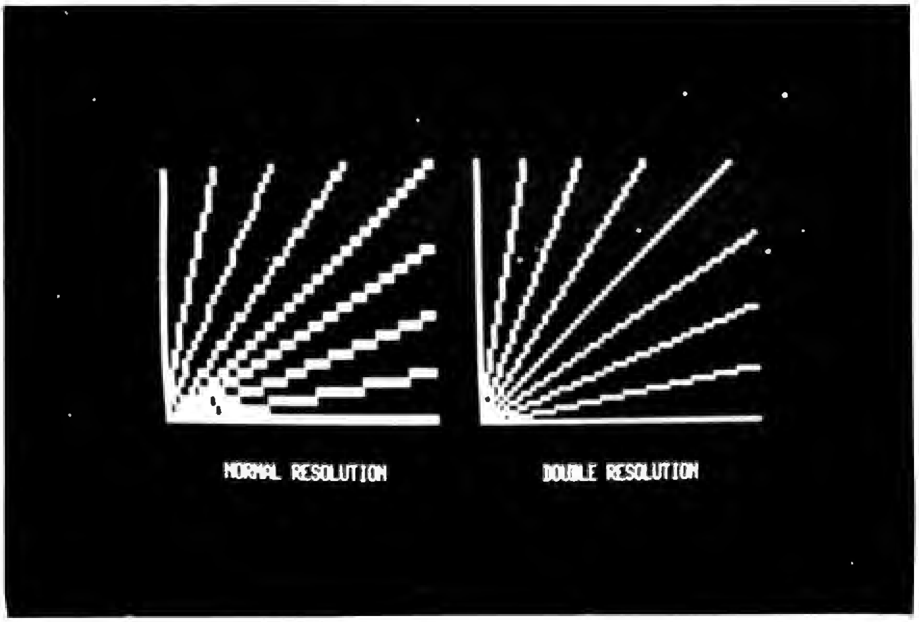

Photo 1: *The result of running the BASIC program shown in listing 1. This photo shows the improvement in graphics capability that can be expected after making the hardware modification described in this article.*

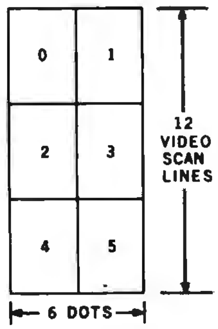

Figure 1: *TRS-80 graphics character. On the TRS-80, a graphics character is divided into 6 rectangular picture elements called pixels. Each pixel is controlled by bits 0 through 5 of the character's ASCII code representation. Bit 6 is not stored. Bit 7 is used to select either alphanumerics or graphics.*

power supply to handle the increased load. All of these problems have been resolved in this modification.

Interlacing Is the Key

This modification requires replacing the video-memory ICs with four higher-density (1K by 4-bit) ICs and adding the necessary control logic. Refer to the *TRS-80 Technical Reference Handbook* for circuit theory and schematics. In the modified configuration, the memory chips are wired as dual 1K by 8-bit blocks. Both memory blocks are addressed by the original 10 address lines and are simultaneously mapped with the same hexadecimal memory locations 3C00 through 3FFF. Controlled multiplexing of the two video-memory pages makes this memory-map-sharing technique possible. It also simplifies adaptation of the resident software and keeps hardware changes minimal. Figure 2 illustrates the method used.

Enabling of either one or both memory sections is done under output port control (see figures 3 and 4). When the computer is powered up or reset, the normal low-resolution operation occurs, enabling one memory

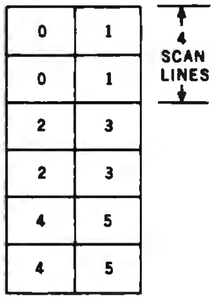

Figure 2: *New format of interlaced graphics cells, formed after the hardware modification by accessing the first video-memory block during the upper two video-scan lines of a pixel. The second block of memory, which shares the same address, takes over for the two remaining lines.*

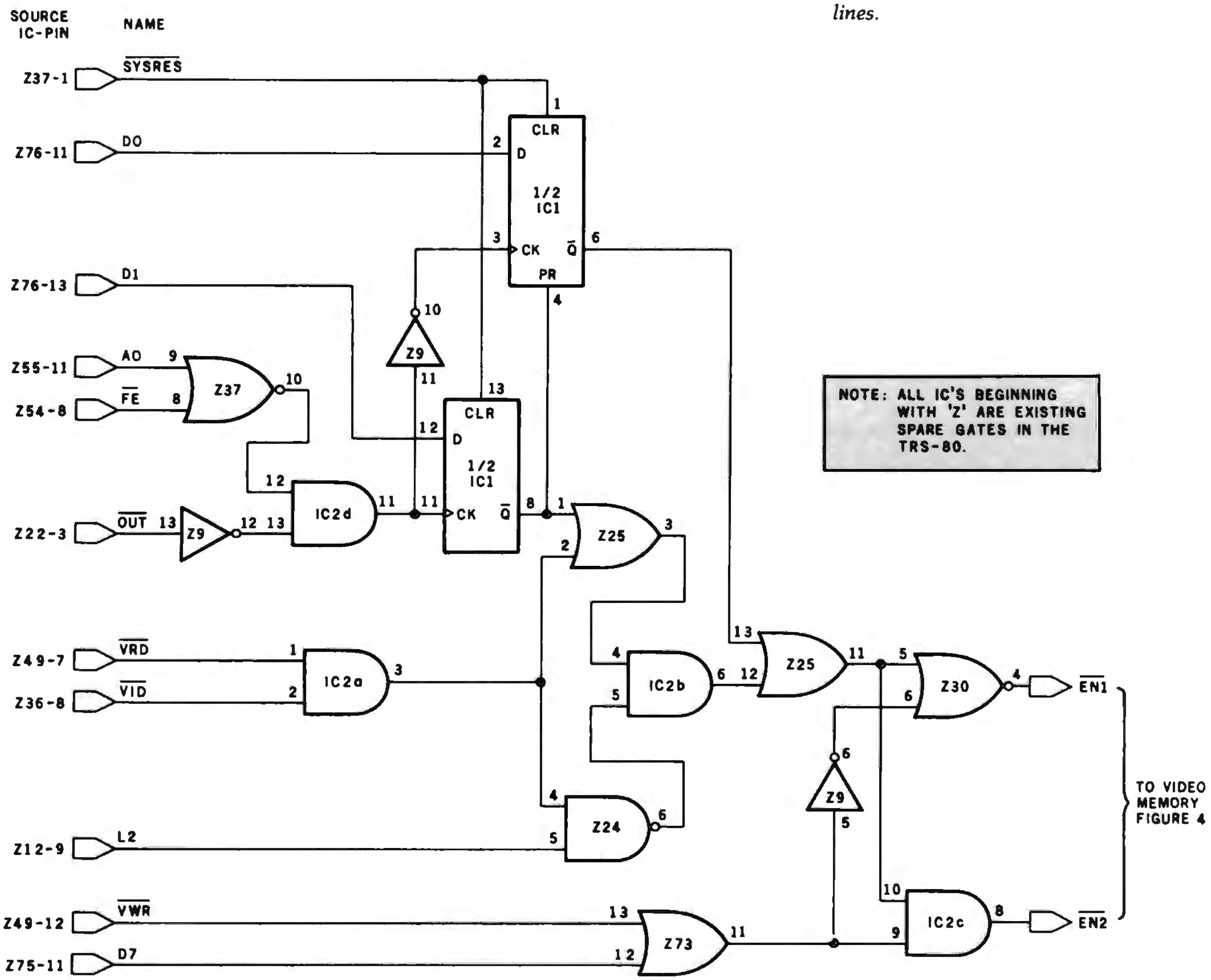

Figure 3: *The modified TRS-80 video-control circuit. IC1 is a 74LS74; IC2 is a 74LS08. All other elements shown are spare gates on the TRS-80 video board.*

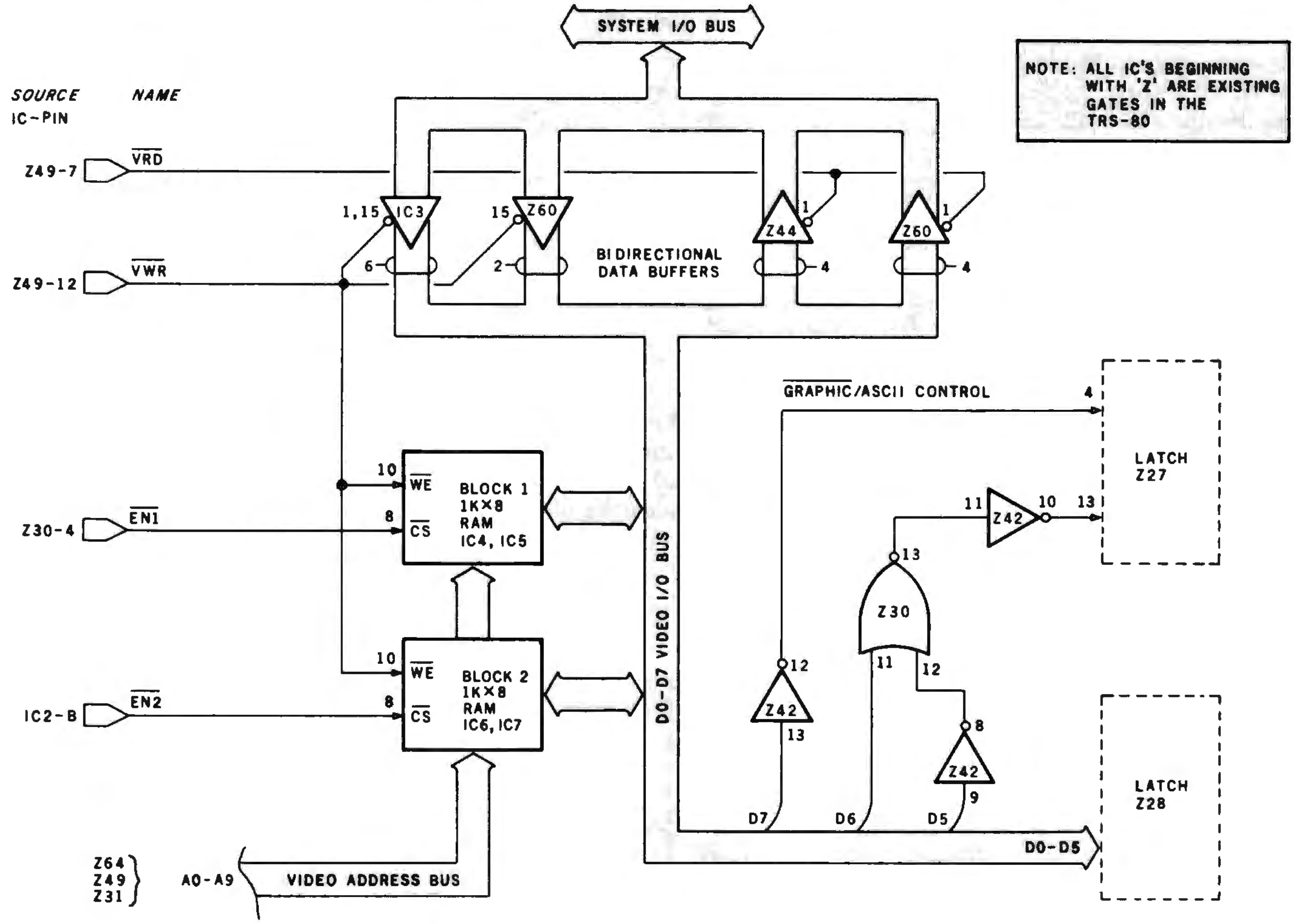

Figure 4: *The TRS-80 video memory and interface.*

block. Sending the value 1 to port 254 latches the system in the double-resolution mode and makes video-memory block 1 active for graphics handling. Sending the value 2 to the same port latches the system in the double-resolution mode and enables video-memory block 2 for graphics handling. The TRS-80 is returned to normal resolution by sending the value 0 to port 254. Only during processor-controlled data transfer in the graphics mode will one block of memory or the other be enabled. Note that when ASCII characters are involved, both sections become active in the alphanumeric mode for parallel data storage to preserve the integrity of the characters in mixed-mode operation. During the time when the screen-refresh counters take hold of the video-memory address, the logic governing the operation merges the two memory sections in an alternating fashion transparent to the video display. The upper half of each pixel, consisting of every two video-scan lines, is covered by the first memory block. The second memory block is devoted to the bottom half of each pixel.

Modifying the Board

This modification requires the removal of several ICs from the keyboard logic board, cutting traces, drilling holes, and rewiring. If you're using the spare gates available on the board, the unused inputs of these gates must be ungrounded. In some production runs the existing ground is on the component side of the board under the ICs. If you use this method, you'll need three devices (74LS74, 74LS08, and 74LS367) as well as four 2114L programmable-memory chips. All of these components will fit in the area from which the seven 2102 programmable-memory chips were removed.

Since the 2114s are 18-pin devices, you'll need to drill two extra holes per chip to accommodate them. And when cutting traces, make absolutely sure you reroute interrupted runs. Good desoldering equipment and a great deal of patience are absolutely essential for a successful job. Also remember that opening the case voids the warranty on your TRS-80.

You may prefer an alternate modification method to avoid some of the board changes associated with the first approach. The circuit can be built on a small board, although you'll need more components. You can attach the board to the main printed-circuit board after removing the existing memory chips and making the necessary changes.

Listing 1: *A BASIC program illustrating graphics programming procedure for the TRS-80 after making the hardware modification described in this article. The result of running this program is shown in photo 1.*

```
5 ' SAMPLE PROGRAM FOR USE WITH MODIFIED TRS-80
10 CLS:PI=3.14:DX=1:DY=1:XMAX=57:YMAX=7
20 FOR I=0 TO PI/2 STEP PI/16
30 XO=1:YO=34
40 X=0:Y=0:SLOPE=TAN(I)
50 IF SLOPE>1.6 THEN 200
60 Y=SLOPE*X/2
70 XP=X+XO:YP=-FIX(Y)+YO
80 IF XP>XMAX THEN 400 ELSE IF YP<YMAX THEN 400
90 OUT254,1:SET(XP,YP):OUT254,2:SET(XP,YP)
100 X=X+DX:GOTO 60
200 X=2*Y/SLOPE:YP=-Y+YO:XP=X+XO
210 IF XP>XMAX THEN 400 ELSE IF YP<YMAX THEN 400
220 OUT254,1:SET(XP,YP):OUT254,2:SET(XP,YP)
230 Y=Y+DY:GOTO 200
400 XO=67:YO=68
410 IF SLOPE<.99 THEN J=1 ELSE IF SLOPE>1 THEN J=3 ELSE J=2
420 XR=0:YR=0:X=XR+XO:Y=-YR+YO
430 IF X>127 THEN 700 ELSE IF Y<13 THEN 700
440 N=2*INT((Y+1)/2)
450 IF N=Y THEN YP=Y/2:OUT254,2:ELSE YP=(Y+1)/2:OUT254,1
460 SET(X,YP)
470 ON J GOTO 600,600,500
500 Y=Y-DY:YR=YR-DY
510 XR=-YR/SLOPE:X=XR+XO:GOTO 430
600 X=X+DX:XR=XR+DX
610 IF J=2 THEN YR=XR:Y=-YR+YO:GOTO 430
620 YR=SLOPE*XR:Y=-FIX(YR)+YO:GOTO 430
700 NEXT:PRINT @ 838,"NORMAL RESOLUTION"
710 PRINT @ 872,"DOUBLE RESOLUTION"
720 GOTO 720
```

Whichever modification method you use, the pixels can be made perfectly square by adjusting the vertical-height trim potentiometer in the video monitor.

Lowercase Display

While the TRS-80 can output upper- and lowercase alphanumerics to a printer, the display does not discriminate between the two. Without this feature, editing lowercase text is difficult and programming errors can occur. These errors may go undetected or be hard to debug. One example occurs when a variable name at one place in the program is inadvertently entered with the shift key pressed. The name will appear on the video display as the same uppercase name assigned somewhere else, yet it will be interpreted by the computer as a different variable name.

When lowercase alphanumeric codes are written into the video memory, the sixth bit in the ASCII code is forced low by the resident program. The complement of this bit forms the seventh bit, or most significant bit (MSB), which cannot be stored due to insufficient video byte width. After modification, the extra bit gained by using full-byte video memory provides the necessary room for the MSB and solves part of the problem. To display lowercase letters, either replace the resident program with a corrected version or use an assembly-language program that outputs the correct code to the video screen. When the sixth bit is correct, the steering logic in the modification allows the new bit to be used for the MSB. Otherwise, normal operation is maintained. For a quick check, run the following program:

```
10 FOR I = 64 TO 127:
   POKE 15680 + I, I :
   NEXT
```

Both uppercase and lowercase alphabets should be displayed.

Graphics Programming Methods

The comparison program used for generating the two sets of lines in photo 1 is shown in listing 1. Each set is a family of straight lines passing through the origin of its established coordinate axes and bounded by specified upper and right-hand boundaries. In each set, the slope is incremented from 0 to 90 degrees at 11.25-degree increments. The mathematical solution is straightforward, but a few steps deserve clarification.

The ordinate variable in the equation for the normal-resolution set of lines is scaled by a factor of 2 to compensate for the 1-to-2 aspect ratio and produce the correct slope.

A slope greater than 1 means that the rate of change in the y-direction is greater than the rate of change in the x-direction and a line with fewer points spaced apart will result. This condition is circumvented in the program by incrementing y as the independent variable and solving for x in terms of y, thereby maintaining line continuity.

Although normal resolution calls for latching the computer in the normal mode, lines of the normal-resolution set were simulated by plotting them in the double-resolution mode in both memory blocks at lines 90 and 220.

The routine for the double-resolution lines starts at line 400. One major difference is that while an ordinate scale of 0 to 95 may be used in the equation, the scale must be broken down to two 0-to-47 scales with odd-even identity.

The ordinate value is reduced to an integer number and the number is examined and converted to its correct identity scale at lines 440 and 450. To store the graphic point in video memory, block 1 is enabled for odd ordinate numbers; block 2 for even numbers.

The same method may be applied for other graphic statements such as RESET and POINT.■

Idiot-Proof Input in Pascal

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Much of the power and elegance of Pascal programming is derived from the programmer's capacity to define data types. Treating data abstractly allows the program to reflect the problem that it is modeling. Unfortunately, Pascal offers no execution-time error recovery, so any invalid user input that is entered causes annoying problems.

The user interface is Pascal's weak link, and the lengthy code necessary to check for input errors shows it. Furthermore, in programs where several user responses may be valid, it would be nice to be able to use Pascal's CASE statement to select the proper course of action.

Since CASE requires a nonreal scalar index, the user must convert the input from a character string to an enumeration-type variable. Thus, editing of input errors becomes possible. Listing 1 demonstrates a method for obtaining "idiot-proof" input in Pascal. Note that an enumeration-type is used to define all valid input commands.

The major loop of the input routine continues until a valid input is found. A simple search of the array TRANSFORM uses the SUCC procedure. Since this code includes a type transformation, a CASE statement can be used to select the proper action.■

Listing 1: *This program demonstrates a method for obtaining idiot-proof input in Pascal.*

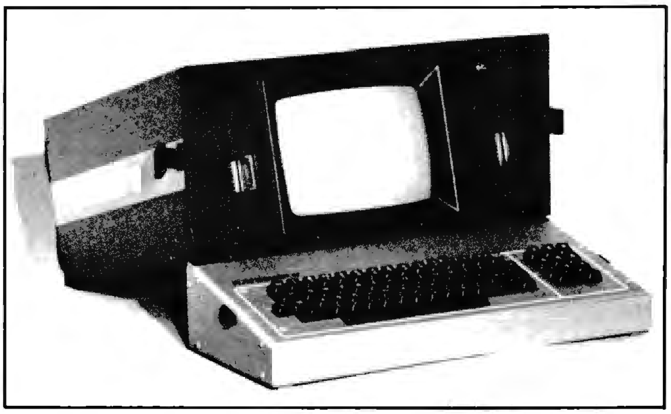
```
program star_trek(input,output);

{This program illustrates the use of idiot-proof input in Pascal}

type
        token                       = packed array[1..10] of char;
        valid_input                 = (warp,impulse,photon,error);
var
        index                       : valid_input;
        good_response               : boolean;
        transform                   : array[warp..error] of token;

begin
  {Initialize the transformation array}
  transform[warp]    := 'WARP      ';
  transform[impulse]:= 'IMPULSE   ';
  transform[photon]  := 'PHOTON    ';

  {Other program code goes here}

  {Start the idiot-proof input}
  good_response:= false;
  {Loop until a valid input is given}
  while not good_response do
```

Listing 1 continued:

```
    begin
      write('ENTER DESIRED COMMAND: ');
      {Get a response from the user}
      readln(transform[error]);
      writeln(transform[error]);
      {Initialize the pointer to the transformation array}
      index:= warp;
      {Search the transformation array for a match}
      while transform[index] <> transform[error] do
        index:= succ(index);
      {Check for an invalid response}
      if index = error then
        writeln('INVALID RESPONSE...TRY AGAIN')
      else
        good_response:= true;
    end;

  {The input has been converted to an enumeration type. Other program
  code goes here, for example:}

  case index of
    warp    : writeln('WARP FUNCTION');          {Program code for each     }
    impulse : writeln('IMPULSE FUNCTION');       {function goes here.       }
    photon  : writeln('PHOTON FUNCTION');        {..........................}
  end;

  {Other program code goes here}

end.

ENTER DESIRED COMMAND: PHASER
INVALID RESPONSE...TRY AGAIN
ENTER DESIRED COMMAND: PHOTON
PHOTON FUNCTION
```

What's New?

SYSTEMS

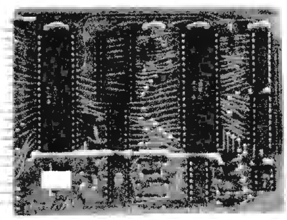


CP/M-Compatible Portable Computer

The Kaycomp II is a CP/M-compatible portable computer. The Z80A-based Kaycomp has 64K bytes of memory and a 9-inch display screen with a 24-line by 80-column format. Other standard features include dual 5¼-inch floppy-disk drives, an RS-232C interface, and a snap-together, fan-cooled metal cabinet. Software supplied with the Kaycomp II includes the CP/M operating system and a word processor, and, from Microsoft, MBASIC, the Multiplan electronic spreadsheet, and the Mu/Math mathematics utility program.

The Kaycomp II costs $1795. Contact Non-Linear Systems, POB N, Del Mar, CA 92014, (714) 755-1134.

Circle 500 on inquiry card.



AIM-Compatible Computer Controller

The μCortex/65 is an AIM-65-compatible, single-board computer controller. The board has a 1K-byte RAM (random-access read/write memory), a socket for a 2K-byte 2716 EPROM (erasable programmable read-only memory), a crystal-controlled clock, a 6522 VIA (versatile interface adapter) with 16 I/O lines, four control lines, and two 16-bit timers. Other features include a 44-pin edge connector that's pinout-compatible with Rockwell International's AIM-65 application connector, a 555 clock startup and reset circuit, and VIA memory location compatibility with the AIM-65's application VIA.

The μCortex/65 costs $79.95, plus shipping. For details, contact Cortex Research Corp., 1912 Raymond Dr., Northbrook, IL 60062, (312) 480-1088.

Circle 501 on inquiry card.

Low-Cost Computers Have 64K-Byte Memory

Milwaukee Computers' MC-1000 series of 6502-based single-board computers features a 64K-byte memory, dual 5¼-inch disk drives, a real-time clock, two RS-232C interfaces, and a Centronics-type parallel printer port. Additionally, the MC-1000 is provided with extensive self-diagnostics in ROM (read-only memory).

A wide assortment of options are available for the MC-1000, including expanded disk capacities to 1.8 megabytes and UCSD Pascal, BASIC, and FORTRAN-77 compilers. In single units, the MC-1000 costs $995. For complete details, contact Milwaukee Computers Inc., 16235 West Ryerson Rd., New Berlin, WI 53151, (414) 784-2312.

Circle 502 on inquiry card.

68000 Computer with Unix

Dual Systems Control Corporation's System 83 is a 68000-based computer running under Unix version 7. The System 83 has a dynamic 256K-byte RAM (random-access read/write memory) with parity and a 20-slot IEEE-696/S-100-compatible backplane. The Unix operating system is provided with such enhancements as C-shell, the Visual editor, a C language compiler, a 68000 assembler, and a linker/loader. Other features of the System 83 include the ability to execute 1 million instructions per second, the ability to support up to 16 megabytes of directly addressable memory, and resident-memory capacities of up to 4 megabytes within the enclosure.

Optional equipment for the System 83 includes single- and double-density and single- and double-sided 8-inch disk drives, 8-inch Winchester hard-disk drives, A/D and D/A (analog-to-digitial and digital-to-analog) converters, and output-controller boards. Prices for the System 83 with Unix and floppy-disk drives start at $8295. For details, contact Dual Systems Control Corp., 720 Channing Way, Berkeley, CA 94710, (415) 549-3854.

Circle 503 on inquiry card.

Sage II

The Sage II is a 68000-based single-board computer recently introduced by Sage Computer Technology. The Sage II can be equipped to carry from 128K to 512K bytes of RAM (random-access read/write memory) and up to 1.3 megabytes of mass storage on two 5¼-inch floppy disks. Standard features include two RS-232C serial ports, a

Centronics-compatible parallel port, and an IEEE-488 interface. The Sage II supports Pascal, BASIC, FORTRAN, and assembly language.

The Sage II ranges in price from $3600 to $6000, depending upon disk and RAM configurations. An optional interrupt-driven UCSD operating system costs $400, and extra RAM is available for $400 per 128K bytes. Contact Sage Computer Technology, Suite 14, 195 North Edison Way, Reno, NV 89502, (702) 322-6868.

Circle 504 on inquiry card.

Xenix-Compatible Single-Board Computer

The FT-68M/10 is a 10-MHz 68000-based Multibus-compatible single-board computer carrying 128K or 256K bytes of RAM (random-access read/write memory). Completely compatible with the Xenix operating system, the 6- by 12-inch 68M/10's RAM features error detection and memory management. Other standard features include two serial communications channels and a parallel input channel.

In single quantities, the 128K-byte FT-68M/10 costs $3495, and the 256K-byte unit costs $3995. For further details, contact Forward Technology Inc., 2595 Martin Ave., Santa Clara, CA 95050, (408) 988-2378.

Circle 505 on inquiry card.

Desktop Computer Has Winchester Drives

Durango Systems' 900 series of fully integrated desktop business computers features a built-in Winchester disk drive that offers up to 15 megabytes of online storage. Standard features include a keyboard, a display screen, and a dot-matrix printer. Two models are available: the 900, which has a single-mode printer, and the 900XR, which has a dual-mode printer. The 900XR provides letter-quality printing on single sheets and envelopes at speeds of up to 200 characters per second. Additionally, the 900 series stores a variety of type styles in memory, and foreign-language characters and special fonts can be created or modified.

Options for the 900 series include an auxiliary fixed disk for an additional 7 or 14 megabytes of storage. Prices for 900 series systems range from $11,950 to $14,950, depending upon configurations. For complete details, contact Durango Systems, 3003 North First St., San Jose, CA 95134, (408) 946-5000.

Circle 506 on inquiry card.

Foxy Computer

Digital Microsystems' Fox desktop computer can serve as a stand-alone unit or as a member of a HiNet local area network. The portable Z80A-based Fox features two 5¼-inch single- or double-density double-sided floppy-disk drives, a high-speed RS-422 network port, four RS-232C serial ports, two 8-bit bidirectional parallel ports, and a high-resolution 9-inch display screen with a 25-line by 80-character format. Running under the CP/M operating system, the Fox has 64K bytes of RAM (random-access read/write memory), 1K byte of ROM (read-only memory), and mass-storage capacities of 600K bytes per double-density double-sided disk for a total of 1.2 megabytes. Other standard features include a detachable keyboard and 12 programmable function keys.

The Fox has a suggested retail price of $3995. For details, contact Digital Microsystems, 1840 Embarcadero, Oakland, CA 94606, (415) 532-3686.

Circle 507 on inquiry card.

PUBLICATIONS

BASIC Scientific Subroutines

The second volume of Fred Ruckdeschel's extensive collection of BASIC-language subroutines is now available from BYTE Books/McGraw-Hill. BASIC Scientific Subroutines, volume 2, focuses on least-squares approximation, interpolation, differentiation, integration, the roots of functions, and optimization. Continuing the format of volume 1, this volume of **BASIC Scientific Subroutines** also provides complete program listings in Microsoft and North Star BASIC, and an appendix shows you how to convert the subroutines into other BASIC dialects. Additional topics covered in volume 2 are first-order, second-order, and nth-order least squares; tangent iteration; natural logarithm by recursion; trigonometric functions; LaGrange interpolation; calculating derivatives from tables; and successive substitution geometry.

BASIC Scientific Subroutines, volume 2, costs

$23.95 (volume 1 is still available for $19.95). Contact BYTE Books, 70 Main St., Peterborough, NH 03458, (800) 258-5420; in New Hampshire and Canada, (603) 924-9281.

Circle 508 on inquiry card.

Book Explores 8051

The **8051: Programming, Interfacing, and Applications** is one of the first books to explore Intel Corporation's new 8051 single-chip microcomputer. The book has more than 80 experiments using the SDK-51 single-board microcomputer system as the hands-on vehicle for learning, prototyping, and experimenting with the 8051. Among the book's features are 8051 and SDK-51 reference materials, the mechanics of writing and executing assembly-language programs with the SDK-51, SDK-51 monitor subroutines, and 17 control applications.

The **8051: Programming, Interfacing, and Applications**, by Dr. Howard Boyet and Ron Katz, costs $19.95. It is available from Dr. Howard Boyet, 14 East 8th St., New York, NY 10003, (212) 473-4947.

Circle 509 on inquiry card.

Technical Journal for Amusement Industry

The **Star Tech Journal** is a technical monthly for distributors and operators of coin-operated electronic amusement machines. Articles are geared toward technicians who are responsible for the service and maintenance of these specialized machines. **Star Tech Journal** identifies trouble areas to be watched and shows you the fix. Among the topics covered are modifying existing test equipment, theory of operation, circuit analysis, step-by-step system check through, and indepth discussions on major manufacturers of pins, alleys, and video games.

Twelve issues of the **The Star Tech Journal** cost $32 in the U.S., $36 in Canada, and $56 elsewhere. Contact the Star Tech Journal, POB 1065, Merchantville, NJ 08109, (609) 662-3432.

Circle 510 on inquiry card.

Health Hazards of CRTs

Health Hazards of CRTs is an authoritative list of sources for balanced information on the possible health hazards associated with extended exposure to cathode-ray tubes. The book is an index of magazine articles, state laws, and scientific studies on the topic, as well as a directory of sources for additional information. Also provided is a list of major video-terminal manufacturers.

Health Hazards of CRTs is available for $4.95 from Ryan Research International, 1593 Filbert Ave., Chico, CA 95926, (916) 343-2373.

Circle 511 on inquiry card.

Magazine Devoted to Computer Games

Computer Gaming World is a bimonthly publication for computer and video game enthusiasts. It's filled with game reviews, articles on the industry, and other features.

A year's subscription (6 issues) to **Computer Gaming World** costs $11 in the U.S., $15 in Canada, and $19 elsewhere. For complete details, contact Computer Gaming World, Subscription Department, 1919 East Sycamore #203, Anaheim, CA 92805, (714) 776-4979.

Circle 512 on inquiry card.

List of Products for the Apple

A list of more than 100 Apple-related products is available for $2. The list, updated monthly, includes books, directories, periodicals, posters, and data sheets and provides such information as company name, address, and product price. For your list, contact Bob Broedel, POB 20049, Tallahassee, FL 32304.

FORTH Reference Books

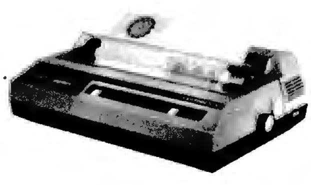
Two new FORTH reference books have been produced by Mountain View Press. **All About FORTH**, by Glen B. Haydon, is a glossary of FORTH words (definitions) as defined in several major implementations of FORTH: FORTH-79, the dialect used in Leo Brodie's book **Starting FORTH**, and MVP-FORTH, a version developed by the Mountain View Press that's based on fig-(FORTH Interest Group-) FORTH. Each entry includes the definition, implementation in FORTH, and usage of the word being defined.

Mitch Derick's and Linda Baker's **The FORTH Encyclopedia** is an advanced reference book that explains in words and flowcharts the compile- and run-time behavior of the fig-FORTH word set. In addition, all definitions are related to the word set of the FORTH-79 standard.

All About FORTH and **The FORTH Encyclopedia** are available postage paid for $20 and $25, respectively. Order your copies from Mountain View Press Inc., POB 4656, Mountain View, CA 94060.

Circle 513 on inquiry card.

PERIPHERALS



Graphics Dot-Matrix Printer

Centronics' Model 122 graphics dot-matrix printer is a heavy-duty 120-cps (character per second) desktop unit intended for data- and business-processing applications. Standard features include 120 cps bidirectional and logic-

STATIC RAMS

			Each	100 pcs
2101	256 x 4	(450ns)	1.95	1.85
5101	256 x 4	(cmos) (450ns)	4.95	3.95
2102-1	1024 x 1	(450ns)	.89	.85
2102L-2	1024 x 1	(LP) (250ns)	1.69	1.55
2102L-4	1024 x 1	(LP) (450ns)	1.29	1.15
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/16.95	1.95
2114L-2	1024 x 4	(LP) (200ns)	8/19.95	2.35
2114L-3	1024 x 4	(LP) (300ns)	8/18.95	2.25
2114L-4	1024 x 4	(LP) (450ns)	8/17.95	2.10
2147	4096 x 1	(55ns)	9.95	call
TMS4044-4	4096 x 1	(450ns)	3.49	3.25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMS40L44-2	4096 x 1	(LP) (200ns)	4.49	4.25
MK4116	1024 x 8	(250ns)	9.95	call
TMM2016	2048 x 8	(150ns)	call	call
HM6116-4	2048 x 8	(cmos) (200ns)	call	call
HM6116-3	2048 x 8	(cmos) (150ns)	call	call
HM6116-2	2048 x 8	(cmos) (120ns)	call	call
HM6116LP-4	2048 x 8	(LP) (cmos) (200ns)	call	call
HM6116LP-3	2048 x 8	(LP) (cmos) (150ns)	call	call
HM6118LP-2	2048 x 8	(LP) (cmos) (120ns)	call	call
Z-6132	4096 x 8	(Qstat) (300ns)	34.95	call

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

			Each	100 pcs
TMS4027	4096 x 1	(250ns)	2.50	2.00
MK4108	8192 x 1	(200ns)	1.95	call
MM5298	8192 x 1	(250ns)	1.85	call
4116-120	16384 x 1	(120ns)	8/29.95	call
4116-150	16384 x 1	(150ns)	8/18.95	1.95
4116-200	16384 x 1	(200ns)	8/13.95	call
4116-250	16384 x 1	(250ns)	8/13.90	call
4116-300	16384 x 1	(300ns)	8/13.80	call
2118	16384 x 1	(5v) (150ns)	4.95	call
MK4816	2048 x 8	(5v) (300ns)	24.95	call
4164-200	65536 x 1	(5v) (200ns)	call	call
4164-150	65536 x 1	(5v) (150ns)	call	call

EPROMS

			Each	8 pcs
1702	256 x 8	(1us)	4.95	4.50
2708	1024 x 8	(450ns)	3.75	3.50
2758	1024 x 8	(5v) (450ns)	9.95	8.95
TMS2516	2048 x 8	(5v) (450ns)	6.95	5.95
2716	2048 x 8	(5v) (450ns)	4.95	3.95
2716-1	2048 x 8	(5v) (350ns)	9.00	8.50
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(5v) (450ns)	9.95	7.95
2732	4096 x 8	(5v) (450ns)	9.95	7.95
2732A-2	4096 x 8	(5v) (200ns)	call	call
2764	8192 x 8	(5v) (450ns)	call	call
TMS2564	8192 x 8	(5v) (450ns)	call	call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/CM²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320T	X	32	15,000	595.00

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HM6116 (200NS)

8/7.95 EA.

64K DYNAMIC

4164 (200NS)

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16K DYNAMIC

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16K EPROMS

2716 (450NS)

8/3.95 ea.

32K EPROMS

2532 or 2732 (450NS)

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Order by National Part No.	Function	TI	SIG	MMI	Harris	
		EQUIVALENT PART NUMBERS				
74S188	32x8 OC	18SA030	82S23	6330-1	7602	2.95
74S287	256x4 TS	14S10	82S129	6301-1	7611	3.25
74S288	32x8 TS	18S030	82S123	6331-1	7603	2.75
74S387	256x4 OC	14SA10	82S126	6300-1	7610	2.95
74S471	256x8 TS	18S22		6309-1		10.95
74S472	512x8 TS	18S42	82S147	6349-1	7649	10.95
74S473	512x8 OC	18SA42	82S146	6348	7648	10.95
74S474	512x8 TS	18S46	82S141	6341	7641	12.95
74S475	512x8 TS	18SA46	82S140	6340	7640	12.95
74S478	1Kx8 TS	28S86				19.95
74S570	512x4 OC	27S12	82S130	6305	7620	5.95
74S571	512x4 TS	27S13	82S131	6306-1	7621	5.95
74S572	1kx4 OC	24SA41	82S136	6352-1	7642	9.95
74S573	1kx4 TS	24S41	82S137	6353-1	7643	9.95
87S180	1kx8 OC	28SA86	82S180	6380-1	7680	19.25
87S181	1kx8 TS	28S86	82S181	6381-1	7681	16.25
87S184	2kx4 OC	24SA81	82S184		7684	17.20
87S185	2kx4 TS	24S81	82S185		7685	16.95
87S190	2kx4 OC	28SA166	82S190		76160	39.95
67S191	2kx8 TS	28S166	82S191		76161	39.95

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74LS04	.25	74LS175	.95
74LS05	.25	74LS181	2.15
74LS08	.35	74LS189	9.95
74LS09	.35	74LS190	1.00
74LS10	.25	74LS191	1.00
74LS11	.35	74LS192	.85
74LS12	.35	74LS193	.95
74LS13	.45	74LS194	1.00
74LS14	1.00	74LS195	.95
74LS15	.35	74LS196	.85
74LS20	.25	74LS197	.85
74LS21	.35	74LS221	1.20
74LS22	.25	74LS240	1.29
74LS26	.35	74LS241	1.29
74LS27	.35	74LS242	1.85
74LS28	.35	74LS243	1.85
74LS30	.25	74LS244	1.29
74LS32	.35	74LS245	1.90
74LS33	.55	74LS247	.75
74LS37	.55	74LS248	1.25
74LS38	.35	74LS249	.99
74LS40	.35	74LS251	1.30
74LS42	.55	74LS253	.85
74LS47	.75	74LS257	.85
74LS48	.75	74LS258	.85
74LS49	.75	74LS259	2.85
74LS51	.25	74LS260	.85
74LS54	.35	74LS266	.55
74LS55	.35	74LS273	1.85
74LS63	1.25	74LS275	3.35
74LS73	.40	74LS279	.55
74LS74	.45	74LS280	1.98
74LS75	.50	74LS283	1.00
74LS76	.40	74LS290	1.25
74LS78	.50	74LS293	1.85
74LS83	.75	74LS295	1.05
74LS85	1.15	74LS298	1.20
74LS86	.40	74LS324	1.75
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74LS91	.89	74LS353	1.55
74LS92	.70	74LS363	1.35
74LS93	.65	74LS364	1.95
74LS95	.85	74LS365	.95
74LS96	.95	74LS366	.95
74LS107	.40	74LS367	.70
74LS109	.40	74LS368	.70
74LS112	.45	74LS373	1.75
74LS113	.45	74LS374	1.75
74LS114	.50	74LS377	1.45
74LS122	.45	74LS378	1.18
74LS123	.95	74LS379	1.35
74LS124	2.99	74LS385	1.90
74LS125	.95	74LS386	.65
74LS126	.85	74LS390	1.90
74LS132	.75	74LS393	1.90
74LS136	.55	74LS395	1.65
74LS137	.99	74LS399	1.70
74LS138	.75	74LS424	2.95
74LS139	.75	74LS447	.37
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS624	3.99
74LS148	1.35	74LS668	1.69
74LS151	.75	74LS669	1.89
74LS153	.75	74LS670	2.20
74LS154	2.35	74LS674	9.65
74LS155	1.15	74LS682	3.20
74LS156	.95	74LS683	2.30
74LS157	.75	74LS684	2.40
74LS158	.75	74LS685	2.40
74LS160	.90	74LS688	2.40
74LS161	.95	74LS689	2.40
74LS162	.95	74LS763	24.95
74LS163	.95	81LS95	1.69
74LS164	.95	81LS96	1.69
74LS165	.95	81LS97	1.69
74LS166	2.40	81LS98	1.69
74LS168	1.75		

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2N3906	10/1.00	100/ 8.99
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68000 Assembly Language Programming	16.99
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The 8086 Book	16.99

SYBEX

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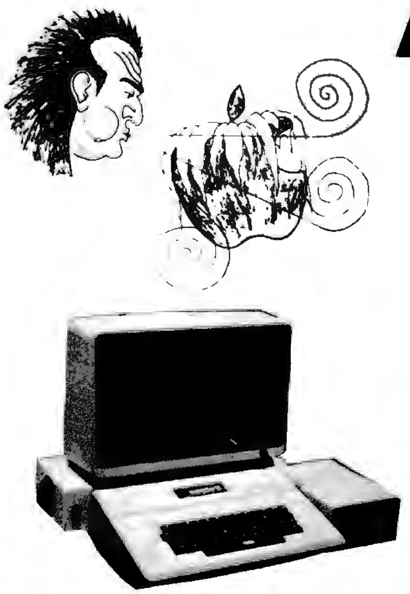

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★ Includes cable
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Circle 205 on inquiry card.

seeking printing in monospaced alphanumeric mode, unidirectional and logic-seeking printing in the graphics mode, 6- or 8-pin graphics, 7 resident international character sets, selectable forms length from 3½ inches to 15½ inches in half-inch increments, and user-selectable 6, 9, or 18 lines per inch. The Model 122 is software-compatible with the Centronics Model 739.

The Model 122 graphics dot-matrix printer costs $1195. Further information is available from Centronics Data Computer Corp., Hudson, NH 03051, (603) 883-0111.

Circle 514 on inquiry card.

Add-on Memory for the IBM

Davong Systems of Mountain View, California, has introduced a series of add-on memory cards for the IBM Personal Computer. The cards offer 64K, 192K, and 256K bytes of RAM (random-access read/write memory) and complete hardware- and software-compatibility with the IBM. The boards range in price from $395 to $1075 and are available at selected Computerland stores. For your nearest dealer, contact Davong Systems Inc., 1061 Terra Bella Ave., Mountain View, CA 94043, (415) 965-7130.

Circle 515 on inquiry card.

Color Computer Expansion Unit

The Color Computer Expansion Unit gives the TRS-80 Color Computer an additional 64K bytes of RAM (random-access read/write memory) and the circuitry necessary for an 80-character by 25-line alphanumeric display. The Expansion Unit has a Z80A microprocessor that gives the Color Computer the added versatility of running the CP/M operating system while maintaining full compatibility with 6809 software such as the Flex and OS-9 operating systems. Other features provided with the Expansion Unit include software-selectable video-display formats of 80 characters by 25 lines or the standard 32 characters by 16 lines and a dual-density 5¼-inch disk controller capable of supporting four drives with up to 800K bytes of storage per drive for a total of 3.2 megabytes. Standard features supplied include a Color Computer-compatible RS-232C serial port, two expansion buses for hard-disk and custom applications, and a built-in audio driver and speaker.

Optionally the Expansion Unit can be equipped with an IEEE-488/1980 controller and a light pen. The Color Computer Expansion Unit has a suggested price of $1585; dealer inquiries are invited. For further information, contact George Associates, POB 960, Berkeley, CA 94701, (415) 843-3587.

Circle 516 on inquiry card.

Chess Peripheral

Mate, a hardware and software peripheral for the Apple II, includes the strongest chess-playing program ever developed for a microcomputer, according to the manufacturer. Designed for 32K-byte Apple, TRS-80, and PET computers, Mate is supplied with a magnetic sensor chessboard, magnetic pieces, plug-in interface card, and a cable. Its many game-playing features include the ability to "think" on opponent's time, nine levels of play, an opening library of more than 6000 moves, best and randomized move selection, move suggestions, reverse board, and printout of an entire game. Full documentation for the interface software is provided for those who want to create their own chess programs.

Manufactured by Applied Concepts, Mate is available for $269.95, including game program on cassette or disk and a manual, from PMK Associates, POB 598, East Brunswick, NJ 08816, (201) 246-7680.

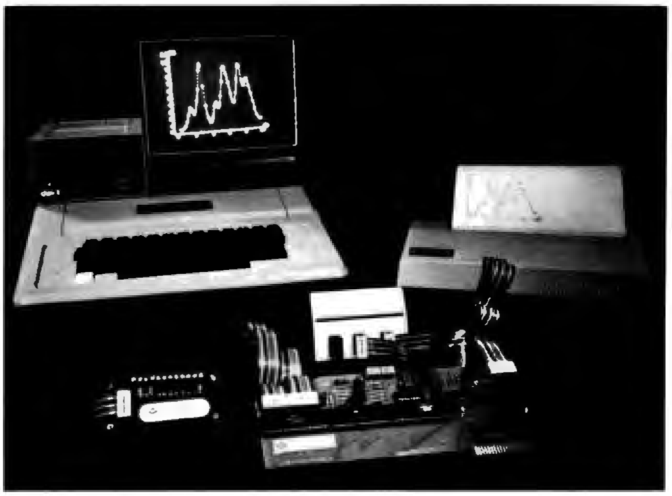
Circle 517 on inquiry card.

Color Monitor for IBM and Apple

Amdek's Color II is a 16-color, high-resolution video monitor designed for the IBM Personal Computer or, with the Amdek DVM (digital video multiplexer) interface board, the Apple II. The 13-inch RGB (red/green/blue) Color II can generate an 80-character by 24-line display and 560 horizontal by 260 vertical resolution.

The Color II, including access cable, is available at Computerland stores, IBM Personal Computer Centers, and Apple dealers for $999. The DVM, including an access cable for the Apple II and III, costs $200. Further details can be obtained from Amdek Corp., 2420 East Oakton St., Arlington Heights, IL 60005, (312) 364-1180.

Circle 518 on inquiry card.

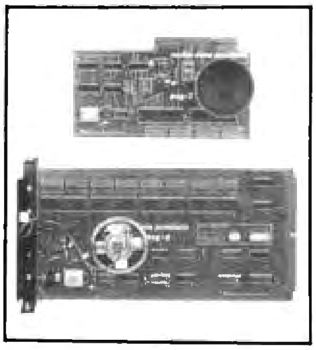


Scientific Control and Data-Collection Tools

The Adalab data-acquisition and control interface card for the Apple II controls and collects data from most scientific instruments, including spectrophotometers, strip-chart recorders, chromatography systems, and temperature controllers. Optional accessories for the Adalab include the Ada-Amp instrumentation amplifier with a 0.1 to 1000 gain range, the Vidisampler real-time data-acquisition software package that permits simultaneous data-acquisition from four analog inputs, and the Tempsense hardware and software package for monitoring up to 64 thermocouples or heat sensors. Other equipment available for the Adalab includes a 32-bit digital I/O multiplexer accessory called Ada-Byte and Vidimemory, an extended-memory/bulk data-storage option that works with 16K-, 64K-, or 128K-byte RAM (random-access read/write memory) cards.

Complete details on the Adalab data-acquisition and control interface card and its wide variety of accessories are available from Interactive Microware Inc., POB 771, State College, PA 16801, (814) 238-8294.

Circle 519 on inquiry card.



Give the H-89 Speech

Mako's multiple programmable sound generators (PSGs) give Heath or Zenith computers equipped with the General Instrument AY3-8910 PSG chip the ability to produce a wide variety of complex sounds under software control. The PSGx2, designed for the Z-89 or H-89, plugs directly into the P504 or P505 bus slots and uses any decoded port address. The PSGx4 has four PSG chips and plugs directly into the H-8 bus. Each board is supplied with a speaker, a built-in audio monitor amplifier, and crystal time base. Options for the boards include the Micro-Piano 2.0, which is capable of playing up to a six-note polyphony over an eight-octave range.

The PSGx2 costs $125, and the PSGx4 costs $225, plus $5 shipping and handling. The Micro-Piano is available for $24.95. Orders are being accepted at Mako Data Products, 1441-B North Red Gum, Anaheim, CA 92806, (714) 632-8583.

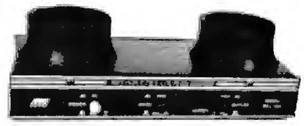
Circle 520 on inquiry card.

Turn Your Micro into a Mini

The Loadstar 8000 upgrades any single-user 8-bit Z80 microcomputer with from 4K to 64K bytes of RAM (random-access read/write memory) to a 16-bit Z8000 minicomputer with 64K bytes of RAM (expandable to 8.3 megabytes and multiple users). The Loadstar has two ROMs (read-only memories) that contain part of the operating system and the interface circuitry and are capable of storing 8K bytes. Other features include a 4-MHz system clock, 414 machine-language instructions, and the ability to handle from 1250 to 5000 instructions per second. When the Loadstar 8000 is connected to any Z80-based system, such as the TRS-80, Apple (with the Microsoft Softcard), Exidy, Superbrain, Godbout, or Cromemco, the system has the capability of addressing 128 times more memory and increasing system speed 5 to 20 times.

The Loadstar 8000 has a suggested retail price of $900. Additional details can be obtained from Loadstar Technology Corp., 10073 Saich Way, Cupertino, CA 95014, (408) 996-8333.

Circle 521 on inquiry card.



Modem Uses Inductive Coupling

The MFJ-1230 originate/answer modem uses an inductive-coupling technique for receiving data. This approach provides more reliable data transfer because it eliminates errors caused by room noise, vibrations, and other acoustic-coupling problems. The Bell 103-compatible MFJ-1230 operates at data rates from 0 to 300 bps (bits per second) and features half- and full-duplex operation, TTL, CMOS, and RS-232C compatibility, and I/O ports for a cassette tape recorder.

The price for the crystal-controlled MFJ-1230 is $129.95. A version for the Apple, the MFJ-1231, costs $139.95. Complete specifications are available from MFJ Enterprises Inc., 921 Louisville Rd., Starkville, MS 39759, (800) 647-1800; in Mississippi, (601) 323-5869.

Circle 522 on inquiry card.

Add a Computer to the IBM Personal Computer

Baby Blue is an accessory printed-circuit board and software package for the IBM Personal Computer. When used with its software, the Baby Blue board becomes a Z80 computer within your computer, allowing you to run programs written for the CP/M-80 operating system. Baby Blue's hardware is made up of 64K bytes of dual-ported 200-nanosecond RAM (random-access read/write memory) with parity checking and a Z80B microprocessor that can operate with the 4.77-MHz system clock speed of the IBM's 8088 microprocessor. The software is made up of a translator and an intelligent converter that activates the Z80B, reads files from many 5¼-inch soft-sectored CP/M disk formats, and determines which files are executable machine-language files.

The Baby Blue, complete with software on disk, costs $600. Optionally, Baby Blue can be purchased with the Wordstar and Mailmerge programs for $980. For further details, contact Xedex Corp., 1345 Ave. of the Americas, New York, NY 10105, (212) 489-0444.

Circle 523 on inquiry card.

Video Controllers

Zircon International's Video Command series of video controllers are designed for game or graphics applications on Apple, Atari, PET, VIC, and TRS-80 computers. Among the controllers available is the Video Stick, which combines X and Y functions in a single unit. Video Stick features dual fire buttons and gimbal assembly, potentiometers, and switches. Its suggested retail price is $49.95, and versions are available for the Apple, the TRS-80 Color Computer, and the IBM Personal Computer.

The Video Command XYZ controller has an eight digital switch mechanism and is compatible with most existing PET, VIC, and Atari software. The suggested price for the Video Command is $14.95. For complete details on the Video Command series of controllers, contact Zircon International Inc., 475 Vandell Way, Campbell, CA 95008, (408) 866-8600.

Circle 524 on inquiry card.

SOFTWARE

Language Series for the IBM

The Computer Language series offers IBM Personal Computer users a wide choice of programming languages and operating systems. Some of the products available are a macro assembler that runs under PC-DOS, a FORTRAN compiler that also runs under PC-DOS, and UCSD Pascal p-System, an advanced operating system with UCSD Pascal or FORTRAN-77.

Prices for products in the Computer Language series range from $100 to $625. The series is available at local IBM Product Centers, Computerland stores, and Sears Roebuck and Company's Business Systems Centers. For the address of your nearest IBM dealer, call (800) 447-4700; in Illinois, (800) 322-4400; in Alaska and Hawaii, (800) 447-0890.

Circle 525 on inquiry card.

Robot Simulator

The Karel Simulator implements a Pascal-like compiler/debugger environment that can be used to teach beginners structured programming techniques. The Simulator lets students write programs that make Karel, an on-screen robot, manipulate a world of intersecting streets and objects. The Simulator's language is easy to learn, but rich enough for challenging tasks such as escaping from mazes and following paths. The Simulator's programming language is documented in Richard E. Pattis's **Karel the Robot: A Gentle Introduction to the Art of Programming** (John Wiley & Sons, 1981).

The Karel Simulator runs on Apple computers with a language card, one disk drive, and a 40- or 80-column display screen. The complete package costs $85 and includes a notebook, a protected copy of the Simulator, a preformatted disk with two demonstration programs, a 24-page instruction manual, and a tutorial on using the UCSD Pascal filer and editor. For teaching or self-instruction, a complete set of two course disks containing all the examples from the book (a total of more than 125 files) is available for $150. The Karel Simulator can be purchased from Cybertronics International Inc., Software Publishing Division, 999 Mount Kemble Ave., Morristown, NJ 07960, (201) 766-7681.

Circle 526 on inquiry card.

Pascal Compiler for CP/M

JRT Systems recently introduced version 2 of its Pascal compiler for CP/M. Version 2 is a one-step compiler with separately compiled external procedures and functions that allow very large programs to be developed. Standard features include the ability to link together or autoload program sections at run-time, a virtual storage manager that allows programs of unlimited size to be run while providing full support for dynamic Pascal variables, and no size limit for procedures, nesting levels, or recursion. The compiler's arithmetic ability has 14 digits of precision, and its BCD (binary-coded decimal) format eliminates conversion errors. For scientific applications, the compiler's floating-point exponent ranges from

−64 to +63. Dynamic text strings can be as large as 64K bytes. Other features include the ability to access random disk files by relative record number or relative byte address and the ability to process disk files as ASCII text or as binary data.

A single-user license for version 2 of the JRT Pascal compiler for CP/M costs $29.95. It is available from JRT Systems Inc., 1891 23rd Ave., POB 22365, San Francisco, CA 94122, (415) 566-4240.

Circle 527 on inquiry card.

Pascal-like Language for the Apple

The XPLO language system gives Apple II users a fast-executing alternative to UCSD Pascal. It retains Pascal's syntax and control structures, so it is easy for Pascal programmers to learn. In contrast to Pascal, XPLO has loose variable typing, which gives it greater flexibility for most programming applications. Among its standard features are the full set of Pascal control structures; a full range of simple data types including integers, reals, and characters; a complete set of intrinsic functions for mathematical calculations; support for Apple hardware such as high- and low-resolution graphics, game paddles, and sound; and program-development features such as chaining, overlays, and library capability.

The XPLO Language system costs $185. Optionally, XPLO is available with Advanced Micro Devices' 9511 floating-point processor for number-crunching applications for $205. XPLO can be obtained from Computer Sight, Suite 503, 2490 Channing Way, Berkeley, CA 94704, (415) 644-1688.

Circle 528 on inquiry card.

IBM Word Processor and Text Editor

Lifetree Software has introduced a new word processor and text editor for the IBM Personal Computer called the Volkswriter. Standard editing features include a full-screen editor, Reset key, automatic word-wrap, rapid line or character insertion, flexible search and replace, automatic centering, left and right justification, and an onscreen, step-by-step tutorial. Print features include page numbering as well as the ability to define the format through a menu, to print an entire document or a single page at a time, and to define paper size and printing area. With an optional asynchronous adapter, you can prepare files for transmission to a typesetter. Since its files are standard PC-DOS format, Volkswriter is compatible with most IBM Personal Computer software.

Volkswriter requires an IBM Personal Computer with a minimum of 64K bytes of memory, a single disk drive, PC-DOS, and an IBM, Epson, or NEC Home Electronics printer with Centronics-type parallel interface. For extensive writing, two disks and 128K bytes of memory are recommended. The Volkswriter is available for $195. For the name of your nearest dealer, contact Lifetree Software Inc., Suite 342, 177 Webster St., Monterey, CA 93940, (408) 659-3211.

Circle 529 on inquiry card.

Apple Graphics Language

The GraFORTH graphics programming language for the Apple II has easy-to-read code and programs that are fully compiled to machine language for fast execution. It features fast three-dimensional color animation graphics, including rotation, scale, transposition, and perspective. According to the manufacturer, lines can be drawn faster than with BASIC and colored lines are never broken. GraFORTH includes turtle graphics, for rapidly drawing line shapes at any angle, and a software-based music synthesizer.

GraFORTH requires a 48K-byte Apple II with DOS 3.3 and one disk drive (use of a 16K-byte RAM card is recommended). It's available for $75, including a 220-page manual, from Insoft, Suite 202B, 10175 Southwest Barbur Blvd., Portland, OR 97219, (503) 244-4181.

Circle 530 on inquiry card.

Relational Query Language

RQL is a relational algebraic query language implemented in Applesoft floating-point BASIC that lets you see a database as a collection of tables. This approach allows computer novices to use RQL to build, interrogate, and search databases. Commands provided with RQL include define and access a database; define a table; insert, delete, and update rows in a table; create a table from one or two existing tables by means of selection, union, intersection, symmetric difference, etc.; and compute the aggregate functions of average, count, sum, minimum, and maximum.

RQL requires an Apple II or Apple II Plus computer with DOS 3.3, Applesoft, and two floppy-disk drives. RQL on a floppy disk, a program listing, and the user's manual together cost $140. The user's manual and the program listing alone cost $120, and the user's manual is available separately for $20. For details, contact Hello Software, 8380 Roanne Dr., Orlando, FL 32817, (305) 677-1108.

Circle 531 on inquiry card.

MISCELLANEOUS

Office Filing System

The Colortrol is a business filing system that's used in conjunction with a desktop computer or a word processor. It provides an automatic computer-generated color-coded filing system and a database for easy file management. When used with a printer, Colortrol can print color-coded file labels. Formats include 8-inch IBM soft-sectored, North Star double-density, Micropolis Model II, Superbrain 3.0, Apple II with CP/M, and 5¼- and 8-inch Xerox.

Colortrol requires an 8080-, 8085-, or Z80-based microcomputer with 48K bytes of RAM (random-access read/write memory), CP/M, and an Epson or NEC Home Electronics printer. Its price is $195. The manual alone costs $30. Complete details are available from Digital Marketing, 2670 Cherry Lane, Walnut Creek, CA 94596, (415) 938-2880.

Circle 532 on inquiry card.

BASIC Reference Card for the IBM

Minimagic has introduced a BASIC language reference card for the IBM Personal Computer. The card has 14 panels of selected information, including a discussion on getting BASIC up and running, alphabetized descriptions of more than 80 BASIC statements, graphics and color programming information, BASIC control commands for program development and execution, and functions relating to mathematics, string manipulation, and I/O. All entries are alphabetized and grouped by function for quick and easy reference, and each entry has a brief description and examples of usage. Each grouping contains all the facilities offered by IBM BASIC.

The BASIC language reference card for the IBM Personal Computer costs $3.50, postage paid. Contact Minimagic Co., 104 Park Rd.#34, West Hartford, CT 06119.

Surge Suppressors

Kalglo Electronics' Quad series of surge suppressors features four filtered outlets. The Quad-I has transient absorption only, while the Quad-II has transient absorption and dual three-stage low-pass filters for radio-frequency-interference noise filtering. All units are prewired and ready to use. The Quad-I costs $49.95, and the Quad-II costs $59.95. For further details, contact Kalglo Electronics Co. Inc., Department Quad, 6584 Ruch Rd., East Allen Township, Bethlehem, PA 18017, (800) 523-9685. For technical information or to order within Pennsylvania, call (215) 865-0006.

Circle 533 on inquiry card.

Automatic Shut Off for Disk Drives

Optronics Technology's Drive Control Unit (DCU) gives you automatic on/off control over your 8-inch floppy-disk drive motor. The DCU has connectors that allow it to fit within the drive assembly in series with the drive motor. During drive access, the motor is energized at zero-crossing for low noise. After 8 seconds (adjustable) of idle time, the drive will switch off, which minimizes media damage due to constant use and lowers overall system noise levels.

In kit form, the DCU costs $29.95. An assembled and tested version is available for $39.95. For additional details, contact Optronics Technology, POB 81, Pittsford, NY 14534, (716) 377-0369.

Circle 534 on inquiry card.

High-Density Floppy Disks

Brown Disc Manufacturing has unveiled a new series of high-density 5¼-inch floppy disks: the UHR I and the VHR I families. The UHR I floppy disk provides ultra-high-density recording capabilities for 150- to 200-tpi (track per inch) applications. According to the manufacturer, the UHR I disk is the only media qualified as a 1.6-megabyte single-sided disk for use with Amlyn Corporation's Models 5860 and A506 high-capacity mini-floppy-disk drives. The VHR I is designed for 96-tpi data-storage applications.

Both families are made with a spin coating technique that's similar to that used for hard-disk media. This method provides a more consistent dispersion of the magnetic coating. Further information is available from Brown Disc Manufacturing Inc., 1015 Garden of the Gods Rd., Colorado Springs, CO 80907, (303) 593-1015.

Circle 535 on inquiry card.

Data-Encryption Device

The Black Board is an S-100-bus-compatible module with a built-in, high-speed data-encryption device and bus interface/control logic that is certified by the National Bureau of Standards. Designated the Model ESB-2S, the device is useful for secure tape or disk storage, program protection, and data security and protection schemes. The Black Board uses two consecutive output ports for control and data, and the key, which is not externally accessible, is stored on a chip. Other features include encryption and decryption of 64-bit data words using a 56-bit key, a 1.3-megabit-per-second transfer rate, parity checking during key loading, and no wait states at a speed of 4 MHz. It's compatible with the CP/M, CDOS, Unix, Cromix, and MP/M operating systems. Supplied software includes low-level drivers and encryption/decryption programs.

Optional software for

the Black Board includes the Keyper System, which is an automated file-access security system with infinite master key capabilities. The Black Board, including documentation and software to get your system up and running, is available for $595; the bare board alone costs $495. For more details, contact Cydat Inc., Suite 322, 500 Airport Blvd., Burlingame, CA 94010, (800) 227-2400, ext. 906; in California, (800) 772-2666, ext. 906.

Circle 536 on inquiry card.

Software Locator Service

Subscribers to the Sofsearch software locator service have access to information on more than 12,000 software products for both small computers and large computers. Sofsearch provides custom reports on software products that meet up to five sets of subscriber-specified selection criteria ranging from computer system used or considered to industry/activity to be served. Each report has product name, supplier address, contact information, and a general description of the product. Product reports are packaged in an indexed binder and are updated quarterly. Subscribers can also request special one-time reports for an additional fee.

A year's subscription to the Sofsearch software locator service costs $125. A complete description of Sofsearch is available from CCS Inc., Corporate Offices, POB 5276, San Antonio, TX 78201, (512) 340-8735.

Circle 537 on inquiry card.

Eliminate Contact Problems

The Gold Plug 80 can eliminate disk errors due to oxidation of the solder surface of Radio Shack's TRS-80 Model I's keyboard printed-circuit board and expansion ports. The Gold Plug 80 is a male gold-plated card edge plug that's soldered directly to the existing card edge plug on the printed-circuit board of the keyboard and expansion ports. Compatibility is maintained because it permits the use of existing female connectors on all cables. Additionally, all existing expansion devices can be used without modifications.

To install the Gold Plug 80, disassembly of the keyboard and/or Expansion Interface is required, as well as soldering directly to the Model I's existing card connector. The Gold Plug 80 adds slightly more than a half inch to the card edge plugs.

In kit form, the Gold Plug 80 for the keyboard printed-circuit board to Expansion Interface costs $18.95. Versions for the Expansion Interface to disk, printer, screen printer, or RS-232C ports cost $9.95 each. A complete set of cables for all the ports is available for $54.95. For details, contact E.A.P. Co., POB 14, Keller, TX 76248, (817) 498-4242.

Circle 538 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.

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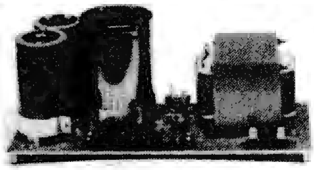
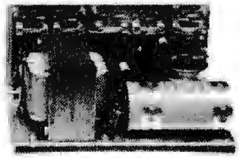
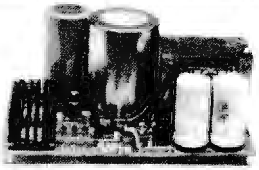
POWER SUPPLIES
(LINEAR & SWITCHING)
FOR S-100, DISK DRIVES



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)

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KIT 1	15 CARDS SOURCE	15A	———	2.5A	2.5A	———	12" × 5" × 4⅞"	54.95
KIT 2	SYSTEM SOURCE	25A	———	3A	3A	———	12" × 5" × 4⅞"	61.95
KIT 3	DISK SYSTEM	15A	1A	2A	2A	4A	14" × 6" × 4⅞"	69.95

DISK DRIVE POWER SUPPLY "R3" REGULATED, OPEN FRAME, ASSY. & TESTED 69.95

SPECS +5V @ 6A OVP, −5V @ 1A +24V @ 6A, SHORTS PROTECT. 2 SIZES AVAIL., 1) 9" (W) x 6¼" (D) x 4⅜" (H), 2) 9" (W) x 4⅞" (D) x5¼" (H)
OPTION 1) REPLACE +24V BY +12V, 2) FOR SIZE 1 ONLY, ADD ± 12V @ 1A, AT AN ADDITIONAL $12.00.
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REGULATED OUTPUTS FOR DISK DRIVES: +5V @ 5A, −5V @ 1A, +24V @ 5A (OR +12V @ 5A).
UNREGULATED OUTPUTS FOR S-100. +8V @ 14A, ± 16V @ 3A.
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WITH OVP CIRCUIT FOR +5V.

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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"	22.95
T_2	110/120	2 × 8 Vac, 25A	28 Vac, CT, 3.5A		3¾" × 4⅜" × 3⅛"	28.95
T_3	110/120	2 × 8 Vac, 15A	28 Vac, CT, 2.5A	48 Vac, CT, 2A	3¾" × 4⅜" × 3⅛"	30.95
T_4	110/120	2 × 8 Vac, 6A	28 Vac, CT, 1.5A	48 Vac, CT, 3A	3¾" × 3⅝" × 3⅛"	23.95
T_5	110/120	2 × 8 Vac, 6A	28 Vac, CT, 2A		3" × 3" × 2½"	15.95

SHIPPING FOR EACH POWER SUPPLY: $5.50 in Calif.; $8.00 in other states; $18.00 in Canada.
For each Transformer $5.00 in all states; $12.00 in Canada. Calif. residents add 6% sales tax.

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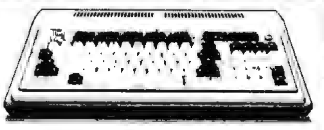

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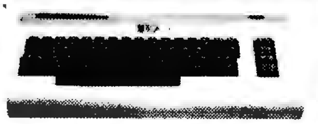

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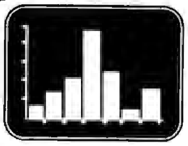

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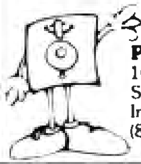

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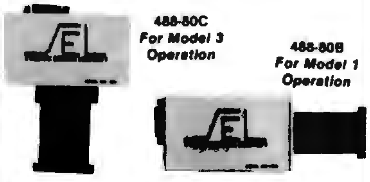

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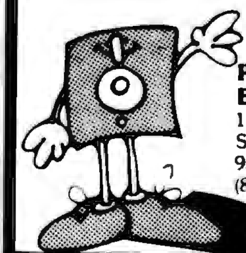

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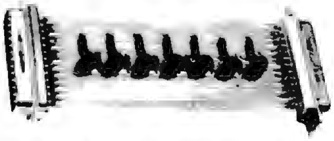

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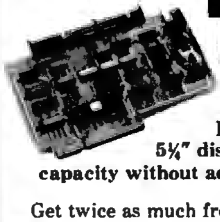

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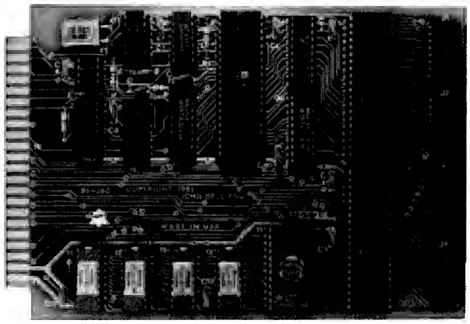

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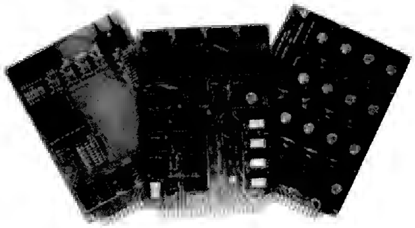

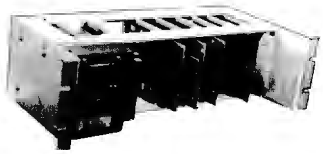

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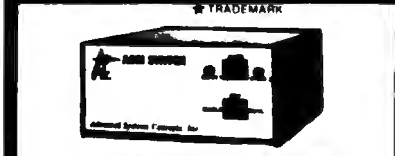

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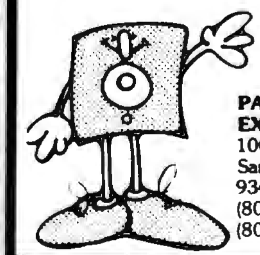

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4001	.30	4072	.30
4002	.30	4073	.30
4006	.90	4075	.30
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4008	.90	4078	.30
4009	.45	4081	.30
4010	.45	4082	.30
4011	.30	4085	.90
4012	.30	4086	.90
4013	.45	4093	.90
4014	.90	4098	2.49
4015	.90	4099	1.90
4016	.45	4502	.90
4017	1.15	4503	.60
4018	.90	4508	1.90
4019	.45	4510	.90
4020	.90	4511	.90
4021	.90	4512	.90
4022	1.10	4514	1.20
4023	.35	4515	2.20
4024	.75	4516	1.50
4025	.35	4518	1.20
4026	1.60	4519	1.20
4027	.60	4520	1.20
4028	.75	4522	1.20
4029	.90	4526	1.20
4030	.45	4527	1.90
4034	2.90	4528	1.20
4035	.85	4531	.90
4040	.90	4532	1.90
4041	1.20	4538	1.90
4042	.75	4539	1.90
4043	.75	4543	2.70
4044	.75	4555	.90
4046	.90	4556	.90
4047	.90	4581	1.90
4049	.50	4582	1.90
4050	.50	4584	.90
4015	.90	4585	.90
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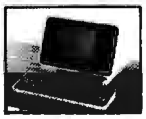

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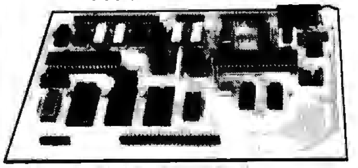

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VDM-201201	List price $189.95	$129.95

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THREE BOARD SET - SD Systems

4 MHz Z-80A CPU, 64K RAM (optional 256K), serial I/O port, parallel I/O port, double density disk controller, CP/M 2.2 & manual set, system monitor, control & diagnostic software. Includes SBC-200, 64K ExpendoRAM II, Versafloppy II, & CP/M 2.2 - all boards are assembled & tested.

Board set with 64K of RAM	$1095.00
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Apple II Accessories

16K RAM CARD - for Apple II

Expand your Apple to 64K. 1 year warranty

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PB-1 - SSM Microcomputer

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MEM-99510K	Kit with manual	$154.95
MEM-99510A	A & T with manual	$219.95

PROM-100 - SD Systems

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Full-function color graphics board, up to 8 colors, 256 x 192 graphics, parallel I/O port, 8K RAM

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MBS-121K	Kit	$69.95
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CPU-20510C *6/8 MHz CSC* $497.95

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CPU-70520C *8 MHz 8086 CSC* $764.95
CPU-70530A *with 8087 A & T* $1224.95
CPU-70530C *with 8087 CSC* $1455.95

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CPU-30500C *3/6 MHz CSC* $374.95

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CPC-30200A *A & T* $399.95

THE BIG Z - Jade
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CPU-30201K *Kit with manual* $139.95
CPU-30210A *A & T with manual* $199.95

CB-2 - SSM Microcomputer
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 with manual* $229.95
CPU-30300A *A & T with manual* $274.95

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2 or 4 MHZ Z-80 CPU with serial I/O port & on-board monitor PROM, front panel compatible.

CPU-30400A *A & T with PROM* $289.95

2820 Z-80 DMA CPU - C.C.S.
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CPU-30420A *A & T with manual* $569.95

S-100 Disk Controllers

DISK 1 - CompuPro
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IOD-1810A *A & T* $449.95
IOD-1810C *CSC* $554.95
SFC-52506580F *8" CP/M 2.2 for Z-80* $174.95
SFC-52506586F *8" CP/M 2.2 for 8086* $299.95
SFO-54158000F *Oasis single user* $499.95
SFO-54158002F *Oasis multi-user* $849.95

DOUBLE D - Jade
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IOD-1200K *Kit w/hdwr & sftwr man* $299.95
IOD-1200A *A & T w/hdwr & sftwr man* $359.95
SFC-59002001F *CP/M 2.2 with Double D* .... $ 99.95

VERSAFLOPPY II - SD Systems
Double density disk controller for any combination of 5¼" and 8" single or double sided, analog phase-locked loop data separator, vectored interrupts, CP/M 2.2 & Oasis compatible, control/diagnostic software PROM included.

IOD-1160A *A & T with PROM* $359.95
SFC-55009047F *CP/M 2.2 with VF II* $99.95

2242 DISK CONTROLLER - C.C.S.
5¼" or 8" double density disk controller with on-board boot loader ROM, free CP/M 2.2 & manual set.

IOD-1300A *A & T with CP/M 2.2* $399.95

S-100 Memory Boards

256K RAMDISK - SD Systems
ExpandoRAM III expandable from 64K to 256K using 64K x 1 RAM chips, functions as ultra-high speed disk drive when used with optional RAMDISK software, compatible with CP/M, MP/M, Oasis, Cromemco, & most other Z-80 based systems.

MEM-65064A *64K A & T* $474.95
MEM-65128A *128K A & T* $574.95
MEM-65192A *192K A & T* $674.95
MEM-65256A *256K A & T* $774.95
SFC-55009000F *RAMDISK sftwr CP/M 2.2* $24.95

128K RAM 21 - CompuPro
128K x 8 bit or 64K x 16 bit static RAM board, 12 MHz, 24 bit addressing.

MEM-12810A *A & T* $1609.95
MEM-12810C *CSC* $1794.95

64K EXPANDORAM II - SD Systems
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MEM-16630A *16K A & T* $344.95
MEM-32631A *32K A & T* $364.95
MEM-48632A *48K A & T* $384.95
MEM-64633A *64K A & T* $399.95

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MEM-64180A *64K A & T* $549.95
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MEM-32180A *RAM 16 A & T* $598.95
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IEEE 696/S-100 standard, up to 6MHz/8 Bit, 12MHz/16 Bit, 24 Bit extended addressing, disable-able in 2K increments

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64K STATIC RAM - Mem Merchant
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MEM-64400A *64K A & T* $594.95

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MEM-99730K *Kit with no RAM* $179.95
MEM-32731K *32K kit* $199.95
MEM-64733K *64K kit* $249.95
Assembled & Tested .... add $50.00

32K RAM 20 - CompuPro
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MEM-16180A *16K A & T* $259.95
MEM-16180C *16K CSC* $324.95
MEM-24180A *24K A & T* $324.95
MEM-24180C *24K CSC* $364.95
MEM-32185A *32K A & T* $384.95
MEM-32185C *32K CSC* $449.95

16K STATIC RAM - Mem Merchant
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MEM-16171A *16K A & T* $154.95

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SYSTEM SUPPORT 1 - CompuPro
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IOI-1820A *A & T* $218.95
IOI-1820C *CSC* $288.95

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IOI-1835A *5 port A & T* $558.95
IOI-1835C *5 port CSC* $628.95
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IOI-1875C *4K MPX CSC* $534.95
IOI-1880A *16K MPX A & T* $584.95
IOI-1880C *16K MPX CSC* $674.95

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2 serial I/O ports plus 2 parallel I/O ports.

IOI-1010B *Bare board w/manual* $35.00
IOI-1010K *Kit with manual* $179.95
IOI-1010A *A & T with manual* $249.95

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IOI-1015A *A & T* $289.95

I/O-8 - SSM Microcomputer
Eight software programmable serial I/O ports, 110 -19.2K Baud, ideal for multi-user systems

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MPC-4 - SD Systems
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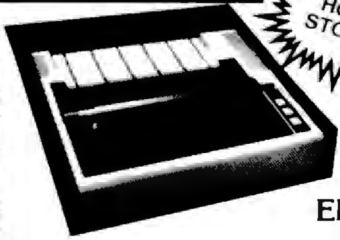

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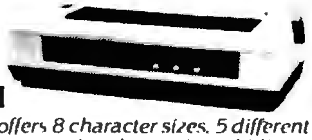

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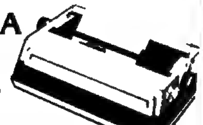

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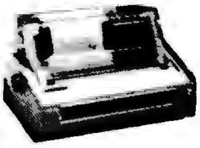
NEC	$77/Doz.
Qume	45/Doz.
Diablo	66/Doz.
Anadex	135/6 ea.
Tritel	95/Doz.
TI/DEC/TTY	45/Doz.
Epson	13.95/ea.
MPI/Axiom/Base 2	13.95/ea.



NEC SPINWRITERS

Letter quality printers: 7700 serial print 55 CPS, 3500 series print 33 CPS. Both series offer up to 128 char., take paper up to 16 in. wide. 7700 series: 136 col. at 10 CPI, 163 col. at 12 CPI. Same for 3500 series plus 204 col. at 15 CPI.

7710/7730 RO w/tractor .... $2475.
7720 KSR w/tractor .... 2850.
3510/3530 RO .... 1695.
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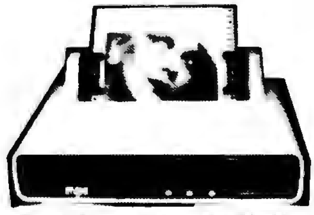

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with Graphics Prom (Ap-Pak)...... 145.
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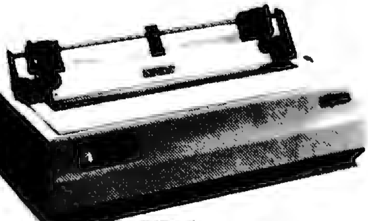

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20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39

ST = SOLDERTAIL

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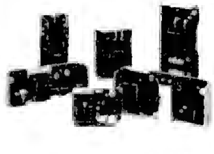

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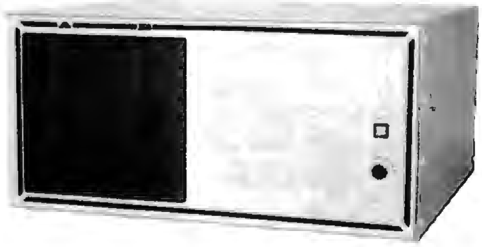

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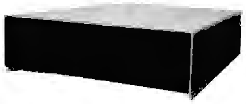
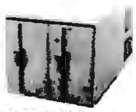


HORIZONTAL



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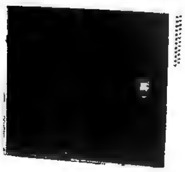

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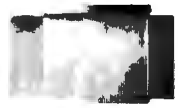

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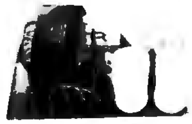

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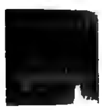

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$26.50

Your Choice **SCOTCH MEMOREX VERBATIM**

	Soft Sector	10 Sector	16 Sector	
SCOTCH	744-0	744-10	744-16	$26.50
MEMOREX	3401	3403	3405	26.50
VERBATIM	525-01	525-10	NA	26.50
DYSAN	104/1	107/1	NA	39.50

Single Side Double Density

DYSAN	104/1D	107/1D	NA	45.00

Double Side Double Density

SCOTCH	745-0	745-10	745-16	42.50
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

EIGHT INCH DISKETTES

Single Side Single Density

SCOTCH	740-0	29.50
MEMOREX	3060	29.50
DYSAN	3740/1	39.50

Thirty Two Sector

SCOTCH	740-32	29.50

Scotch Head Cleaning Kits 5¼ & 8"	$24.95
Plastic Library Cases 5¼ & 8"	2.90
Diskette Flip Tubs fifty diskettes 5¼"	24.95
Diskette Flip Tubs fifty diskettes 8	29.95

Single Side Double Density

SCOTCH	741-0	39.00
MEMOREX	3090	35.00
DYSAN	3740/D	57.50

Double side Double Density

SCOTCH	743-0	47.50
MEMOREX	3114	39.50
DYSAN	3740/2D	65.00

PLEASE PHONE FOR VOLUME PRICING.

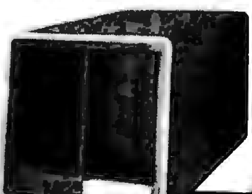
BSR SYSTEM X·10

The new BSR timer runs your home just like clockwork. Turns on lamps and appliances while your away from home. Completely compatible with your existing System X-10 devices.

BSR Timer eight channel	$85.00	Appliance Module 500 W.	$13.95
Master control console	34.95	Lamp Module 300 Watts	13.95
Ultrasonic Controller	19.95	NEW full control wall switch	14.50

WINCHESTER SUBSYSTEM

$1250



Includes seven megabyte Winchester hard disk, dual enclosure and power supply.
Floppy backup drive $199.00 additional.

MEMORY

64K DYNAMIC	16K STATIC
$9.95	$13.95
4164 100·	2167 70ns.
16K DYNAMIC	**2716 EPROM**
$2.10	$4.95
4116 100·$1.85	100·$4.50 1K·$4.00

2732 EPROM SALE $7.95

STATIC

		ea.	32+	100+	1K+
21L02	1K	1.19	1.09	1.05	.99
2114	300ns.	2.95	2.75	2.50	1.99
4044-4	450ns.	4.50	4.19	4.00	3.75
4044-2	250ns.	4.95	4.65	4.50	4.25
6116	16k 24 pin	7.95	7.50	6.75	6.45
2167/6167	20 pin	11.95	10.75	9.65	9.25

EPROM

2708	450ns.	3.95	3.50	3.25	3.00
2716	5V.	4.95	4.00	3.75	3.50
2716	tri-volt	8.50	7.95	7.65	7.25
2732	Intel/Fitac.	7.95	7.50	7.00	6.65
2532	Texas Inst	12.95	11.50	10.00	9.50
2764	64K Eprom	29.95	27.00	25.00	23.50

direct connect MODEM

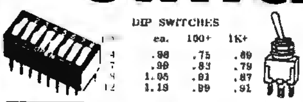
Your Choice $169

[illegible] modems eliminate loss of information due to the carbon compression [illegible] acoustic modems. Choose either of these two great units.

The [illegible] 103LP [illegible] between answer and originate [illegible] connects to the new modular [illegible]. No need to locate modem in [illegible] pounds.

[illegible] to [illegible] the new "Bell" modular [illegible]. Requires external A.C. power. [illegible]

SWITCHES



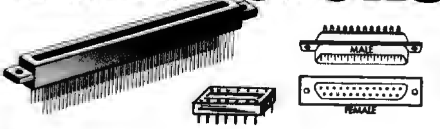
DIP SWITCHES

	ea.	100+	1K+
4	.98	.75	.69
7	.99	.83	.79
8	1.05	.91	.87
12	1.19	.99	.91

TOGGLE

		ea.	100+
7101	on/on	1.19	.98
7103	on/off/on	1.39	1.19
7107	mnt. on	1.39	1.19
7108	mnt. on	1.39	1.19
7205	dpdt mnt	1.85	1.65

CONNECTORS



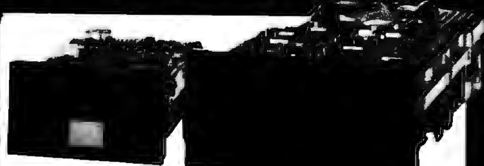
GOLD EDGE CONNECTORS

S-100 .125" centers	each	10+
Imsai solder .250" row	$2.95	$2.50
Imsai wire wrap (TI)	3.95	3.50
Sullins Hi-Rel. .250"	4.50	4.00
Sullins Hi-Rel. W/W	5.35	4.90
Sullins / Altair .140"	4.95	4.50
.156" Centers (standard)		
22/44 Kim Eyelet	2.50	2.15
36/72 Digital Group S/T	5.95	5.50
36/72 Digital Group W/W	6.60	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.65

INTEGRATED CIRCUIT SOCKETS

	Low Profile each	Low Profile 100+	Wire Wrap each	Wire Wrap 100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.45	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.42	.40	1.60	1.47

"D" Type	each	10-24	25+
DE9P male	$1.60	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.35	1.30
DB25P male	2.50	2.35	2.25
DB25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.15	1.05
DC37P male	4.20	4.00	3.70
DC37S female	6.00	5.75	5.50
DC hood 2/P	2.25	2.00	1.75
DD50P male	5.50	5.10	4.75
DD50S female	9.40	8.60	8.00
DD50 hood 2/P	2.60	2.40	2.10
CENTRONICS			
57-30360	7.95	6.75	5.75
RIBBON CABLE CONNECTORS			
17/34 5" disk	4.85	4.15	3.95
20/40 TRS-80	5.85	5.05	4.70
25/50 8" disk	5.90	5.15	4.90



NEW OLIVETTI 801 Eight Inch Disk Drive $295

		ONE	TWO	TEN
★ OLIVETTI 801	single	$319	309	295
★ OLIVETTI 802/851	double	425	419	410
SHUGART 801/R	single	395	385	375
SHUGART 851/R	double	525	495	475
QUME DATA TRACK 8	double	525	495	475

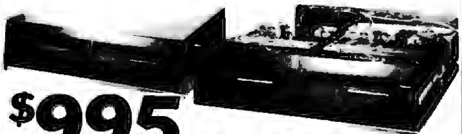
★ The 8" Olivetti drives are aprox. ½" wider than the Shugarts.

Five Inch Disk Drives

OLIVETTI 501/400	single	199	185	175
OLIVETTI 502/451	double	235	225	215

Upon request, all drives are supplied with power connectors and one manual per order.

230 volt 50Hz. 8" add $50.00 per drive.



$995 ***Eight inch Subsystem***

Two Olivetti 801 disk drives with power supply, 4" exhaust fan complete in dual enclosure with all necessary power cables. Documentation included. 50 Lbs. CAL-2801

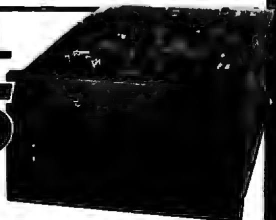
Signal cable add $35.00 WCA-6500

Same as above but with:

Shugart 801R	MSD2801	$1195	Olivetti 802	CAL2802	$1250
Shugart 851R	MSD2851	1450	Qume DT8	MSD8DT	1450

SPECIAL

$895



Volumn Pricing Upon Request

Seagate Compatable 7.5 MEGABYTE Winchester Hard Disk Drive

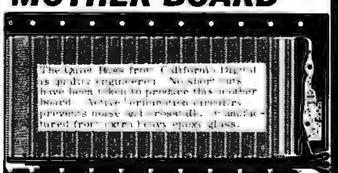
We have priced this so low that the manufacturer has asked not to use their brand name in our advertising.

Industry standard Seagate plug compatable. Drive fits into the same space as a 5¼" floppy disk drive. CAL-561/2

S-100 MOTHER BOARD

$35

IMSAI
18 Slot
CAL-M18



VISA

master charge

All merchandise sold by California Digital is premium grade.
Shipping: First five pounds $2.00; each additional add $.40
Foreign orders 10% shipping. Excess will be refunded.
California residents add 6% sales tax. COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a "Strong Dun & Bradstreet."
Warehouse: 15608 Inglewood Blvd. Visitors by appointment.

TOLL FREE ORDER LINE
(800) 421-5041
TECHNICAL & CALIFORNIA
(213) 679-9001
TWX 910 325-6212

ADVANCED COMPUTER PRODUCTS

TOLL FREE ORDER LINE
800-854-8230

apple computer

COMPUTERS

	LIST	ACP
Apple II 16K	$1330 00	$1028 00
Apple II 48K	1530 00	1099 00
Apple II 64K	1728 00	1225 00
Apple II 64K w/Z80 Softcard & Vision 80	2519 00	1775 00
★ Apple III 128K	3495 00	★ 2895 00

AVAILABLE IN STORE ONLY

APPLE HARDWARE

AVAILABLE IN STORE ONLY

	LIST	ACP
Apple Disk II w/interface	$ [illegible]	$ [illegible]
Apple Disk II w o	[illegible]	[illegible]
Silentype Printer	[illegible]	[illegible]
Prototype Card	[illegible]	[illegible]
IEEE-488 Interface	[illegible]	[illegible]
1 year ext warranty	[illegible]	[illegible]
Parallel Printer Interface	[illegible]	[illegible]
Communications Card	[illegible]	[illegible]
Pascal Language System	[illegible]	[illegible]
High Speed Serial Interface	[illegible]	[illegible]
Applesoft II ROM Card	[illegible]	[illegible]
★ Hard Disk Subsystem	[illegible]	[illegible]

APPLE COMPATIBLE HARDWARE

Mountain Computer: Joystick, Numeric Pad, ROMplus, ROM Writer, RAMPlus, CPS Multifunction, Expansion Chassis, Thunderclock, X-10 option, Pascal option

Versacard 4 in 1

CCS Serial I/O, Parallel I/O

M & R Enterprises: Apple Fan, Sup'R Mod, Aux Switcher Supply, Sup'R Term

Corvus Hard Disk

APPLE SOFTWARE

Visicalc, SuperCalc, VisiTrend/VisiPlot, VisiDex, VisiTerm, BPI General Ledger, Accounts Receivable, Inventory

SUPERCALC for Apple only $199.00

FLOPPY DISK DRIVES

Qume Only $569.95

D/S	$ 569 95
5 1/4" Disk Drive	279 00
1/4" 40 tracks	279 00
1/4 35 tracks	295 00
[illegible]	449 00
[illegible]	429 00
[illegible]	1195 00
[illegible]	349 00
[illegible]	290 00
Density Single Side	375 00
Double Side	475 00

16K RAMCARD

- Apple II compatible

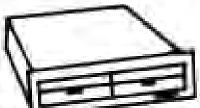
List $195.00 ACP $74.95

DEALER PRICING AVAILABLE

Vista

VISTA COMPUTER

	LIST	ACP
★ Vision 80 © 80x24 display card	[illegible]	[illegible]
Vision 40 © 40 col enhancement	[illegible]	[illegible]
Vision 20 © lower case ROM	[illegible]	[illegible]
★ A800 Double Density 8" Controllers	[illegible]	★ [illegible]
MMB 9 voice music	[illegible]	[illegible]
GB75 IBM Regent Apple I O	[illegible]	[illegible]
POS PROM development	[illegible]	[illegible]
TYPE AHEAD BUFFER	[illegible]	[illegible]



Vision 80 $299.00

VISTA V DRIVE

NOW W/TANDON

[illegible]	$ 459 95
ps&c	$1495 00
[illegible]	$1995 00

VISTA V 80

case ps	(Supplied	$299 00
case	Separately)	$589 00

APPLE COMPATIBLE DRIVES (MicroSci)

	LIST	ACP
★ [illegible]	$479 00	★ [illegible]
[illegible]	100 00	[illegible]
[illegible]	449 00	[illegible]
[illegible]	599 00	[illegible]
A40/A70	100 00	[illegible]

DISKETTES

VERBATIM & Maxell Diskettes

100% CERTIFIED ERROR-FREE!

$29 95, $29 95, $29 95, $39 95, $39 95, $39 95, $33 50, 33 50, 44 80, 49 80

ROBOTIC ARM

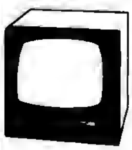
- Automation or Robotic Assembly
- Education in Robotic Pricipies
- Artificial Intelligence Experiments
- Computer Art and Games

Microbot **$1695.00**

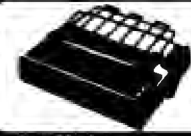
Microbot Minimover-5	
Completely Assembled w/Applications Manual	$1695 00
ARMBASIC Software For TRS-80	39 95
Application/Reference Manual	16 95

USI INTERNATIONAL — USI Computer Products

VIDEO MONITOR (Sanyo Look Alike)



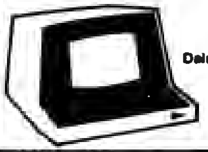
Model Pi 1 9" Green	$159.95
Model Pi 2 12" Green	159 95
Model Pi 3 12" Orange	199 95



$429.00

PRINTERS

		LIST	ACP
MX-80 Dot Matrix		$645 00	★ $429 00
★ MX-80/FT		745 00	529 00
MX-100		999 00	725 00
Apple I/O & cable		110 00	89 00
Graftrax option		95 00	89 00
IEEE I/O & cable		130 00	95 00
Serial I/O & cable		130 00	95 00
Serial w/2K & cable		175 00	149 00
Universal Graphics Utility		39 95	★ 35 95
NEC			
8023 Dot Matrix		795 00	649 00
DIABLO			
★ 630 Daisywheel		2985 00	★ 2295 00
Tractor		249 00	169 95
C ITOH/VISTA			
★ Starwriter/V300	25 cps	1895 00	★ 1495 00
	45 cps	2195 00	1795 00
8510	100 cps	749 00	★ 675 00
ANADEX			
9500 9501		1650 00	1350 00
QUME			
9/45		3295 00	2995 00
IDS			
460G w/graphics		1395 00	899 00
560G 14 75 carriage		1695 00	1199 00



BROTHER Daisywheel Printer Only $895

TERMINALS

	LIST	ACP
TELEVIDEO		
910	$ 699 00	$ 599 00
912C	950 00	699 00
920C	995 00	799 00
950C	1195 00	999 00
SOROC		
IQ120		699 00
IQ135		899 00
IQ140		1149 00

SANYO

MONITORS

SANYO	LIST	ACP
[illegible]	[illegible]	$169 95
[illegible]	[illegible]	199 95
[illegible]	[illegible]	249 00
[illegible]	[illegible]	279 00
[illegible]	[illegible]	429 00
[illegible]	[illegible]	995 00

Novation

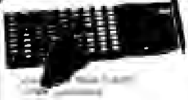
MODEMS

NOVATION

	LIST	ACP
Cat	$199 95	$149 00
D-Cat	199 95	169 00
Apple-Cat	349 95	309 00
Auto-Cat	299 95	239 95
HAYES		
Micromodem	$379 00	$299 00
Smartmodem	279 00	249 00

IBM

IBM COMPATIBLE BOARDS



MAX-OUT YOUR IBM PC

[illegible]	$1199 00
populated	1739 00
populated	1849 00
192K ADD-ON w/SUPERCALC WOW! Superdeal @ That's for both	799 00
IBM Wire Wrap Board	89 00
IBM Extender Board	19 95

ATARI

ATARI COMPUTER

[illegible]

ADD-ON MEMORY

	LIST	ACP
Atari 16K	$ 99 50	$ 74 00
Atari 32K	199 00	139 00
Vic 20 16K	199 50	149 00

XEROX 820

FREE TCS BUSINESS SOFTWARE w/purchase A/R G/L A/P Payroll Inventory $1100 00 VALUE 8 only

		LIST	ACP
820-1	5 1/4 system	$2995 00	$2495 00
★ 820-2	8 system	3795 00	★ 3195 00
CP/M		200 00	169 95
SuperCalc		295 00	239 95
Word Processing		500 00	429 95

HEWLETT PACKARD

HEWLETT-PACKARD COMPUTERS

	LIST	ACP
HP-87	$2495 00	$1895 00
HP-85A	2750 00	2095 00
HP-83	2395 00	1050 00
HP-125	2750 00	2095 00
5 1/4" Dual Floppy		1875 00
w/Winchester		4765 00
[illegible]		5135 00
[illegible]		1375 00
[illegible]		249 00
[illegible]		379 00
[illegible]		675 00
[illegible]		425 00

CALCULATORS

	LIST	ACP
for 41C		[illegible]
[illegible]	95 00	[illegible]
Card Reader for 41C CV	215 00	[illegible]
41C CV	385 00	[illegible]
Optical Wand for 41C CV	125 00	[illegible]
HP-11C Advanced Scientific ★ NEW!	135 00	[illegible]
HP-12C Financial	150 00	[illegible]
HP-34C Prog Scientific	150 00	[illegible]
HP-38C Prog Business	150 00	[illegible]
HP-97 Programmable Printer	750 00	[illegible]

NOTE WE STOCK ACCESSORIES

HPIL Interface Loop $119 95 — Turns your calculator into a complete computer system

82182A Time Module 75 00 64 95

TERMS: MO Cashier's Check Bank Wire Personal checks allow 2 weeks for processing Include Driver's License and credit card #s Visa MC AMEX CB add 3% service charge Add 3% shipping & Handling or $2 whichever is greater Add 10% for foreign orders or US Parcel Post Include Telephone number NO CODs Prices subject to change without notice Some items subject to prior sale We reserve the right to substitute manufacturer Retail prices may vary

SUPER SPECIALS

MOUNTAIN COMPUTER

CPS Multifunction Card $239.00

Sale $169.95

SAVE $300

	LIST	ACP
Apple Board Set		
Z80 Softcard (Microsoft)	$395 00	$289 00
16K Ramcard	195 00	169 00
Vision 80 display card (Vista)	395 00	299 00

ALL THREE ONLY $679 save $306

ELPAC FD206 8"

Floppy Disk Power Supply

Drives 2 Drives

+24V @ 3A +5V @ 2 5A -5V @ 0 5A

LIST $159 00 ACP $99 00

AMDEK

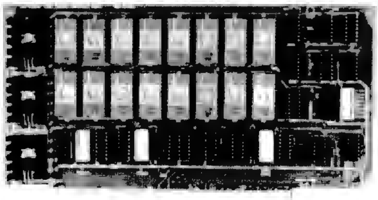
12" B&W Monitor (Super Value)

$89 ea.

Circle 8 on inquiry card.

DIGITAL RESEARCH COMPUTERS
(214) 271-3538

32K S-100 EPROM CARD
NEW!



$79.95
KIT

USES 2716's

Blank PC Board - $34

ASSEMBLED & TESTED
ADD $30

SPECIAL: 2716 EPROM's (450 NS) Are $9.95 Ea. With Above Kit.

KIT FEATURES
1. Uses +5V only 2716 (2Kx8) EPROM's
2. Allows up to 32K of software on line!
3. IEEE S-100 Compatible
4. Addressable as two independent 16K blocks
5. Cromemco extended or Northstar bank select
6. On board wait state circuitry if needed
7. Any or all EPROM locations can be disabled
8. Double sided PC board, solder-masked, silk-screened
9. Gold plated contact fingers
10. Unselected EPROM's automatically powered down for low power
11. Fully buffered and bypassed
12. Easy and quick to assemble

64K S100 STATIC RAM

$399.00 KIT

NEW!

LOW POWER!
RAM OR EPROM!

BLANK PC BOARD
WITH DOCUMENTATION
$55

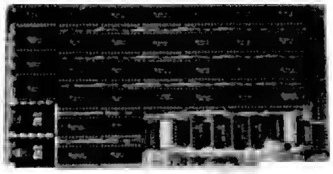
SUPPORT ICs + CAPS
$17.50

FULL SOCKET SET
$14.50

FULLY SUPPORTS THE
NEW IEEE 696 S100
STANDARD
(AS PROPOSED)

FOR 56K KIT $349

ASSEMBLED AND
TESTED ADD $40

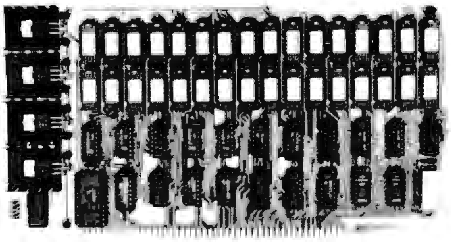


FEATURES:
* Uses new 2K x 8 (TMM 2016 or HM 6116) RAMs.
* Fully supports IEEE 696 24 BIT Extended Addressing.
* 64K draws only approximately 500 MA.
* 200 NS RAMs are standard. (TOSHIBA makes TMM 2016s as fast as 100 NS. FOR YOUR HIGH SPEED APPLICATIONS.)
* SUPPORTS PHANTOM (BOTH LOWER 32K AND ENTIRE BOARD).
* 2716 EPROMs may be installed in any of top 48K.
* Any of the top 8K (E000 H AND ABOVE) may be disabled to provide windows to eliminate any possible conflicts with your system monitor, disk controller, etc.
* Perfect for small systems since BOTH RAM and EPROM may co-exist on the same board.
* BOARD may be partially populated as 56K.

16K STATIC RAM KIT-S 100 BUSS

PRICE CUT!
$149.95 KIT

FOR 4MHZ
ADD $10



KIT FEATURES
1. Addressable as four separate 4K Blocks
2. ON BOARD BANK SELECT circuitry (Cromemco Standard!) Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams
4. ON BOARD SELECTABLE WAIT STATES
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers
6. All address and data lines fully buffered
7. Kit includes ALL parts and sockets
8. PHANTOM is jumpered to PIN 67
9. LOW POWER under 1.5 amps TYPICAL from the +8 Volt Buss
10. Blank PC Board can be populated as any multiple of 4K.

BLANK PC BOARD W/DATA-$33
LOW PROFILE SOCKET SET-$12
SUPPORT IC'S & CAPS-$19.95
ASSEMBLED & TESTED-ADD $35

OUR #1 SELLING
RAM BOARD!

64K SS-50 STATIC RAM

$299.00 (48K KIT)

NEW!

LOW POWER!
RAM OR EPROM!

BLANK PC BOARD
WITH
DOCUMENTATION
$52

SUPPORT ICs + CAPS
$18.00

FULL SOCKET SET
$15.00

56K Kit $349

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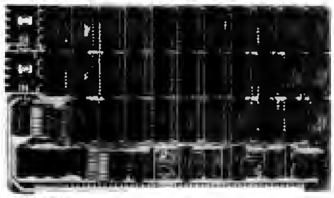

FEATURES:
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* Board is configured as 3-16K blocks and 8-2K blocks (within any 64K block) for maximum flexibility.
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* RAM supports 2MHZ operation at no extra charge!
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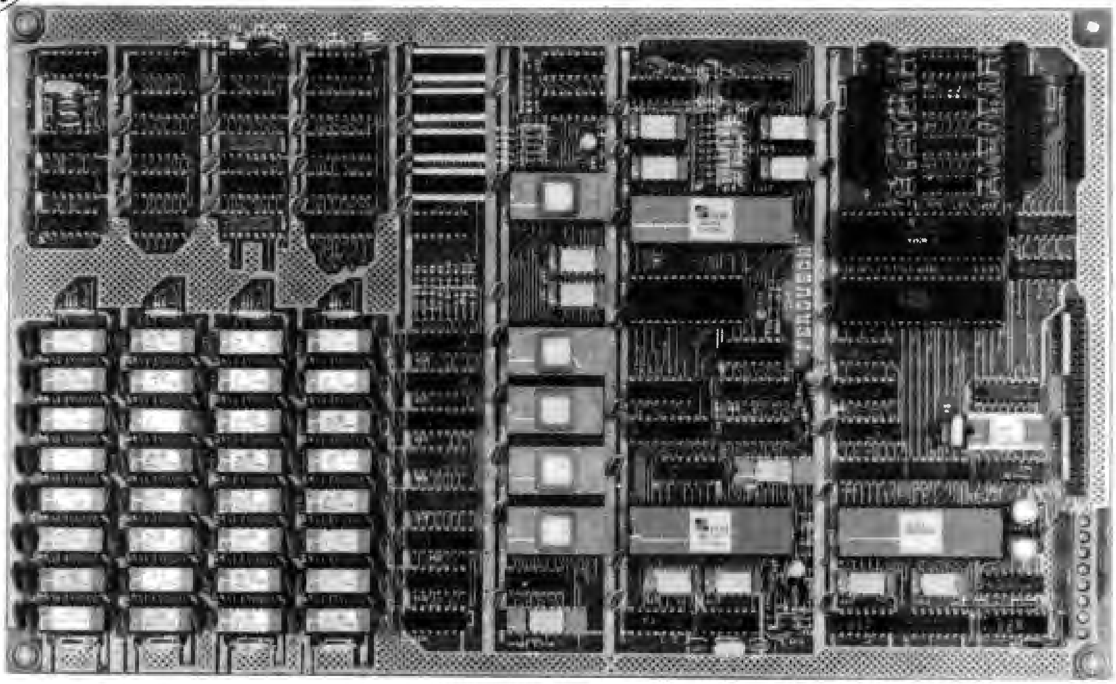

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74LS

74LS00	.29			74LS192	1.15
74LS01	.29			74LS193	1.15
74LS02	.29	74LS92	.75	74LS194	1.15
74LS03	.29	74LS93	.75	74LS195	1.15
74LS04	.35	74LS95	.99	74LS197	1.19
74LS05	.35	74LS96	1.15	74LS221	1.19
74LS08	.35	74LS107	.45	74LS240	1.49
74LS09	.35	74LS109	.45	74LS241	1.49
74LS10	.35	74LS112	.45	74LS242	1.49
74LS11	.39	74LS113	.49	74LS243	1.49
74LS12	.35	74LS114	.49	74LS244	1.49
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74LS27	.35	74LS138	.89	74LS258	.69
74LS28	.35	74LS139	.89	74LS260	.69
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74LS48	1.15	74LS161	1.15	74LS353	1.29
74LS49	1.15	74LS162	1.15	74LS365	.69
74LS51	.35	74LS163	1.15	74LS366	.69
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74S03	.45	74S124	3.95	74S251	1.45
74S04	.55	74S133	.55	74S253	1.45
74S05	.55	74S134	.69	74S257	1.35
74S08	.50	74S135	1.19	74S258	1.35
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MAN 2	320	Red	5x7 Alphanumeric	[illegible]
MAN 52	300	Green	C.A. (LHDP)	[illegible]
MAN 54	300	Green	C.C. (RHDP)	[illegible]
MAN 72	300	Red	C.A. (LHDP)	[illegible]
MAN 74	300	Red	C.C. (RHDP)	[illegible]
MAN 82	300	Yellow	C.A. (LHDP)	[illegible]
MAN 84	300	Yellow	C.C. (RHDP)	[illegible]
MAN 3620	300	Orange	C.A. (RHDP)	[illegible]
MAN 3630	300	Orange	C.A. ±1 Over Flo	[illegible]
MAN 3640	300	Orange	C.C. (RHDP)	[illegible]
MAN 4610	400	Orange	C.A. (LHDP)	[illegible]
MAN 4640	400	Orange	C.C. (RHDP)	[illegible]
MAN 6610	560	Orange	C.A. (RHDP) 2 Digit	[illegible]
MAN 6630	560	Orange	C.A. ±1 1/2 Digit	[illegible]
MAN 6640	560	Orange	C.C. (RHDP) 2 Digit	[illegible]
MAN 6650	560	Orange	C.C. ±1 1/2 Digit	[illegible]
MAN 6660	560	Orange	C.A. (RHDP)	[illegible]
MAN 6680	560	Orange	C.C. (RHDP)	[illegible]
MAN 6710	560	Red	C.A. (RHDP) 2 Digit	[illegible]
MAN 6740	560	Red	C.C. (RHDP) 2 Digit	[illegible]
MAN 6780	560	Red	C.C. ±1 1/2 Digit	[illegible]
DL 34M	110	Red	C.C. 4 Digit Bubble RHDP	[illegible]
DLO 304	300	Orange	C.C. (RHDP)	[illegible]
DLO 307	300	Orange	C.A. (LHDP)	[illegible]
DLG 300	500	Green	C.A. (LHDP)	[illegible]
DLG 307	500	Green	C.C. (RHDP)	[illegible]
DL 704	300	Red	C.C. (RHDP)	[illegible]
DL 707	300	Red	C.A. (LHDP)	[illegible]
DL 747	630	Red	C.A. (LHDP)	[illegible]
DL 750	630	Red	C.C. (LHDP)	[illegible]
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FND 357	357	Red	C.C. (RHDP) FND 359	[illegible]
FND 500	500	Red	C.C. (RHDP) FND 503	[illegible]
FND 507	500	Red	C.A. (RHDP) FND 510	[illegible]
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5082 7300	600	Red	4x7 Numeric (RHDP)	[illegible]
5082 7302	600	Red	4x7 Numeric (LHDP)	[illegible]
5082 7304	600	Red	Over Flo ±1	[illegible]
5082 7340	600	Red	4x7 Hexadecimal (0-9, A-F)	[illegible]
5082 7432	110	Red	C.C. (2 Digit-3 Bubble)	[illegible]
HDSP 3401	800	Red	C.A. (RHDP)	[illegible]
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4N33	Single Chan. 500% 1500V (Photo Darlington)	[illegible]
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	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

JUMPER AND CABLE ASSEMBLIES

Custom Jumpers! *Custom Cables!*

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No.	AP Cross Reference	No. Pins	Description	Wire Length	Price
DJ14-1	924102 12	14	single end	12"	$1.79
DJ14-2	924102 24	14	single end	24"	2.05
DJ14-3	924102 36	14	single end	36"	2.38
DJ14-1-14	924106 12	14	double end	12"	3.20
DJ14-2-14	924106 24	14	double end	24"	3.49
DJ14-3-14	924106 36	14	double end	36"	3.79
DJ16-1	924112 12	16	single end	12"	1.86
DJ16-2	924112 24	16	single end	24"	2.19
DJ16-3	924112 36	16	single end	36"	2.59
DJ16-1-16	924116 12	16	double end	12"	3.35
DJ16-2-16	924116 24	16	double end	24"	3.69
DJ16-3-16	924116 36	16	double end	36	4.05
DJ24-1	924122 12	24	single end	12	2.69
DJ24-2	924122 24	24	single end	24	3.39
DJ24-3	924122 36	24	single end	36"	3.95
DJ24-1-24	924126 12	24	double end	12	4.79
DJ24-2-24	924126 24	24	double end	24	5.29
DJ24-3-24	924126 36	24	double end	36"	5.89

JAMECO Part No.	AP Cross Reference	No. Pins	Description	Wire Length	Price
DJ40-1	924132 12	40	single end	12"	5.89
DJ40-2	924132 24	40	single end	24	6.79
DJ40-3	924132 36	40	single end	36	7.69
DJ40-1-40	924136 12	40	double end	12	10.95
DJ40-2-40	924136 24	40	double end	24	11.89
DJ40-3-40	924136 36	40	double end	36	12.79

STANDARD DB25 SERIES CABLES

Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4-foot lengths. **Call today.**

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
DB25P-4	4 feet	1 DB25P	$ 9.95 ea.
DB25S-4	4 feet	1 DB25S	10.95 ea.
DB25P-4-P	4 feet	2 DB25P	16.95 ea.
DB25P-4-S	4 feet	1 DB25P/1 DB25S	17.95 ea.
DB25S-4-S	4 feet	2 DB25S	18.95 ea.

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6% Sales Tax
Postage — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sale Flyer!

Spec Sheets — 25¢ each
Send 88¢ Postage for your
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Prices Subject to Change

NEW 1982 CATALOG

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7/82

INTERSIL

* Evaluation Kits

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
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
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter CA	12.95
7217AIPI	4-Digit LED Up/Down Counter CC	14.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	6.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39			74C221	1.95
74C02	.39	74C95	1.59	74C240	2.25
74C04	.39	74C107	1.89	74C244	2.25
74C08	.39	74C151	2.95	74C373	2.49
74C10	.39	74C154	3.95	74C374	2.59
74C14	.75	74C157	2.25	74C901	.69
74C20	.39	74C160	1.69	74C903	.69
74C30	.39	74C161	1.60	74C911	10.95
74C32	.39	74C162	1.49	74C912	10.95
74C42	1.39	74C163	1.69	74C915	1.69
74C48	1.95	74C164	1.59	74C917	10.95
74C73	.79	74C173	1.39	74C922	5.49
74C74	.79	74C174	1.39	74C923	5.75
74C85	1.95	74C175	1.19	74C925	7.50
74C86	.99	74C192	1.69	74C926	7.50
74C89	6.95	74C193	1.69	80C95	.79
74C90	1.29	74C195	1.59	80C97	.79
74C93	1.29				

LINEAR

LH0002CN	6.85			NE571N	3.95
LM10CLH	4.50			LM703CN	.89
LM11CLH	4.75	LM340T-5	1.25	LM709N	.29
LH0070-OH	4.95	LM340T-12	1.25	LM710N	.79
TL071CP	.79	LM340T-15	1.25	LM711N	.79
TL072CP	1.39	LM341P-5	.75	LM723N	.69
TL074CN	2.49	LM341P-12	.75	LM733N	1.00
LH0082CD	35.80	LM341P-15	.75	LM739N	1.19
TL082CP	1.19	LM342P-5	.69	LM741CN	.35
TL084CN	2.19	LM342P-12	.69	MC1741SCG	3.00
LH0094CD	35.80	LM342P-15	.69	LM747N	.79
LM300H	.99	LM348N	1.25	LM748N	.59
LM301CN	.35	LM350K	5.75	LM1014N	2.75
LM302H	1.95	LF351N	.60	LM1310N	1.95
LM304H	1.95	LF353N	1.00	LM1458CN	.59
LM305H	.99	LF355N	1.10	LM1488N	1.25
LM307CN	.45	LF356N	1.10	LM1489N	1.25
LM308CN	1.00	LM358N	1.00	LM1496N	1.95
LM309H	1.95	LM359N	1.79	LM1556V	1.75
LM309K	1.25	LM370N	4.49	LM1800N	2.95
LM310CN	1.75	LM373N	3.25	LM1871N	5.49
LM311/CN	.90	LM377N	2.95	LM1872N	5.49
LM312H	2.49	LM380N	1.25	LM1877N-9	3.25
LM317MP	1.15	LM381N	1.95	LM1889N	3.20
LM317T	1.75	LM382N	1.79	LM1896N	1.75
LM317K	3.95	LM384N	1.95	LM2002T	1.49
LM318CN	1.95	LM386N-3	1.29	LM2877P	2.05
LM319N	1.95	LM387N	1.45	LM2878P	2.25
LM320K-5	1.35	LM389N	1.35	LM2896P-1	2.25
LM320K-12	1.35	LM392N	.69	LM3189N	2.95
LM320K-15	1.35	LF398N	4.00	LM3900N	.69
LM320T-5	1.25	LM399H	5.00	LM3905CN	1.25
LM320T-12	1.25	TL494CN	4.49	LM3909N	1.15
LM320T-15	1.25	TL496CP	1.75	LM3914N	3.95
LM323K	5.95	NE510A	6.00	LM3915N	3.95
LM324N	.99	NE529A	4.95	LM3916N	3.95
LM329DZ	.65	NE531H	3.95	RC4136N	1.25
LM331N	3.95	NE536H	6.00	RC4151NB	3.95
LM334Z	1.30	NE540H	6.00	RC4194TK	6.95
LM335Z	1.40	NE544N	4.95	RC4195TK	5.49
LM336Z	1.75	NE550A	1.30	LM4500A	3.25
LM337T	1.95	NE555V	.39	ICL8038B	4.95
LM337MP	1.15	LM556N	.99	LM13080N	1.29
LM338K	6.95	NE564N	3.95	LM13600N	1.49
LM339N	.99	LM565N	1.25	75138N	1.95
LM340K-5	1.35	LM566CN	1.95	75450N	.89
LM340K-12	1.35	LM567V	1.25	75451CN	.39
LM340K-15	1.35	NE570N	4.95	75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.06
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.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

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

Circle 204 on inquiry card.

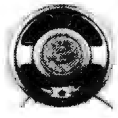
UTC Mini Stereo AM/FM Receiver

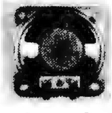
WITH HEADPHONES — For Joggers, Cyclists, Skaters & Sports Events

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3⅞" x 4⅞" x 1". Wt. 6 oz.

Model 2830 List Price $89.95 .... **$34.95**

SPEAKERS





2¼" Round — 8 Ohm .25 Watt (4" Leads) Size: 2¼" x ¾"	2½" Square — 16 Ohm .25 Watt (4 mount. holes) Large Ceramic Magnet Size: 2⅜" x 2⅜" x ¾"
Part No. / Price	Part No. / Price
A0201 . . .$1.25 or 2/1.98	SF-25016 . $1.39 or 2/2.98

National Semiconductor RAM SALE

STATIC RAMS

MM2114N-2 4K (200NS) .... **$2.49 each**
(8 EACH $16.95/lot) (100 EACH $195.95/lot)

MM2114N-2L 4K (200NS) Low Power .... **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM2147N 4K (70NS) .... **$4.95 each**
(8 EACH $34.95/lot) (100 EACH $419.95/lot)

MM6116P-4 16K (200NS) .... **$9.95 each**
(8 EACH $69.95/lot (100 EACH $795.00/lot)

DYNAMIC RAMS

MM4164N-20 64K (200NS) .... **$9.95 each**
(8 EACH $69.95/lot) (100 EACH $795.00/lot)

MM5261N 1K (300NS) **8/1.95**

MM5262N 2K (365NS) **8/1.95**

MM5290N-2 16K (150NS) 4116 ...... **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM5290N-4 16K (250NS) 4116 ...... **$1.95 each**
(8 EACH $14.95/lot) (100 each $175.00/lot)

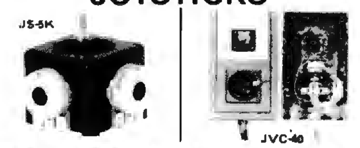
EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11EL Replacement Bulb $16.95

UVS-11E $79.95

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in case	$4.95

5¼" Mini-Floppy Disc Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I, III (Industry Standard)

Features single or double density. Recording mode FM single, MFM double density. Power +12VDC (±0.6V) 1.6 amps max., 5VDC (±0.25V) 0.8 amps max. Unit as pictured at left (does not incl. case, power supply or cables). 30-page data book included. Weighs 3½ pounds. Size: 5¾"W x 8"D x 3¼"H

Part No. *Limited Quantity!* Price

FD200 .... **$179.95**
Single-sided, 40 tracks, 250K bytes capacity

FD250 .... **$199.95**
Double-sided, 35 tracks, 438K bytes capacity

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200	Reg. Power Supply Kit (5VDC, 1 amp) . .	$14.95
JE205	Adapter Brd. (to JE200) ±5, ±9 & ±12V .	$12.95
JE210	Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	15.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	2.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	5.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6507	MPU w/Clock (8K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95

1173AN-1 30 Tune Musical MPU Chip 8.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016N	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2511N	MOS Dual 200-Bit Static	.99
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

DC10	Mostek DC/DC Convert. +5V to -9V	32.95
MC3470P	Floppy Disc Read AMP System	4.95
MC1408L7	7-Bit D/A Converter (DAC0807LCN)	4.95
MC1408L8	8-Bit D/A Converter (DAC0808LCN)	5.75
AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	2.25
2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
74S200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	1.95
4164N-3	64K Dynamic 200ns	14.95
MM2147N	4096x1 Fast 70ns	4.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	2.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	1.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x4OC)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	4.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716Intel(2516)TI	16K EPROM (Single +5V)	8.95
2732Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123 (74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

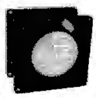
SPECIAL FUNCTION

DS0026CN	Dual MOS Clock Driver (5MZ)	3.50
DS0025CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

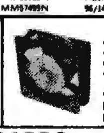
Pee Wee Boxer Fan



- 36cfm free air delivery
- 3.125" sq. x 1.665" depth
- 10 yrs. cont. duty at 20°C
- 115V 50/60Hz
- For Apple users

PWS2107U Cleaned & tested (used) .... $ 9.95 ea.
PWS2107F New .... $14.95 ea.

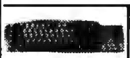
Muffin® Fan



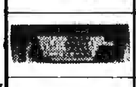
- 105cfm free air delivery
- 4.68" sq. x 1.50" depth.
- 10 yrs. cont. duty at 20°C
- Impedance protected, ambients to 70°C
- 115V 50/60Hz 14W Wt. 17 oz.

MU2A1-U Cleaned & tested (used) .... $9.95 ea.
MU2A1-N New .... $14.95 ea.

KEYBOARDS

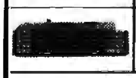


MICRO SWITCH 69-KEY KEYBOARD *Limited Quantity!*
Uses AMI SW20350K Chip. Size: 16⅜"L x 5¼"W x 1⅞"H Metal Frame. Light and dark grey key caps (no data sheet).
Part No. KB69SD12-2 .... $19.95 each



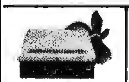
DATANETICS 74-KEY KEYBOARD *Limited Quantity!*
Uses EA20134 Chip (Electronic Array). Size: 16¾"L x 5½"W x 1⅞"H. White, black, blue, grey key caps. Data sheets not available.
Part No. KB354 .... $29.95 each

STACKPOLE 62-KEY ASCII KEYBOARD *Standard Stocked Item!*
SPST Switching (Mechanical). Size: 13"L x 3¾"W X 1½"H. Grey key caps. Data sheets are available.
Part No. K-62 .... $34.95 each
(ASCII Encloded Keyboard Kit — JE610K .... $79.95)



MICRO SWITCH 88-KEY KEYBOARD
Uses SD 25010K Chip (AMI). Size: 18¼"L x 5¾"W x 1⅜"H Dark and light gray key caps. Used in a Diablo 1640 Terminal (schematic avail.)
Part No. 88SD22 .... $69.95 each

POWER SUPPLIES



POWER SUPPLY — 5VDC @ 1 AMP REGULATED *Transaction Tech*
Output: +5VDC @ 1 amp (also +30VDC) reg. Input 115VAC 60Hz. Two-tone (black/beige) self-enclosed case. 6 foot, 3 conductor black power cord. Size: 6½"W x 7"D x 2¼"H — Wt. 3 lbs.
Part No. PS51194 .... $19.95 each

POWER SUPPLY — 5VDC @ 1 AMP REGULATED *B Industries*
Output: +5VDC @ 1 amp, +36-42VDC Adjusted. 400mA or less, 30VAC (isolated) @ 1.5 amp. Input 115VAC 60Hz. Circuit breaker re-set button. Black self-enclosed case with 4 rubber feet. 6 foot, 3 conductor black power cord. On/off switch. Size: 6¾"W x 7¾"D x 3⅞"H — Wt. 7 lbs.
Part No. PS407D .... $24.95 each

POWER PAC *Heavy Duty Multi-Voltage Power Supply* — **5VDC, 12VDC & 24VDC**
Output: +5VDC @ 30A, +12VDC @ 2A, -12VDC @ 4A and +24VDC @ 3A. Input: 115VAC, 7A, 220VAC, 3.5A. Regulation: ± .15% line and load combined. Ripple: 10MV peak to peak (3MV RMS). Overvoltage protection: 5V, +12V, -12V. Overcurrent protection included. Size: 15½"L x 6"H x 11⅞"D — Wt. 40 lbs.
Part No. 285-016 .... $119.95 each

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6% Sales Tax
Postage — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sale Flyer!

Spec Sheets — 25¢ each
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Prices Subject to Change

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BOOKS

National Semiconductor — Intersil — Intel

30001 National CMOS Data Book **$5.95**
(640 pages) 74C, CD4000, and A/D Converters

30002 National Interface Data Book **$6.95**
(704 pages) DP, DS8000, DS3600, DS75000, etc.

30003 National Linear Data Book **$11.95**
(1376 pages) LM, LF, ADC, DAC, LH Series

30004 National Series 80 — Board Level Computer (224 pages) .. **$4.95**

30005 National TTL Logic Data Book **$6.95**
(624 pages) 7400, LS, L, H, S, and DM8000 Series

30006 Above (3) 30001,3,5 as set $24.95/lot

010400 Intel Component Data Catalog **$14.95**
Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)

205610 Intel Peripheral Design Handbook **$9.95**
Full data sheets, appl. notes for Intel peripheral device components (644 pages)

AC and DC Wall Transformers

With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-). six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz. 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
DC 800	120V/60Hz	8VDC 400mA (batt. charger)	$1.95
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95

CONNECTORS

DB25P DB25S Meet RS232

Computer Users!

DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K
Kit comes complete with:

- **8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)**
- **Documentation for conversion**

TRS-16K2 *150ns $19.95
TRS-16K3 *200ns $16.95
TRS-16K4 *250ns $14.95

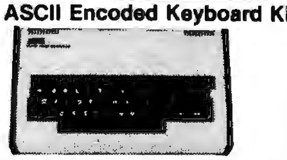
Mostek DC/DC Converter

+5 VOLTS TO -9 VOLTS

Input: +5V. Output: -9V (regulated) @ 30mA. Printed circuit mounting.

DC10 .... $2.95 ea. or 2/$4.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10 mA for operation. Features: 60 keys generate the 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14¾"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) ... **$124.95**

JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) ... **$ 79.95**

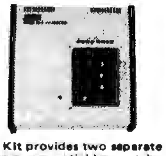
K62 62-Key Keyboard (Keyboard only) ... **$ 34.95**

DTE-AK (case only — 3⅛"Hx11"Wx8¾"D) **$ 49.95**

NEW! **JE212 — Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT**
Provides -12VDC from incoming 5VDC . . **$9.95**

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . **$59.95**

K19 19-Key Keyboard (Keyboard only) . . . **$14.95**

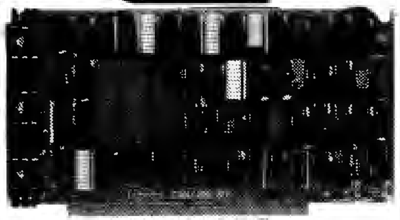
DTE-HK (case only — 3½"Hx8¾"Wx8¾"D) **$44.95**

Circle 204 on inquiry card.

PRIORITY ONE ELECTRONICS

ONE

CompuPro



NEW!

CPU BOARDS

CO-PROCESSOR 8086/8087 (816)

16 bit 8 or 10 MHz 8086 CPU with sockets for 8087 and 80130

Part No.	Description	List Price	Our Price
BGGBT186A	A&T 8MHz 8086 only	$695.00	$625.00
BGGBT186C	CSC 10MHz 8086 only	$850.00	$765.00
BGGBT186A87	A&T with 8087 option	$1295.00	$1225.00
BGGBT186C87	CSC with 8087 option*	$1550.00	$1456.00

*8087 requires slower clock speeds

DUAL PROCESSOR 8085-8088

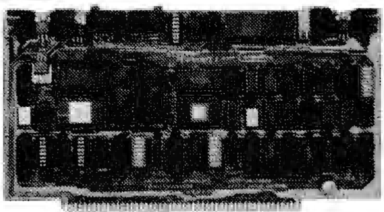
6 or 8 MHz Provides true 16 Bit Power with a standard 8 bit S-100 bus

BGGBT1612A	A&T 6Mhz	$425.00	$399.00
BGGBT1612C	CSC 6/8 MHz	$525.00	$498.00

CPU-Z Z80 CPU

2/4 MHz Z80 CPU 24 Bit Addressing

BGGBT180A	A&T	$295.00	$260.00
BGGBT180C	CSC 3-6 MHz	$395.00	$375.00



I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

Serial port (software prog. baud), 4K EPROM or RAM provision, 15 levels of interrupt, real time clock, optional math processor

Part No.	Description	List Price	Our Price
BGGBT182A	Assembled & Tested	$399.00	$360.00
BGGBT182C	CSC	$495.00	$460.00
BGGBT8231	Math Chip		$195.00
BGGBT8232	Math Chip		$195.00
BGGBT182AM1	A&T with 8231 Math Chip		$555.00
BGGBT182CM1	CSC w/8231 Math Chip		$655.00
BGGBT182AM2	A&T w/8232 Math Chip		$555.00
BGGBT182CM2	CSC w/8232 Math Chip		$655.00

MPX CHANNEL BOARD

I/O Multiplexer, using 8085A-2 CPU on board with 4K RAM

BGGBT166A4	Assembled & Tested	$495.00	$445.00
BGGBT166C4	CSC	$595.00	$535.00

With 16K RAM

BGGBT166A16	Assembled & Tested	$649.00	$585.00
BGGBT166C16	CSC	$749.00	$675.00

INTERFACER 1

Two Serial I/O

BGGBT133A	Assembled & Tested	$249.00	$219.00
BGGBT133C	CSC	$324.00	$298.00

INTERFACER 2

Three parellel, one serial I/O board

BGGBT150A	Assembled & Tested	$249.00	$219.00
BGGBT150C	CSC	$324.00	$289.00

INTERFACER 3

Eight chennel multi-use serial I/O board

BGGBT1748A	Assembled & Tested	$699.00	$629.00
BGGBT1748C	CSC 200 hr. 8 Port	$849.00	$750.00
BGGBT1745A	Assembled & Tested	$599.00	$559.00
BGGBT1745C	CSC 200hr. 5 port	$699.00	$629.00

NEW!

INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BGGBT187A	Assembled & Tested	$350.00	$315.00
BGGBT187C	CSC	$450.00	$415.00

SPECTRUM COLOR GRAPHICS

Color Graphics board with Parallel I/O

BGGBT144A	Assembled & Tested	$399.00	$349.00
BGGBT144C	CSC	$449.00	$339.00
BGGBT2D	Sublogic Universal Graphics Interpreter Software		$35.00

S-100 MOTHERBOARDS

Active termination, 6-12-20 Slot

BGGBT153A	A&T 6 slot, 2 lbs.	$140.00	$128.00
BGGBT153C	CSC 6 slot, 2 lbs.	$190.00	$175.00
BGGBT154A	A&T 12 slot, 3 lbs.	$175.00	$155.00
BGGBT154C	CSC 12 slot, 3 lbs.	$240.00	$220.00
BGGBT155A	A&T 20 slot, 4 lbs.	$265.00	$235.00
BGGBT155C	CSC 20 slot, 4 lbs.	$340.00	$310.00

ACTIVE TERMINATOR

Allows older S-100 motherboards to run faster and quieter

BGGBT106A	Assembled & Tested		$59.50

CompuPro

STATIC MEMORY BOARDS

RAM 20 - 32K STATIC RAM

RAM 20 10 MHz, 4K byte block disable, bank select or 24 bit addressing available 8, 16, 24 or 32K

Part No.	Description	List Price	Our Price
BGGBT164AA8	8K A&T	$210.00	$190.00
BGGBT164AC8	8K CSC	$260.00	$200.00
BGGBT164AA16	16K A&T	$285.00	$260.00
BGGBT164AC16	16K CSC	$355.00	$325.00
BGGBT164AA24	24K A&T	$355.00	$325.00
BGGBT164AC24	24K CSC	$425.00	$385.00
BGGBT164AA32	32K A&T	$425.00	$385.00
BGGBT164AC32	32K CSC	$495.00	$450.00

CMOS STATIC RAM

For a complete analysis of the advantages of CMOS memory, see the "Product Description" on page 416 of the January issue of BYTE

RAM 17 - 64K CMOS STATIC RAM

RAM 17, 10 MHz, 2 Watt, DMA Compatible 24 Bit Addressing

BGGBT175A64	64K A&T	$599.00	$550.00
BGGBT175C64	64K CSC	$750.00	$690.00

RAM 16 - 32K x 16 BIT CMOS STATIC RAM

8 and/or 16 Bit

(816) RAM 16 10 MHz, 32K x 16 or 64K x 8 IEEE/696 16 Bit 2 Watt, 24 Bit Addressing

BGGBT160A	64K A&T	$650.00	$599.00
BGGBT160C	64K CSC	$750.00	$699.00

NEW! RAM 21 - 128K STATIC RAM

(816) RAM 21 12MHz, 128K x 8 or 64K x 16 IEEE/696 8 or 16 Bit 1.2 Amps, 24 Bit Addressing

BGGBT190A	128K A&T	$1695.00	$1610.00
BGGBT190C	128K CSC	$1895.00	$1795.00

M-DRIVE SOLID STATE DISK DRIVE, (816) 3500% FASTER!

Not Really, But the Next Best Thing for CompuPro 8085/88 Users. Call for Detail on M-Drive.

M-Drive requires a 6MHz CPU 8085/88 dual processor, Disk 1 DMA disk controller and System Suport 1 Multifunction Board

BGGBTMD128K	128K of A&T memory & M-DriveSoftware	$1186.00
BGGBTMD128KC	128K of CSC memory & M-Drive Software	$1398.00
BGGBTMD256KA	256K of A&T memory & M-DriveSoftware	$2395.00
BGGBTMD256KC	256K of CSC memory & M-Drive Software	$2795.00

DISK CONTROLLERS

DISK 1 FLOPPY CONTROLLER

Fast DMA, Soft Sector, Controls 6" or 5¼" Single or Double Density. OUR BEST!

BGPDS171ACPM	A&T w/CP/M 2.2 & BIOS	$670.00	$450.00
BGGBT171C	CSC	$595.00	$555.00
BGGBTCPM80*	CP/M 2.2 for Z80/8065 with manuals & BIOS 6" S/D disk		$175.00
BGGBTCPM86	CP/M for 8086 with manuals & BIOS 8" S/D disk		$300.00
BGGBTOAS8S	Oasis 8 bit single user 8" S/D disk		$500.00
BGGBTOAS8M	Oasis 8 bit multiuser, 6" S/D disk		$850.00

NEW!

DISK 2/SELECTOR CHANNEL HARD DISK CONTROLLER

Fast DMA 2 board set. Controls 4 Shugart 4000 series or Fujitsu 2300 type drives

BGGBT177A	Assembled & Tested	$795.00	$750.00
BGGBT177C	CSC	$895.00	$850.00

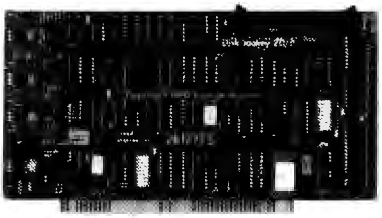
S-100 MAINFRAME

110V 60Hz CVT Mainframe uses famous 20 slot COMPUPRO Motherboard. 55 lbs.

BGGBTENC20RM	20 Slot Rack Mount	$895.00	$825.00
BGGBTENC20DK	20 Slot Desk Top	$825.00	$780.00

Turn page for complete CompuPro Systems

MORROW DESIGNS



FLOPPY DISK CONTROLLERS & SUBSYSTEMS

DISK JOCKEY 2B FLOPPY CONTROLLER

Memory mapped controller handles 4 8" drives, single or double density

Part No.	Description	List Price	Our Price
BGMDSDJ2200	A&T w/CP/M™ 2.2	$399.00	$375.00

DISCUS 2D & DISCUS 2+2 SUBSYSTEMS

Each subsystem includes DJ/2B controller 8" double density drives with cabinet, power supply, CP/M™ 2.2 and Microsoft Basic

SINGLE SIDED - DISCUS 2D

BGMDSF1218	1 Drive	30 lbs.	$1095.00	$ 950.00
BGMDSF1228	2 Drive	48 lbs.	$1875.00	$1675.00

DOUBLE SIDED - DISCUS 2+2

BGMDSSF812	1 Drive	30 lbs.	$1395.00	$1250.00
BGMDSSF822	2 Drive	48 lbs.	$2495.00	$2200.00

DISK JOCKEY/DMA FLOPPY CONTROLLER

DMA Controller supports 4 soft-sectored 8" drives and 4 10 sector 5¼" drives simultaneously. On board Z80A

BGMDSDJDMA	A&T w/CP/M™ 2.2	$495.00	$450.00

DISK JOCKEY DMA SUBSYSTEMS

Each subsystem includes DJ/DMA controller, 8" double-density drives or 5¼" 48 TPI drives, cabinet, power supply, CP/M™ 2.2 and Microsoft BASIC

SINGLE SIDED DISCUS 2D/DMA

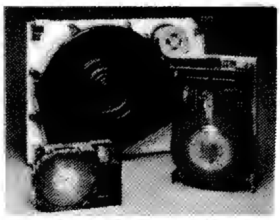
BGMDSDF811	1 Drive	30 lbs.	$1195.00	$1050.00
BGMDSDF821	2 Drive	48 lbs.	$1975.00	$1775.00

DOUBLE SIDED DISCUS 2+2/DMA

BGMDSDF812	1 Drive	30 lbs.	$1495.00	$1325.00
BGMDSDF822	2 Drive	48 lbs.	$2575.00	$2295.00

DOUBLE SIDED - DISCUS MINI-FLOPPY/DMA

BGMDSSF5124	1 Drive	17 lbs.	$ 995.00	$895.00
BGMDSDF5224	2 Drive	32 lbs.	$1695.00	$1525.00



NEW!

S-100 5-26 MB HARD DISK SUBSYSTEMS

5 - 10 Mb DMA SUBSYSTEMS

Each subsystem includes DMA Hard Disk Controller, Seagate ST506 5 Mb or ST412 10 Mb 5¼" Hard Disk, Cabinet, power supply, CP/M™ 2.2 and Microsoft BASIC.

BGMDSDMAM*	Software supplied on 8" IBM 3740 disk with blank I/O and INSTALL program
BGMDSDMAM*2B	Software configured for Morrow DJ/2B controller and Mult I/O as console
BGMDSDMAM*DMA	Software configured for Morrow DJ/DMA controller and Mult I/O as console
BGMDSDMAM*NS	Software suplied on 5¼" 10 sector North Star disk with blank I/O and INSTALL Program

Replace * in above part numbers with 5 for 5Mb Subsystems or 10 for 10Mb Subsystems.

DISCUSM5	- 5Mb Subsystems	$2195.00	$1875.00
DISCUSM10	- 10Mb Subsystems	$3195.00	$2875.00

(order by part numbers listed above)

DISCUS HDC 20-26 Mb SUBSYSTEMS

Each subsystem includes HDCA3 I/O mapped controller, Shugart SA4006 14" 26Mb or Fujitsu 2308 8" 20Mb Hard Disk, cabinet, power supply, CP/M™ 2.2 & Microsoft BASIC.

BGMDSHDC20	Discus M20 A&T	$4795.00	$3995.00
BGMDSHDC20	Discus M26 A&T	$4495.00	$3895.00

I/O BOARDS

MULTI I/O

Three Serial, Two Parallel

BGMDSMB3200	Assembled & Tested	$359.00	$329.00

SWITCHBOARD

Two serial I/O, four parellel I/O, one status port, one strobe port

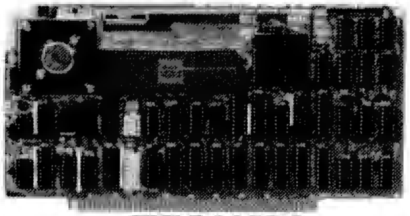
BGMDSS82411	$299.00	$260.00

Call for complete DECISION 1 Systems

Circle 310 on inquiry card.

PRIORITY ONE ELECTRONICS

DUAL



CPU BOARDS

CPU/68000 - 8MHz 68000 CPU

16 bit 68000 CPU with on board ROM containing MACSBUG Monitor or Motorola 68541 Memory Management Unit (MMU).

Part No.	Description	List Price	Our Price
BGDULCPU68000	A&T with Monitor	$1195.00	$1075.00
BGDULCPU68000M	A&T with MMU	$1495.00	$1365.00

MEMORY BOARDS

DMEM256KP-256K DYNAMIC MEMORY MODULE

256Kb with byte parity error detection for 8 or 16 bit computers

BGDULDMEM256	256K A&T	$1495.00	$1395.00

CMEM NONVOLATILE CMOS MEMORY

Nonvolatile CMOS memory with 3-10 year battery backup on board.

BGDULCMEM8	8K A&T	$695.00	$620.00
BGDULCMEM16	16K A&T	$795.00	$725.00
BGDULCMEM32	32K A&T	$995.00	$840.00

2716/2732 EPROM BOARD WITH 16 BIT DATA PATHS

Designed to hold 32Kb of 2716 type or 64Kb of 2732 type EPROMs, or ROMs for read only use with 16 bit CPU systems.

BGDULEPROM32	2716 EPROM Board A&T	$295.00	$280.00
BGDULEPROM64	2732 EPROM Board A&T	$295.00	$280.00

REAL TIME & DATA AQUISITION

SIO4/DMA INTELLIGENT CONTROLLER

4 port RS232 interface with DMA transfers for output. 256b FIFO input buffer; On board 8085A-2 processor; 16 program selectable baud rates and occupies only 16 I/O addresses. Ideal for DUAL UNIX or other multi-user systems.*

NEW!

BGDULSIO4DMA	Assembled & Tested	$695.00	$650.00

AIM 12-12 BIT A/D CONVERTER

A/D input module with 12 bit accuracy, 32 input channels and optional instrumentation amplifier

BGDULAIM12	A&T with Instrumentation Amp.	$745.00
BGDULAIM12B	A&T without Instrumentation Amp.	$560.00

AOM 12-12 BIT D/A CONVERTER

D/A output module, 4 channels, 12 bit accuracy. Optional VIC420 industrial output module (4-20Ma), 4 channels, used in conjunction with AOM12.

BGDULAOM12	Assembled & Tested	$675.00	$640.00
BGDULVIC420	Assembled & Tested	$675.00	$640.00

CLK24-NONVOLATILE CLOCK/CALENDAR

Day, date, hours, minutes, seconds, and 3-5 year battery backup on board. Read or write directly from I/O port. Jumperable for 64Hz UNIX or real time applications.*

BGDULCLK24C	A&T w/64Hz Interrupt	$300.00	$265.00

SOFTWARE

DIGITAL RESEARCH

BGDIRCPM	CP/M* 2.2 Control Program/ Microcomputers	$150.00
BGDIRMAC	MAC* Macro Assembler	$ 90.00
BGDIRRMAC	RMAC* Relocating MAC	$200.00
BGDIRSID	SID* Symbolic Instruction Debugger	$100.00
BGDIRTEX	TEX* Text Formatter	$100.00
BGDIRDES	DESPOOL* Background Print Utility	$ 50.00
BGDIRCB80	CBASIC* Programming Language	$150.00
BGDIRCB86	CBASIC-86* Programming Language	$325.00

*Trademark of Digital Research

MICROPRO INTERNATIONAL

BGMDSWDSTR	Wordstar Version* 3.0	$300.00
BGMDSMLMRG	Mail Merge*	$100.00
BGMDSSPSTR	Spell Star*	$150.00
BGMDSCALSTR	Calc Star*	$200.00
BGMDSDATSTR	Data Star*	$200.00
BGMDSSUPSET	Supersort*	$150.00

*Trademark of Micropro International

SORCIM

BGSURSCAL	SUPERCALC* a Superior Electronic Worksheet	$295.00
BGSORACTI	ACT I* 8080/Z80 Assembler	$175.00
BGSORACTII	ACT II* 8086/8088 Assembler	$175.00
BGSORTRNS	TRANS* 8086/8088 Translator	$125.00
BGSORPM80	PASCAL/M* REL4 8080/8085/Z-80	$395.00
BGSORPM86	PASCAL/M* 8086	$495.00

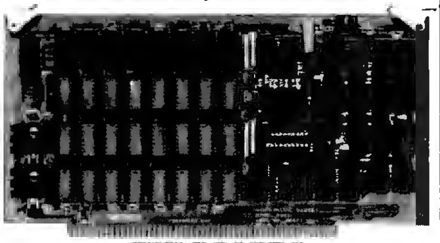
*Trademark of Sorcim

MICROSOFT

BGMDSBAS80	BASIC-80* Version 5.X Extended Disk Basic	$300.00
BGMCPBASC	BASIC* Compiler Version 5.X	$305.00
BGMDSMFT	FORTRAN-80*	$500.00

*Trademark of MicrosoftConsumer Products

California Computer Systems



CPU BOARDS

2810 Z80 SBC CPU

2/4 MHz Z80A CPU with RS232C Serial I/O Port complete with Monitor PROM for 2422 Disk Controller

Part No.	Description	List Price	Our Price
BGCCS2810A	Assembled & Tested		$300.00

2820 Z80 DMA CPU

4MHz Z80 with 2 RS232C Serial Ports, Centronics Parallel Port, separate data and status ports and DMA Daisy Chain Capability

BGCCS282001	Assembled & Tested	$585.00

I/O BOARDS

2830 - 6 PORT SERIAL

Six Asynchronous RS232C Ports using three Z-80 DARTS. Programmable baud rates.

BGCCS283001	Assembled & Tested	$550.00

2710 4 PORT SERIAL

4 Full handshaking RS232 ports and optional 2K ROM

BGCCS271001	Assembled & Tested	$325.00

2719 2 SERIAL & 2 PARALLEL

2 RS232C ports, 2 8 bit parallel ports & optional 2K ROM

BGCCS271901	Assembled & Tested	$360.00

2720 4 PORT PARALLEL

4 8 bit parallel ports and optional 2K ROM

BGCCS272001	Assembled & Tested	$275.00

2422 FLOPPY DISK CONTROLLER

I/O Mapped, controls 8", single or 5¼" double density A&T with CPM™2.2 8" S.D.

BGCCS2422A	Assembled & Tested	$425.00

MEMORY BOARDS

2065 64K DYNAMIC MEMORY BOARD

64K 4MHz, Z80 or 8080 compatible, bank select for memory expansion to 512K, DMA compatible.

BGCCS20653	Assembled & Tested	$375.00	$350.00

2066 BANK SWITCH DYNAMIC MEMORY

64K Memory with bank and block select switching functions for Cromemco Cromix™ & Alpha Microsystems

BGCCS2066C1	Assembled & Tested	$450.00	$425.00

2116 16K STATIC RAM

16K 4MHz using 2114 RAMs. Maybe divided into 4K blocks Cromemco & Alpha Microsystems compatible

BGCCS21163	Assembled & Tested	$280.00

2032 32K STATIC RAM

32K 4MHz using 2114s. Divided into 4 8K blocks. Bank-port/bank-byte scheme compatible with Cromemco and Alpha Microsystems.

BGCCS20323	Assembled & Tested	$500.00

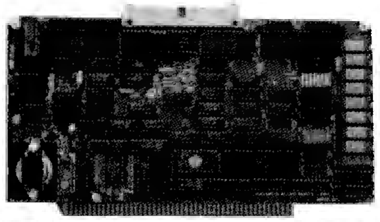
S-100 MAINFRAME

12-slot motherboard with removable termination card

BGCCS220001	Office Cream	35 lbs.	$575.00
BGCCS220002	Blue	35 lbs.	$575.00

SEND $1.00 TODAY FOR THE NEW, FULL COLOR SPRING 1982 ENGINEERING SELECTION GUIDE!

ADVANCED MICRO DIGITAL CORPORATION

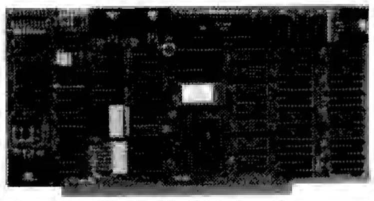


SUPERQUAD - ADVANCED MICRO DIGITAL AT LAST, A FULL S-100 SYSTEM ON A SINGLE BOARD!

● IEEE S-100 Bus Compatible ● Z80A CPU @ 4MHz ● Floppy Disk Controller, Single & Double Density (Supports up to 4 disk drives 5¼" or 8") ● 64Kb Memory, 16K Bank Selectable ● S-100 Extended Address A16-23 ● 2 Serial and 2 Parallel I/O Ports ● 2K or 4K of Shadow EPROM ● Real Time Interrupt Clock ● One Year Warranty ● Runs with CP/M, MP/M, CP/NET ● All of These Features on a Single Standard Size S-100 Board

Part No.	Description	List Price	Our Price
BGAMDSQC1	A&T w/Asych RS232 ports	$875.00	$795.00
BGAMDPS1	1 Asych adapter board required for each serial port used		$ 30.00

SSM



VIDEO AND I/O

VB 3 - HIGH RESOLUTION VIDEO

80 x 25 or 50 character video display Memory Mapped, Parallel Keyboard port

BGSSMVB3A24	80 x 24 A&T	$499.00	$440.00
BGSSMVB3UP	80 x 50 Line Upgrade		$ 39.00

VB 2 - I/O MAPPED 64 x 16 DISPLAY

I/O Mapped Video Board, with Parallel Keyboard port 64 x 16

BGSSMVB2A	Assembled & Tested	$269.00	$229.00

VB1B MEMORY MAPPED 64 x 16 DISPLAY

Memory Mapped Video Board 64 x 16 character display or 64 x 16 graphics display

BGSSMVB1A	Assembled & Tested	$242.00	$220.00

I/O 4

Two serial I/O, two parallel I/O

BGSSMIO4A	Assembled & Tested	$290.00	$260.00

NEW!

I/O 5

2 Serial, 3 parallel Including 1 Centronics

BGSSMIO51	Assembled & Tested	$329.00	$300.00

NEW!

I/O 8

6 Port Serial I/O with Timer

BGSSMIO8A	Assembled & Tested	$550.00	$495.00

CPU, RAM & PROM

CB2 Z80 CPU

2/4 MHz will accept 2716, or 2732, or RAM

BGSSMCB2A	Assembled & Tested	$299.00	$275.00
BGSSMZ80M	SSM Z80 Monitor		$ 80.00

MB10A 16/8K 8/16 BIT STATIC RAM

16K byte /8K word, 24 bit extended, addressing, "M write," Phantom disable, addressable In 4K blocks

BGSSMMB10A	Assembled & Tested	$299.00	$275.00

MB8A 1K/16K EPROM BOARD

1K/16K 2708 EPROM board, disable in 1K increments

BGSSMMB8AA	Assembled & Tested	$179.00	$160.00

PB1 PROM PROGRAMMER

Programs 2708 or 2716's, operates as a 4K/8K EPROM BOARD AS WELL

BGSSMPB1A	Assembled & Tested	$265.00	$220.00

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Circle 310 on inquiry card.

ONE

CompuPro™

PERFORMANCE, QUALITY, RELIABILITY, HIGH PERFORMANCE SYSTEMS DESIGNED TO EXPAND WITH YOUR NEEDS

Al CompuPro systems have been designed with your future in mind. Each system is expandable so you can upgrade your system as your needs continue to grow. Single user systems may be upgraded into multi-user systems for under $3,000.00. Additional users may be added to multi-user systems at any time. Hard disk storage is also available with the new DISK 2 DMA Winchester disk controller. Unlike many "personal" computers, your CompuPro system will not become obsolete when it is time to expand. The modular design of the IEEE 696/S-100 bus allows you to plug in additional boards when they are needed. CompuPro system components feature the latest state-of-the-art technology to prevent obsolescence.

Each CompuPro system component is fully assembled and tested under rigorous burn-in conditions at the facdtory and then shipped to *Priority One Electronics*, your authorized CompuPro Systems Center, for final integration and configuration. CompuPro systems carry the best warranty in the business; 1 year on A & T systems, 2 years on CSC systems. The Qume drives have a full six month warranty; the best drive warranty anywhere. The components are integrated into a complete system by a factory trained *Priority One Electronics* technician. The systems are then partially disassembled for shiping. After a short time for unpacking and check-out, your CompuPro system will be ready to load and go!

SYSTEM COMPONENTS

Each CompuPro system includes the following:
- CPU 8085/88 6MHz Dual Processor CPU (8088 runs at 8MHz in CSC systems
- Disk 1 Lightning Fast DMA Floppy Disk Controller
- CP/M® 2.2 and CP/M 86™ Operating Systems
- Sorcim's SUPERCALC-86 Electronic Sreadsheet program
- Two double-sided, double-density Qume DT-8 disk drives in an attractive desk top enclosure
- Rugged Desk Enclosure 2 with 20 slot actively terminated motherboard, fan, air and line filters, and constant voltage power supply for years of reliable operation
- Internal I/O cables and floppy disk data cable
- Complete documentation for each system component as well as a system integration guide

ENTRY LEVEL SINGLE-USER SYSTEM — The system is designed for high performance at a minimal cost. It may be upgraded at any time by additional memory. Each system includes the common components listed above *and* the following:
- 128K 10MHz Low Power Static Ram for low power consumption and reliability
- Interfacer 4 I/O board with three RS232 Serial ports, one bi-directional parallel port, and one Centronics parallel port

BGGSTSYS10KA	Single User System Desk Top, A&T	$5495.00
BGGSTSYS10KC	Single User System Desk Top, CSC	$5895.00

M-DRIVE OPTION — M-Drive provides up to a 3500% increase in speed during intensive computing. M-Drive uses the 16 bit 8088 CPU on the Dual Processor board to run extended address IEEE 696/S-100 RAM under CP/M® 2.2, so that the memory appears identical to a disk drive. The RAM can be formatted, it has a directory, and it can hold files which may be written, read, copied to or from another disk, or executed. A floppy disk drive is still required for system initialization, and for saving finished files. Additional CompuPro memory may be added at any time without having to change or recompile your programs. M-Drive requires a 6 MHz CPU 8085/88 dual processor, Disk 1 DMA disk controller and System Support 1 Multifunction Board.

BGGSTMD128KA	128K of A&T memory & M-Drive Software	$1198.00
BGGSTMD128KC	128K of CSC memory & M-Drive Software	$1398.00
BGGSTMD256KA	256K of A&T memory & M-Drive Software	$2395.00
BGGSTMD256KC	256K of CSC memory & M-Drive Software	$2795.00

SINGLE USER M-DRIVE SYSTEM — This system may be operated with CP/M® 2.2 in 8 bit mode as a 128K M-Drive system or in 16 bit mode with CP/M 86™ to give the user maximum flexibility. This system includes the common components listed above *and*:
- 192K 10MHz Low Power Static RAM for low power consumption and reliability
- System Support 1 Multifunction Board
- Interfacer 3 Eight port RS232 Serial Interface Board
- M-Drive Software for use in 8 bit mode

BGGSTSYS20KA	M-Drive System Desk Top, A&T	$6995.00
BGGSTSYS20KC	M-Drive System Desk Top, CSC	$7745.00

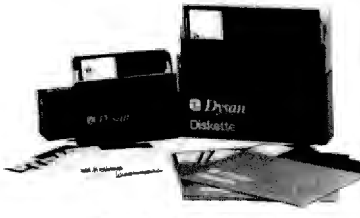
ENTRY LEVEL MULTI-USER SYSTEM — This system is designed for two or three users depending upon user memory allocation size. This system includes everyrhing in the above **Single-User M-Drive System** *plus*:
- 8MHz 8088 standard on Dual Processor CPU board
- 64K of additional memory for a total of 256Kb of low power 10MHz static memory
- MPX1-16 Multiplexer to increase system throughout
- MP/M 816 Multi-user software. MP/M 816 is a CompuPro proprietary implementation of Digital Research's MP/M 86™ 16 bit multi-user operating system. This software package includes CP/M® V2.2, CP/M86™, and MP/M 86™. The beauty of this software is that both 8 bit CP/M® 2.2 and 16 bit CP/M 86™ programs may be run on the system at the same time by different users. This allows the user to take advantage of the vast library of 8 bit software as well as the growing selection of 16 bit software without being limited to one or the other. When running CP/M® 2.2 programs under MP/M 816 there is 60K of user memory rather than the usual 48K for better system performance; another CompuPro exclusive! This unique software package, ideal for software development or scientific appli cations, is available only as part of a CompuPro system.

BGGSTSYS30KA	Multi-User System Desk Top, A&T	$8995.00
BGGSTSYS30KC	Multi-User System Desk Top, CSC	$9945.00

Rack mount systems are also available; please call or write for details. All CompuPro systems are shipped via motor or air freight collect; please specify at time of order. All boards are shipped in standard configurations

CP/M, CP/M 86, and MP/M 86 are trademarks of Digital Research. MP/M 816, a proprietary implementation of MP/M 66, is a trademark of CompuPro under license from Digital Research. 816 is a trademak of CompuPro.

Dysan CORPORATION



WHY SETTLE FOR LESS?

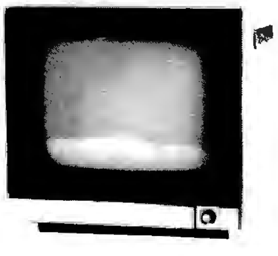
DYSAN DISKETTES have long been regarded as the standard that all others attempt to duplicate. Today, Dysan still manufactures the ultimate in flexible recording media for 5¼" and 8" flexible disk drives. Both the 5¼" and 8" diskettes are certified to be 100% error free over the entire recording surface providing you with the best insurance from data error.

5¼" DISKETTES
35/40 TRACK CERTIFIED

Part No.	Sectors	Density	Sides/ Heads	PRICE Box of 10
BGDSN1041	Soft	Single	1/1	$45.00
BGDSN10410	Soft	Double	1/1	$50.00
BGDSN10510	16 Hard	Double	1/1	$50.00
BGDSN10710	10 Hard	Double	1/1	$50.00
BGDSN10420	Soft	Double	2/2	$60.00
77/80 TRACK				
BGDSN20520	16 Hard	Double	2/2	$80.00
8" DISKETTES				
BGDSN37401	Soft	Single	1/1	$55.00
BGDSN374010	Soft	Double	1/1	$65.00
BGDSN374020	Soft	Double	2/2	$65.00

SANYO

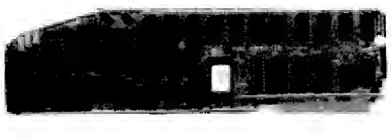
FCC CLASS 2 APPROVED DATA DISPLAY MONITORS



Part No.	Description	List Price	SALE
BGSYOVM4509	9"B&W P4, 10MHz (15 lbs.)	$215.00	$169.00
BGSYODM4509CX	9"Green, P31, 10MHz (15 lbs)	$200.00	$180.00
BGSYODM8012C	12"B&W P4, 18MHz (24 lbs.)	$250.00	$225.00
BGSYODM8112CS	12"GReen, P31, 18MHz (24 lbs.)	$260.00	$235.00
BGSYOVMC6013	13"Color, 16 x 64 (35 lbs.)	$470.00	$425.00
BGSYODM6113*	13"RGB Color (35 lbs.)	$995.00	$895.00

*As used with IBM P.C.

Vista **APPLE II® Peripherals**

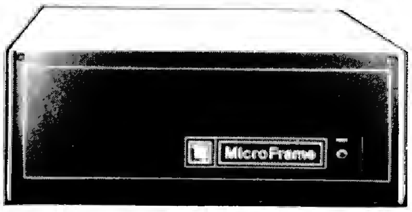


A800 DOUBLE DENSITY 8" DISK CONTROLLER

- High Speed DMA TRansfer of Data (1 Microsecond/Byte)
- Uses All Standard Apple DOS Commands (OPEN CATALOG, LOCK, DELETE, LOAD...etc) Except for INIT Which Has Been Improved and Enhanced in a Vista Format Routine
- Compatible with Apple DOS 3.2/3.3, Pascal 1.1 and CPM 2.2 (With the Z80 Soft Card by Microsoft)
- Interfaces to All Shugart/ANSI Standard Eight-Inch Floppy Disk Drives
- 2Kx8 PROM Contains Autoboot Functions and All 8" Floppy Driver Code Allowing Complete Memory Usage Map Compatibility w/Apple DOS 3.2/3.3

BGVISA800	Controller and disk	$595.00	$499.00
BGVIS0180	Vision 80 80 x 24 Display Card	$395.00	$349.00
BGVIS0104	Vision 40 - 40 Column, upper/ lower case enhancement	$195.00	$175.00

TEI MicroFrame®



110V 60Hz CVT Mainframes, the best money can buy!
12 Slot ±8V 17±16V @2A
22 Slot±8V @ 30A± 16V @ 4A

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE 1-9	OUR PRICE 10-24
BGTEIMCS112	12 Slot Desk	$755.00	$680.00	$627.00
BGTEIMCS122	22 Slot Desk	$910.00	$799.00	$770.00
BGTEIRM12	12 Slot Rackmount	$800.00	$715.00	$661.00
BGTEIRM22	22 Slot Rackmount	$965.00	$880.00	$825.00

Shipping Weight: On 12 Slot Mainframes: 45 lbs.
On 22 Slot Mainframes: 55 lbs.

S-100 MAINFRAME WITH 12 SLOT MOTHERBOARD AND CUTOUTS FOR 3 - 5¼" FLOPPY DISK DRIVES

+8V @ 17A ±16V @ 2A +12V @ 1.2A Internal Power Cable

BGTEITF12	12 Slot desk	$745.00	$670.00	$638.00
BGTEIRF12	12 Slot Rackmount	$855.00	$765.00	$732.00

Shipping Weight: On 12 Slot Desk: 40 lbs.
On 12 Slot Rackmount: 45 lbs.

DUAL 8" DISK DRIVE CHASSIS

For two Shugart 801R or two Qume DT-8 size drives with internal power cables provided
+24V @ 1.5A +5V @ 1.0A - 5V @ .25A

BGTEIDFD8	Desk Top	$565.00	$520.00	$480.00
BGTEIRFD8	Rackmount	$725.00	$650.00	$630.00

Shipping Weight: On Desk Top: 40 lbs.
On Rackmount: 45 lbs.

PRIORITY ONE ELECTRONICS is a master distributor for TEI. Dealers & OEM's call for quantity pricing.

PRENTICE

THE STAR
OUR MOST POPULAR MODEM
We've Sold Thousands!

● 0 to 300 baud ● Bell 103 and 113 ● Exclusive triple seal acoustic chamber ● Self Test ● ±0.3% frequency stability; crystal controlled ● Receiver Sensitivity of -50dB on; -53dB off ● FSK Modulation ● RS232 Compatible ● **Switches:** Originate/Off/Answer, Full Duplex/Test/-Half Duplex ● **Indicators:** Transmit Data, Receive Data, Carrier Ready, Test

Part No.	Description	List Price	SALE
BGPRNSTAR	RS232, TTI, 20Ma Current Loop	$199.00	$129.00

Hayes™

SMARTMODEM

● Auto Answer, Auto Dial, Full or Half-Duplex, Loop Back © Serial binary, and asynchronous data formats with 7 or 8 data bits, 1 or 2 stop bits, odd, even or no parity ● 0-300 bauad ● RS232C interface ● Z8 Microprocessor with 2Kb control program ● 40 character command buffer ● Size: 1.5" x 5.5" x 9.6"

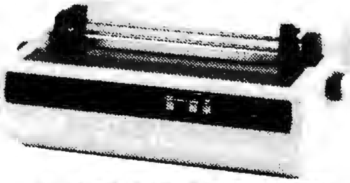
BGDCH0200P	Smartmodem (Sh. Wt. 6 lbs.)	$279.00	$249.00
BGDCH0300P	Chronograph (Sh. Wt. 3 lbs.)	$249.00	$219.00
BGDCH0100P	Micromodem 100 (Sh. Wt. 4 lbs.)	$399.00	$369.00
BGDCN28010	CP/M® 8" Terminal Program for above		$ 25.00
BGDCH0000P	Micromodem II	$379.00	$329.00
BGDCN24010	Datacom (PASCAL patch) for above		$ 50.00

Circle 311 on inquiry card.

PRIORITY ONE ELECTRONICS

FUJITSU & NEC

LETTER QUALITY PRINTERS FROM SELLUM



Speed and Unmatched Performance

Interfaces: • RS232C and Current Loop • Centronics type parallel interface • IEEE/488 All are DIP switch selectable.
Personality Protocols: • NEC5510 • DIABLO 630 • QUME Sprint 9 • IBM Personal Computer • ATARI (Centronics 737).
Special Features: • Z80 CPU • 12K ROM • Standard 16K Buffer • Optional 48K Buffer • 50 - 19.2K baud • Micro-coded alarm differentiates error conditions with pulse combinations • Intelligent bi-directional printing with logic seeking • Complete word processing features • Self test • Auto reprint • Auto clear error • Proportional spacing • Supports Automatic justification • Complete Vector plotting routines • Sheet feeder mode allows easy interface to most mechanical sheet feeders • 6 month warrantee • Quiet - 60db • Front panel forms control • Universal power supply 115/220V 50/60 Hz.

BEST BUY! **80 Characters per Second! LETTER QUALITY! USING THE FUJITSU SP830** **WOW!**

Part No.	Description	List Price	Our Price
BGSLMF86	Intelligent Printer	$3495.00	$2995.00
	OPTIONS		
BGSLMF86VFT	Vertical forms tractor		$200.00
BGSLMF8648K*	48K RAM buffer		$400.00

Call for pricing on sheet feed options

55 CPS USING THE NEC 7700

Part No.	Description	List Price	Our Price
BGSLMN77	Intelligent Printer	$3295.00	$2695.00
	OPTIONS		
BGSLMN77VFT	Vertical Forms Tractor		$ 230.00
BGSLMN77BDFT	Bidirectional Forms Tractor		$ 400.00
BGSLMN77CSF	NEC Cut Sheet Feeder		$1595.00
BGSLMN77CSF2	Twin Cut Sheet Feeder		$2150.00
BGSLMN7748K*	48K RAM Buffer		$ 400.00

*Must be ordered with the printer

INTERFACE CABLES

Part No.	Description	Price
BGCPAM572	Centronics IBM/NEC Cable	$80.00
BGSCB8251	RS232C Serial Cable	$80.00

Call for other cables not listed

Para Dynamics

18 SLOT S-100 MAINFRAME

CVT Power Supply, forced air cooling; security lock
120 or 220V AC at 50 or 60Hz+8V@20A, ±16@3.5

BGPDM2018D	Desk Top	$799.00	$699.00
BGPDM2018R	Rack Mount	$849.00	$749.00

8 SLOT S-100 MAINFRAME WITH CUTOUTS FOR 2 5¼" DISK DRIVES

+5@5A, -5@500MA, +8@15A, +12@6A, +16@2, -16@2

BGPDM2508D	Desk Top	$899.00	$799.00
BGPDM2508R	Rack Mount	$949.00	$839.00

DISK DRIVE FACILITY

Accommodates two 8" floppy drives, of Shugart, Qume, or similar design and dimensions. 110 or 220V AC at 50 or 60Hz CVT power.

BGPDM2200D	Desk Top	$659.00	$579.00
BGPDM2200R	Rack Mount	$679.00	$605.00

PRONTO

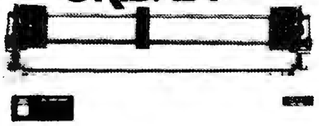
Free standing cabinet. Will accept 2, 8" Floppy disks and 1, 8" Rigid disk. 18 slot card cage will accept the double height 10" x 10" S-100 cards (Alpha Micro and others) CVT Power Supply.

+24@7A, +16@2.2A, -16@3.5A, +8@20A, +5@5A

BGPDM2018	PRONTO	$1295.00	$1129.00
	PRONTO COMPLETE WITH POWER SUPPLY POWER-UP SEQUENCER		
BGPDM2018S	with sequencer	$1395.00	$1249.00

Shipped motor freight collect

OKIDATA



COMPARE OKIDATA'S FEATURES TO ANY OTHER PRINTER!
COMPARE PRIORITY ONE'S PRICES TO ANY — THEN DECIDE!
Don't be fooled by those who try to "soak" you for the options

- BI-DIRECTIONAL-120 CPS
- 9 x 9 Matrix (Alphanumeric)
- 6x9or12 Matrix for graphics
- 5,8.3, 10, 16 Characters Per Inch
- 80 CPL @ 10 CPI for 82A
- 132 CPL @ 100CPI for 83A & 84
- Both Parallel and 1200 baud Serial I/O (82A & 83A)
- Self Test
- Out of Paper Switch
- Friction or Optional Tractor Feed (Tractor Standard on 84)
- 10 different character sets

All three printers feature front panel switch selectable for lengths; 10 lengths from 3" to 14". Front or bottom aper loading for up to 4 part forms and tear bar. All of these features make OKIDATA the best value in low cost printers!

Part No.	Description	List Price	SALE
BGOKIDAT82AT	80 column printer w/friction (25 lbs.)		$539.00
BGOKI82TRK	Tractor Feed for OKIDAT 82A		$ 59.95
BGOKIGRAPH82	High Resolution graphics ROM 60 x 66		$ 75.00
BGPBOKI82ATG	OKIDAT82A w/tractor and graphics		$599.00
BGOKIDAT83A	132 column printer w/friction (35 lbs.)		$750.00
BGOKI83TRK	Tractor Feed for OKIDAT83A		$ 59.95
BGOKIGRAPH83	High Resolution grahics ROM 60x66		$ 75.00
BGPBOKI83ATG	OKIDAT83A w/tractor & graphics		$850.00
BGOKISER2KBF	9600 Baud 2K serial buffer/interface		$140.00
BGOKIDAT84AP	132 col. printer parallel interface with graphics and tractor (35 lbs.)		$ 1095.00
BGOKIDAT84AS	132 col. printer 9600 baud serial 2K interface, graphics and tractor (35 lbs)		$ 1250.00
BGMBSAPLWTWC*	Apple Parallel Interface w/Cable		$ 75.00

*Sold only with printer

COMPARE PRICES!!

ADDS
Applied Digital Data Systems Inc.

SALE! $525.00

VIEWPOINT — ADDS

Detachable keyboard, RS232 interface and auxiliary port, 80 x 24 display, tiltable screen.

BGADDVWPT	Sh. weight: 30 lbs.	$699.00	$525.00

DISK CABINETS

V-100 - VISTA

• Desk or rack mountable • Internal power and data cables • Drives pull out for easy service and maintenance

BGVISV100	Disk Drive Cabinet (43 lbs)	$495.00	$449.00
BGVISV100	With purchase of two 8" Disk Drives		$399.00

SINGLE 8" - Q.T.

Single 8" cabinet with power supply

BGQTCDBC8	(22 lbs.)	$249.00	$225.00

DUAL 8" - Q.T.

Dual 8" cabinet with power supply

BGQTCDBC88	(24 lbs.)	$395.00	$349.00

5" CABINETS - VISTA

BGVIS5001	Single 5" with P.S.	$ 85.00
BGVIS5002	Dual 5" with P.S.	$110.00

SEND $1.00 TODAY FOR THE NEW, FULL COLOR SPRING 1982 ENGINEERING SELECTION GUIDE!

Tandon

Tandon TM-800 Thinline is exactly half the size of conventional 8" floppy disk drives.

ONE

Exactly one-half the height of any other model.
Proprietary, high-resolution, read-write heads patented by Tandon
D.C. only operation - no A.C. required
Industry standard interface.
Three millisecond track-to-track access time (9 lbs.)

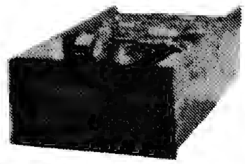
BGTNDTM8481	Single Sided $425.00	2 or more	$395.00
BGTNDTM8482	Double Sided $575.00	2 or more	$550.00
BGTNDTM8M	Manual - not included with drive		$ 10.00

TANDON 5¼" DRIVES

BGTNDTM1001	Single Sided, 250KB (5 lbs.)	$240.00* ea
	2 or More $220.00	
BGTNDTM1002	Double Sided, 500KB	$325.00 ea.
	2 or More $299.00	
BGTNDTM1003	Single Sided, 500KB	$325.00 ea.
	2 or More $299.00	
BGTNDTM1004	Double Sided, 1000KB	$449.00 ea.
	2 or More $420.00	
BGTNDTM5M	manual, not included with drive	$ 10.00

*As used in the IBM P.C.

MITSUBISHI ELECTRIC



Better Than QUME! Better Than SHUGART!

8", Double-sided, double-density, interchangeable with QUME & Shugart

BGMITM2894B3	Sh. Weight 16 lbs.	$560.00
BGMITM2894B3M	Manual	$ 10.00

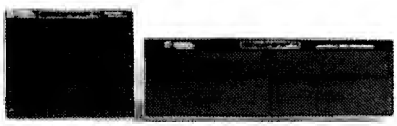
2 or More $525.00 each

Shugart 801R

Single sided, double density - most popular 8" drive

BGSHU801R	$425.00 ea. or 2 or more (16 lbs) for $395.00 ea.	
BGSHUSA801RM	Manual for 801R drives	$ 10.00

INTERNATIONAL INSTRUMENTATION, INC.



UNIVERSAL DISK ENCLOSURES

• Accepts any combination of 8" drives (QUME/Shugart 801R type or ½ size Tandon type) • Also accepts hard disks • Positive pressure • Optional Disk environment monitor shows supply voltage and internal cabinet temperature • Internal power and data cables provided.

UNIVERSAL DRIVE CABINET complete with power supply, fan and filter, and all internal cables for attachment of two 8" floppy drives.

BGIIIUDE004	Dual Drive Cabinet (Sh. Wt. 40 lbs)	$495.00	$450.00
BGIIIUDE004	With purchase of two 8" Disk Drives		$399.00
BGIIIUDE004EM	w/Environmental Monitor installed	$584.95	$535.00
BGIIIUDE004EM	With purchase of two 8" Disk Drives		$485.00
BGIIIUDE004AUG	Dual Drive cabinet with Augmentation power supply module to increase 5V supply from 6 amps to 9 amps for use with two hard disks or 4 Tandon drives. Also includes Disk Environment Monitor (45 lbs.)	$733.00	$650.00
BGIIIUDERCK	19" Rack Mount kit UDE004		$ 69.95

THIN THREE DRIVE CABINET complete with power supply, and all internal cables for attachment of three thin 8" floppy drives (Tankdon type). One AC power connector is also provided for use with full size drive.

BGIIIUDETT	Three Drive Cabinet (Sh. Wt. 35 lbs)	$495.00	$450.00
BGIIIUDETTTEM	with Environmental Monitor installed	$584.95	$535.00

PRIORITY ONE ELECTRONICS

VISA

9161 DEERING AVE • CHATSWORTH, CA 91311

NEDA MEMBER MITA

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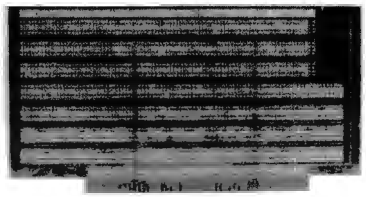
Terms: U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs., plus 25¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, please include your phone number. Prices subject to change without notice. We will do our best to maintain prices through July, 1982. Credit Card orders will be charged appropriate freight. If you haven't received your Spring '82 Engineering Selection Guide, send $1.00 for your copy today! Sale prices are for prepaid orders only.

Circle 312 on inquiry card.

PRIORITY ONE ELECTRONICS

page NC Drilled Boards



Page's NC* DRILLED Printed Circuit Boards offer you benefits not currently available from a conventional *punched* board. If you are involved in professional prototyping of PC boards, you know that a "clean" prototype is always more representative of what you can expect in your final *production* board. AND isn't that what prototyping is all about? **If you Want the Best . . . Ask for PAGE!**

SPECIFICATIONS:

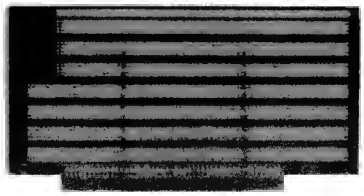
UL Approved.

Material: 062" (1.57mm) thick FR-4 epoxy glass laminated copper per MIL-T-55561 Type GF.

Hole Diameter: .042" NC drilled.

Plating: Circuitry: Electrolers tin 50 x 10-6 in.
Contact fingers: .0010" gold over .0050" nickel.
Contact fingers are chamfered for ease of insertion.

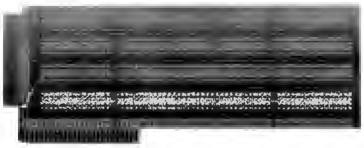
S-100 BOARDS



P1002 Component Side

PART NO.	DESCRIPTION	PRICE 1-4	5-9	10-24
BGPGSP1001	S100 Bare Board	$15.95	$13.95	$11.95
BGPGSP1002	S100 Horizontal Busses	$22.95	$19.95	$17.95
BGPGSP1003	S100 Vertical Busses	$22.95	$19.95	$17.95
BGPGSP1004	S100 Pads Per Hole	$23.95	$20.95	$18.95

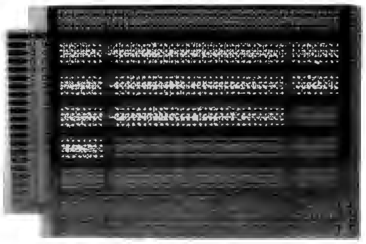
APPLE BOARDS



P5002 Component Side

BGPGBP5001	Apple Bare Board	$15.95	$13.95	$11.95
BGPGBP5002	Apple Horizontal Busses	$22.95	$19.95	$17.95
BGPGBP5004	Apple Pads Per Hole	$23.95	$20.95	$18.95

GENERAL PURPOSE PLUGBOARDS



P4413 Wiring Side

BGPGBP4411	4.5"x6"	22/44	156" Bare Board	$ 9.95	$ 8.95	$ 7.95
BGPGBP4413	4 5"x6"	22/44	156" Vertical Buss	$13.95	$12.50	$11.50
BGPGBP4414	4 5"x6"	22/44	156" Pads Per Hole	$14.95	$13.50	$12.50
BGPGBP4421	4.5"x9.6"	22/44	156" Bare Board	$10.95	$ 9.95	$ 8.95
BGPGBP4423	4.5"x9.6"	22/44	.156" Vertical Buss	$14.95	$13.50	$12.50
BGPGBP4424	4.5"x9.6"	22/44	156" Pads Per Hole	$15.95	$14.50	$13.50
BGPGBP7211	4.5"x6"	36/72	.1" Bare Board	$ 9.95	$ 9.95	$ 7.95
BGPGBP7213	4.5"x6"	36/72	.1" Vertical Buss	$13.95	$12.50	$11.50
BGPGBP7214	4.5"x6"	36/72	.1" Pads Per Hole	$14.95	$13.50	$12.50
BGPGBP7221	4.5"x9.6"	36/72	.1" Bare Board	$10.95	$ 9.95	$ 8.95
BGPGBP7223	4.5"x9.6"	36/72	.1" Vertical Buss	$14.95	$13.50	$12.50
BGPGBP7224	4.5"x9.6"	36/72	.1" Pads Per Hole	$15.95	$14.50	$13.50

We stock the entire PAGE line of boards, pre-cut and pre-stripped wire wrap wire, and pre-assembled IDC flat cable assemblies. Please see our Spring catalog or call for products not listed.

RS232 and "D" SUB-MINIATURE CONNECTORS

SOLDER TYPE

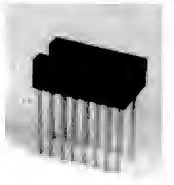
P=Plug, Male Type — S=Socket, Female Type — C=Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
BGCNDDE9P	9 Pin Male	$ 2.10	$ 1.90	$1.70
BGCNDDE9S	9 Pin Female	$ 2.70	$ 2.40	$2.10
BGCNDDE9C	9 Pin Cover	$ 1.50	$ 1.25	$1.10
BGCNDDA15P	15 Pin Female	$ 2.75	$ 2.45	$2.15
BGCNDDA15S	15 Pin Female	$ 3.95	$ 3.60	$3.20
BGCNDDA15C	15 Pin Cover	$ 1.50	$ 1.30	$1.10
BGCNDDA25P	25 Pin Male	$ 3.00	$ 2.75	$2.25
BGCNDDA25S	25 Pin Female	$ 4.00	$ 3.75	$3.00
BGCNDDB51212	1 Pc. Grey Hood	$ 1.60	$ 1.45	$1.30
BGCND025H	2 Pc. Grey Hood	$ 1.50	$ 1.25	$1.10
BGCNDDB51226	2 Pc. Black Hood	$ 1.90	$ 1.65	$1.45
BGCNDDC37P	37 Pin Male	$ 5.80	$ 5.10	$4.45
BGCNDDC37S	37 Pin Female	$ 8.70	$ 7.70	$6.70
BGCNDDC37C	37 Pin Cover	$ 1.80	$ 1.55	$1.30
BGCNDDD50P	50 Pin Male	$ 8.75	$ 7.75	$6.70
BGCNDDD50S	50 Pin Female	$11.65	$10.25	$8.90
BGCNDDD50C	50 Pin Cover	$ 2.00	$ 1.80	$1.60
BGCNDD20418	Hardware Set 2/Pr RS232, DB25P, EIA	$ 1.00	$ .80	$ .70
BGCNDRS232CF	Class 1 Cable 8 Con 8 Ft	$19.95	$17.95	$15.95
BGCND573030	Cent. 700 Series/ Epson Printer Conn.	$ 9.00	$ 7.50	$6.00
BGIDC5730860	IDC Version of Above	$ 9.95	$ 9.90	$8.00

CALL FOR IDC "D" CONNECTORS

ROBINSON NUGENT, INC.

ICN SERIES GOLD 3 LEVEL WIRE WRAP SOCKETS



- 10 μ in GDLD Plated Pins
- Deep Chamfered Closed Entry Contacts
- RN Side Wipe Contact Design
- Phosphor Bronze Contact Material
- Terminal Barbs Allow Self-lock into PC Board
- Rugged Socket Body Design
- Deep Chamfered Closed Entry Contacts

PART NO.	PINS	STANDARD PCKGE.	PRICE EACH	10-24	25-99	100-249	250-999
BGRNS08WWG	8	52	.60	N/A	.49	.45	.41
BGRNS14WWG	14	30	.75	.70	.65	.55	.45
BGRNS16WWG	16	26	.85	.75	.70	.60	.52
BGRNS18WWG	18	23	1.00	.90	.80	.75	.71
BGRNS20WWG	20	21	1.20	1.05	.96	.91	.87
BGRNS22WWG	22	19	1.35	1.25	1.15	1.05	.99
BGRNS24WWG	24	17	1.35	1.25	1.15	1.05	.99
BGRNS28WWG	28	15	1.70	1.55	1.40	1.34	1.25
BGRNS40WWG	40	10	2.20	2.05	1.85	1.60	1.50

*MINIMUM ORDER $1.00 per line item. To receive quantity prices beyond 1st column you must order EXACT multiples of STANDARD PACKAGES.

NEW!
SELECTIVE PLATED PINS THAT WILL SAVE YOU MONEY BY HAVING GOLD ONLY WHERE IT COUNTS!
Same as above except pins are selectively plated.

BGRNS08TWW	8	52	.55	N/A	.45	.41	.37
BGRNS14TWW	14	30	.65	.55	.50	.47	.44
BGRNS16TWW	16	26	.75	.65	.52	.51	.48
BGRNS18TWW	18	23	.90	.70	.75	.70	.65
BGRNS20TWW	20	21	1.10	.95	.91	.87	.82
BGRNS22TWW	22	19	1.25	1.15	1.05	.94	.89
BGRNS24TWW	24	17	1.25	1.15	1.05	.98	.89
BGRNS28TWW	28	15	1.50	1.45	1.35	1.25	1.15
BGRNS40TWW	40	10	2.00	1.80	1.60	1.40	1.30

*MINIMUM ORDER $1 00 per line item. To receive quantity prices beyond 1st Column you must order EXACT multiples of STANDARD PACKAGES.

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PROTECT YOUR INVESTMENT
PROTECT YOUR DATA WITH

GSC ISOBAR ONE

With Built-In Noise Filters and Surge Suppressors

ISOLATES SENSITIVE AND VALUABLE EQUIPMENT FROM: Equipment interaction - Damaging High Voltage Spikes - AC line noise and hash
PROTECTS AGAINST: Voltage transients caused by lightning, contact switching, turn-off of inductive components, noise due to electro-magnetic coupling
USE THE GSC ISOBAR TO ISOLATE: Microprocessor from peripherals - Lab instruments from noisy equipment - Sensitive pre-amp or tape deck from power amplifier
THE GSC ISOBAR ELIMANATES: Equipment interaction - Equipment damage from power line spikes and surges - Errors - False printouts - Disk Skips - Audio or video hash
FEATURES: Inductive isolated ground - Sockets indivdually filter isolated - Circuit breaker protected at 15A.
VOLTAGE TRANSIENT SPIKE PROTECTION: 2000 A peak for up to 6 Sec duration spikes. 1000A, 8/20 Sec protection from repeated spikes.
LOAD HANDLING: 1875 W max. total load; 15A per socket.
INPUT: 125 VAC, 15 amps; standard 3-prong plug.

IBAR 3 - Three common outlets built-in circuit breaker, pilot light, hang-up bracket and a 6-foot cord.

		List Price	Our Price
BGGOFIBAR3	Sh. Wt. 3 lbs.	$59.95	$42.00

IBAR 46 - Four independently isolated outlets. Built-in 15A circuit breaker, pilot light, switch, and 6-foot cord.

BGGOFIBAR46	Sh. Wt. 4 lbs.	$79.95	$49.95

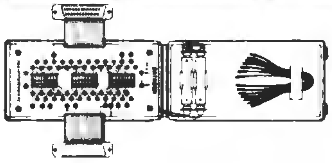
IBAR 86 - 8 outlets, grouped to form 4 independently isolated sets of two. Built-in 15A circuit breaker, on/off switch, pilot light.

BGGOFIBAR86	Sh. Wt. 5 lbs.	$84.95	$64.95

IBAR 8RM - Eight rear-mounted outlets grouped to form four independently isolated sets of two, plus one non-isolated convenience outlet on front face. 19" rack mount cabinet. Built-in 15A circuit breaker, pilot light, on/off switch, and 6-foot cord.

BGGOFIBAR8RM	Sh. Wt. 6 lbs.	$99.95	$74.95

RS232 Breakout Box



A must for every technician, repair man or systems integrator

Databox is contained in a tough, plastic case and is powered by two, 1.5 volt penlight batteries. No power is consumed by the tester when not in use. Dimensions: 2.9"x5.55"x1.45". Weight: 10 oz. w/batteries.

BGBWH23200X	$199.00	$180.00

MICROCOMPUTER PRODUCTS

MEMORY PART NO.	PRICE	8080 SERIES PART NO.	PRICE
BG4116AC20	8/$18.00	BGINS8080A	$5.50
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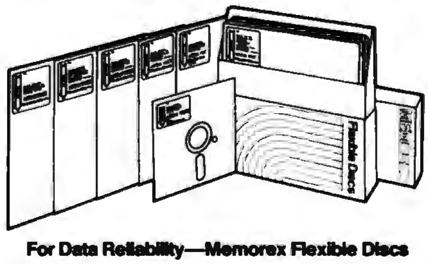

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Unclassified Ads

FOR SALE: BYTE from issue #1 through August 1979. Mint condition. Make offer. Dan S. Tong, Northwestern U. Tech. 3763, Evanston, IL 60201, (312) 492-7686 days.

FOR SALE: Centronics 101 printer: 165 cps, 132 characters per line, 5 by 7 dot matrix, and 60-200 lines per minute. Recently overhauled. Heavy-duty printer for $1500 or best reasonable offer. Also, two Techtran 8410 datacassette recorders, RS-232 interface with manuals. In mint condition. $500 or best reasonable offer. David V. Fansler, 700 Ward St., Graham, NC 27253, (919) 227-7640 after 6 p.m. ET.

FOR SALE: Complete Atari 400 computer system: 16K Atari 400, 410 program recorder, BASIC cartridge, over $100 worth of game cartridges (Star Raiders, Missile Command, Super Breakout, Avalanche), full manuals, and $30 operating-system manuals in a special binder. System only a few months old; would cost over $630 new. Only $389 plus free shipping. Brett Bobley, High Farms Rd., Glen Head, NY 11545, (516) 671-6707.

WANTED: Schematics for Extensys Corporation Model RM64—64K dynamic RAM board for S-100 bus. Will pay reasonable reproduction and mailing costs. W. E. Buoy Jr., 16319 Pebblegien, Houston, TX 77095.

FOR SALE: PDP-8 and dual DEC tape drives. I would also like to hear from microcomputer users in medicine. Derek Enlander, M.D., Nuclear Medicine Department, N.Y.U. Medical Center, 560 First Ave., New York, NY 10016.

FOR SALE: Heavy-duty Centronics 102A printer. Very high speed (330 cps). Perfect working order. Asking $995. L. Neuzerling, 1200 Arundel Dr., Kokomo, IN 46901, (317) 452-8971 evenings.

FOR TRADE: Games for the TRS-80 Color Computer. Original programs sent will be replaced by mine, written for extended 16 K. Also interested in homemade hardware. Cassettes come with listing. M. T. Baran, POB 1448, Hayfork, CA 96041.

FOR SALE: PAIA 8700 computer-based synthesizer system. D/A, QUASH, V.C.O., V.C.A., envelope generator, ring modulator, phlanger, parametric eq, spring reverb, mini preamp, and power supplies. Includes all types of patch cords and all documentation. Jeff Wurstner, 8 Hickory Pl., Seneca Falls, NY 13148.

FOR SALE: 43 issues of BYTE, June 1977 through December 1980. Excellent condition. $80 firm, postage paid. Also, four issues of onComputing, Summer 1979 through Spring 1980, and five issues of Personal Computing, October 1980 through January 1981 and March 1981. $2 each, postage paid. Larry Felton, 5140 Yvette, El Paso, TX 79924

FOR SALE: Two Hazeltine 2000 dual cassette decks and one silent (TI) printer for same. Also, one hard-copy portable terminal with coupler and case (not working). $500 plus shipping takes all. David Greenblatt, 812 Roosevelt Court, Far Rockaway, NY 11691, (212) 471-2456.

FOR SALE: Complete S-100 disk system for $1200. System includes a Micropolis disk drive, Polymorphic 8080 processor and video, 64K memory, 12-inch TV with RF modulator, GRI keyboard, 20-slot motherboard, and 28-A power supply. Everything is assembled, tested, and working. Includes documentation. Also, 15-inch Sanyo monitor; $150. Newtech music (S-100) board; $50, and ASCII CRT; $100. Mark Hanslip, 1128 Lavern Ave., Kettering, OH 45429, (513) 293-3324.

FOR SALE: Apple II communications card; $125. Novation D-Cat modem with cable, $125. Centronics 737 printer (parallel) with cable, $545. Philip Castevens, 3915 A Valley Court, Winston-Salem, NC 27106, (919) 765-5588 evenings.

FOR SALE: IMSAI 8080 mainframe: S-100/IEEE-696 system with 18 slots. Wameco front panel (hex displays), two Wameco 8080 processor boards, Wameco 8K static RAM board, Wameco I/O board, Biotech BCG-800 color graphics board, SSM extender board, and Vector proto board. No monitor. Complete documentation and accessories. Only $700 plus shipping. R. Fischer, 5152 Lynd Ave., Lyndhurst, OH 44124, (216) 442-8054 evenings.

WANTED: Several Pocket Com CB units. They are miniature multichannel units. Also needed is a schematic of the same unit. Please include price. Pat Sagstetter, 8201 NPS USN, Orlando, FL 32813.

FOR SALE: One complete set each, some in binders, of: Interface/Interface Age, BYTE, and Kilobaud Microcomputing. Best offer for a complete set. Pick up only. Alan P. Biddle, 3511 Mae Dr. SE, Huntsville, AL 35801.

WANTED: I am a dedicated college student trying to complete my degree in Computer Science. Any contribution you can send would be greatly appreciated and acknowledged immediately. Please help me. Mark Kopec, 9526 South Central Park, Evergreen Park, IL 60642.

FOR SALE: Attention homebrewers! I am selling much of my home stock of ICs, LEDs, capacitors, memory chips, voltage regulators, etc. All items new and unused. Top-name brands at really low prices. Send SASE for list of items and prices. L. E. Steiner, 4876 Aleda Ave SE, Kentwood, MI 49508.

FOR SALE: PET 2001 8K old ROMs. 32K Expandamen board with Programmers Toolkit. Over 150 programs, mostly games, including Space Invaders and Microchess 2.0. $750. Jeff Taylor, 272 Hartley Ave., Princeton, NJ 08540, (609) 683-0571.

WANTED: Used microcomputer, software, and equipment for use in small rural library. Donate for tax deduction or low fee; send UPS collect. R. W. Dorogi, 37 West Main St., Brocton, NY 14716, (714) 792-9012.

FOR SALE: 48K TRS-80 Model III with powerful Level III BASIC; $850. 32K expansion interface for the Model I, $400. Both components are new. Make an offer on either component. Rene Putnier, 14344 Starbuck St., Whittier, CA 90605, (213) 698-3361.

WANTED: Hammers from Potter LP3000 line printer. Must have blade attached. Will pay $10 each for two or three of them. Stephen Wenzel, 516 South Scoville Ave., Oak Park, IL 60304.

FOR SALE: 32K North Star with two quad-density disk drives and Wordsmith word processor, including Screensplitter video (86 characters by 40 lines), 15-inch monitor, and Wordsmith WP keyboard. (See May 1981 BYTE for review of this WP system.) Also, Diablo 1650 printer for highest quality print plus graphics capabilities. Total system, like new, for $7000. Will consider selling printer or Wordsmith alone. Bob Renegar, 23 Brookside Rd., Wallingford, PA 19086, (215) 566-4097.

FOR SALE OR SWAP: BASF 5-inch disk drive; $175. BYTE: Vol. 1-4, new condition; make offer. EICO Model 460 oscilloscope; $150. I will consider any offer or trade. Want OSI bus-compatible boards, a Superboard, ZX81, or VIC-20. Quintin Leach, 11985 Southwest Parkway, Portland, OR 97225, (503) 646-6644

FOR TRADE: Want to swap game programs for TRS-80 Pocket Computer. Send your list of programs to trade, and I'll send mine. John Riggs, 1114 Elaine, Livermore, CA 94550.

WANTED: Hewlett-Packard 9830 with or without peripherals or other HP desktop. A. Specht, 2302 Viewlynn, North Vancouver, B.C., V7J 2X1 Canada, (604) 987-9691.

FOR SALE: SOL-20 48K with two North Star drives and a Heathkit monitor. Lots of software, including CP/M, CBASIC, ECB Disk BASIC, games, etc. $1200. Works fine. Upgrading to 8-inch system. Texas Instruments 743 printer/terminal; $750. Gerry Fricke, 435 South Charter, Monticello, IL 61856, (217) 762-7143.

FOR SALE: SwTPC 6800/2 computer with 24K memory, CT-64 terminal, CT-EA screen read, AC-30 cassette interface, and software. $900 or best offer. W. Faulconer, 4725 West Quincy #601, Denver, CO 80236, (303) 798-4499.

FOR SALE: Four GTE Model 5-60 teletype terminals with built-in offline tape storage. Uses Selectric-type element and has internal modem capability. Comes with complete documentation. Used, need some work. Jerry Pav, 2370 Fellowship Park Way, Los Angeles, CA 90039.

FOR SALE: SwTPC CT-64 terminal with 9-inch video monitor. RS-232 interface, up to 1200 bps, all options installed. Works fine. $150. Paul Pennington, 2912 Palmetto Dr., Martinez, GA 30907, (404) 860-2934

FOR SALE: Heathkit ET-3400 microprocessor trainer. Assembled and working perfectly. $100. ET-3401 microprocessor trainer course, including components. $50. S. K. Cooper, 533 North Marlborough C., Shreveport, LA 71106.

FOR SALE: Tarbell S-100 cassette interface board. Manual is included and all chips are socketed. $25. January 1979 to January 1981 BYTE. $25. Joe Czyszczewski, 12607 Blackfoot, Round Rock, TX 78664, (512) 258-0337.

FOR SALE: Westware Business Accounting System with KSAM Board, Payroll, Receivables, Inventory, General Ledger, etc. August 1981 revision. Unused manuals and 10 disks for Apple II 48K AS ROM. $800. $1600 retail. Also, new Trendcom printer with Apple interface. $200. Dan Shanis, POB 145, McGrath, AK 99627, (907) 524-3892.

FOR SALE: Okidata Microline printer for TRS-80, Apple, Atari, etc. New, still in box. Asking $375. Bernhard Walther, 100 Cedar 308, Dobbs Ferry, NY 10522, (914) 693-5720.

FOR SALE: Apple II plus with 48K memory, Disk II with DOS 3.3 plus controller, Integer firmware card, and a variety of programs, including Apple Pie, Apple Plot, Microsoft Adventure, Sargon II, and many others. Total value over $2400. Asking $1800. All in excellent condition. Richard Ling, 4550 Scott Ave., Apt. 619, St. Louis, MO 63110, (314) 361-2064 evenings, 454-5351 days.

FOR SALE: Trendcom 40-column printer and interface to Apple II. Two D.C. Hayes Micromodem II with microcoupler. Hewlett-Packard HP-67 calculator plus Business, Math and Stat Pac, and blank cards. Donald Robbins, 251-25 Gaskell Rd., Little Neck, NY 11362, (212) 428-8442.

FOR SALE: Commodore PET 2001. Original 8K with manual and more than 40 programs; $510. Also, two 8-inch Shugart single-sided disk drives with power supply (working), less case. $580. With or after sale of PET will sell Betsi S-100 expansion for PET with power supply and case for $90, three 8K 21L02 S-100 memory boards at $80 each, and 16K EPROM S-100 boards at $60. Edward Shields, 117 Devol Dr., Marietta, OH 45750, (614) 373-7672.

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Unclassified Ads

FOR SALE: Apple II+ with 48 K plus Pascal language card, Apple disk drive, and controller card. Software includes Integer and Applesoft BASICs, DOS 3.3, DOS Tool Kit, Pascal, 3-D Graphics, text editor, Apple Invaders, Apple Adventure, and 10 disks full of games and miscellaneous fun. $1997 Dale N. Reynolds, 719 Sunrise Lane, Boulder, CO 80302, (303) 447-9461.

FOR SALE: TRS-80 16 K Model I, Level II (new 2-chip ROM), like new. Includes CTR-80 recorder, mini-amp for SFX, system desk, Advanced Statistical Analysis (eight tapes, full documentation), Cross-reference Utility, LI-LII Program/Data Conversion, LI in LII, Typing Tutor, Microchess, Space Warp, Flying Saucers, Raaka-Tu, several LI games, TRS-80 Microcomputer News July 1980 to present, miscellaneous books, and magazines. $850 takes all. Tim Howlett, 900 Union Commerce Bldg., Cleveland, OH 44115, (216) 344-8339.

WANTED: Used TRS-80 expansion interface and disk drives. Pick-up only. Tom Jung, 7-04 166 St., Whitestone, NY 11357.

WANTED: Used NEC Spinwriter, Diablo, ITOH Starwriter, or QUME correspondence printer. Kenneth Glyn Hales, 5990 North Calle Kino, Tucson, AZ 85704, (602) 888-9199.

FOR SALE OR TRADE: PMC-80 (16 K, Level II TRS-80 work-alike). $450 or will trade for OSI C4P or KIM-compatible boards. PMC has lowercase modification installed, plus some software and books. Paul Miller, 7623 Pecan Villas #7, Houston, TX 77061, (713) 749-5509 days, 641-3923 nights and weekends.

FOR SALE: NEC TK-80 and TK-80BS (full memory) with power supply (DC +5 V 10 A, −5 V 1 A, +12 V 1 A). Good condition. $700 or best offer on all three. Send two IRCs for more information. Toshiharu Kitano, POB 4, Higashimurayama, Tokyo, 189 Japan.

FOR SALE: BYTE: all of 1979 except March; all of 1980 except February; all of 1981. 34 issues for $75 postpaid. R.L. Murray, POB 5596, Raleigh, NC 27650

FOR SALE: DECwriter IV (LA-34) terminal in absolutely perfect condition, including custom-fitted fabric cover and manual. $900 FOB or best offer over $750. Al Vazquez, Harvard Business School, 2 Soldiers Field Park 507, Boston, MA 02163.

FOR SALE: Radio Shack LP(I)-Centronics 779 printer. Fast 60 cps matrix-type with fully adjustable forms tractor. Adjustable character size. Unit was just upgraded and cleaned by Centronics. Always covered. Mechanically and cosmetically like new. $465. Charles Okstein, 6 Storrs Rd., Willimantic, CT 06226, (203) 487-1616.

FOR SALE: Tarbell cassette-controller board complete with cables, data-stream cassette, instruction manual, and data-stream cassette made with this board. Make reasonable offer. Also have Digital Group cassette-system-controller board. No reasonable offer will be refused. Delbert Williams, 3500 Fleetwood Dr., Salt Lake City, UT 84109, (801) 359-7794 days, 272-3107 evenings.

FOR SALE: AIM-65 microcomputer with 4 K RAM, BASIC and assembler in ROM, power supply (24 V, +12 V, −12 V, +5 V), and audio tape player for mass storage. All mounted in standard briefcase. $500 or best offer. Also, 8086 processor chip, $45. May trade for Apple gear. D.J. Lilja, 404 South Prairie Apt. 8, Champaign, IL 61820, (217) 351-0947.

FOR SALE: SOL-20 computer with burned-out power supply. Worked perfectly for four years until capacitor blew. $280 or best offer. Jeff Roloff, 2503 Myers Court #7, Champaign, IL 61820, (217) 359-8010.

FOR SALE: North Star floating-point board. Working, one year old, but has seen little use. Best offer over $250. 24 K Morrow Memory Master. One year old, reliable. Best offer over $300. Ray Robinson, POB 30452, Atlanta, GA 30332, (404) 872-3850.

MAGAZINES WANTED: Interface Age: December 1975, January 1976-March 1976, September 1976, December 1976, March 1977, and April 1977. BYTE: February 1977. Any condition. Will pay top dollar for good condition. For Sale: BYTE: July 1976 and August 1976; Dr Dobb's: April 1977, January 1978, and May 1978; $2 each. Andy Beck, POB 571, Jackson, NJ 08527, (201) 370-9889 days, 370-9568 evenings.

FOR SALE: Centronics 101A dot-matrix printer, 165 cps; $250. IBM Selectric with RS-232 built in; $599. Perkin-Elmer keyboard, letter quality, 15-inch carriage, 40 cps computer printer/terminal with RS-232 built in (cost over $5000 new); $750. All in perfect condition. Lee Wainwright, 535 Main St., Bethlehem, PA 18018.

FREE: Free fixes available for ramware APL-80 Version 3.0 system. If you are using this system and would like to receive bug fixes for "RESHAPE" and "UPDATE", send a SASE. APL, POB 55, Ardsley, NY 10522.

ATARI MILITARY USERS: Military members who use Atari 400 or 800 computers and are stationed overseas, let's get together and form a users group. Sp/4 Bill Karoly, 212th MP CO, c/o HHC 1st Bde, APO New York, NY 09702 (if you're stationed at an APO, drop the New York, NY for faster mail service).

BOMB

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April BOMB Fooled Us

First place in the April BOMB results goes to Robert G. Cooper Jr., Paul Thain Marston, John Durrett, and Theron Stimmel for their presentation of "A Human-Factors Case Study Based on the IBM Personal Computer." Our congratulations to these authors who will share the $100 prize. Second place, and an award of $50, goes to Philip Schrodt for his humorous parody "The Generic Word Processor, A Word-Processing System for All Your Needs." We guess the joke is on us. Third place was captured by John Durrett and Judi Trezona for "How to Use Color Displays Effectively, A Look at the Elements of Color Vision and Their Implications for Programmers."

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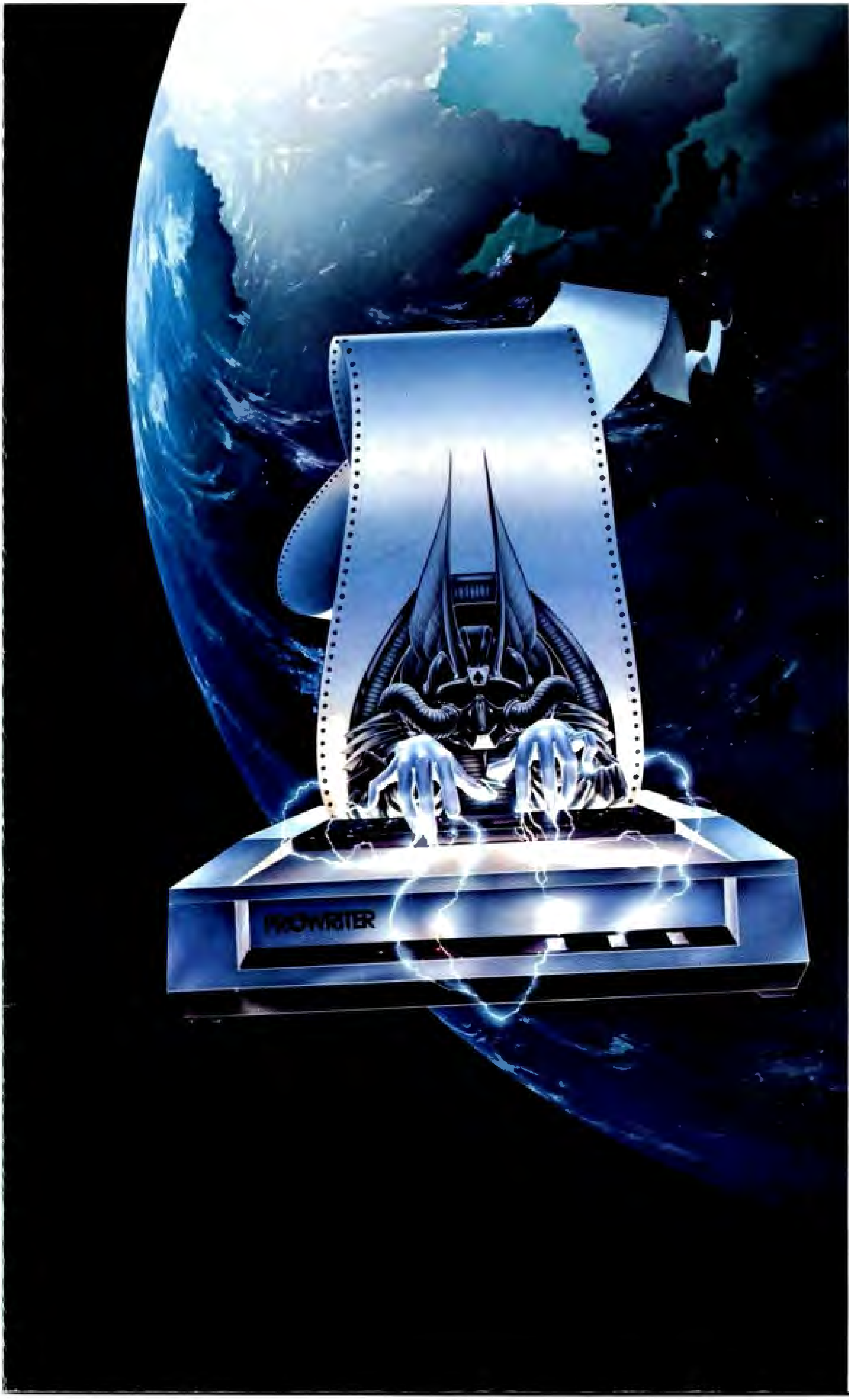

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