BYTE

THE SMALL SYSTEMS JOURNAL

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PROGRAMMING TECHNIQUES

How to avoid paying your bills.

by Alan Greenspan

Alan Greenspan, Famous Economic Advisor

Everyone has to pay their bills, and nobody likes to do it.

You can keep file folders full of bills, drawers stuffed with grocery receipts, envelopes brimming with cancelled checks, and at the end of the month, it still takes hours to figure out just where your money has gone. Not to mention how long it takes to straighten things out at the end of the year.

Well, after years of financial consulting, I've discovered a way to avoid paying your bills: let an Apple® II Personal Computer pay them for you.

There are several advantages to letting an Apple handle your finances.

It will save you time.

It will organize everything.

It will tell you, at a glance, exactly what is going on with your money.

It will pay your bills, and never send you any.

And now, I'd like to turn the page over to those nice people at Apple, who will explain, in their own excruciating detail, just what I'm talking about."

"The other day, a prominent politician in the executive branch of our government phoned me up.

'Alan,' he said to me, 'the budget is a mess.'

'No joke,' I said.

'Not that budget,' the prominent politician continued. 'My budget. My checking's overdrawn. They're threatening to disconnect my phones. I even got into a shouting match with my wife when I tried to lay off the servants.'

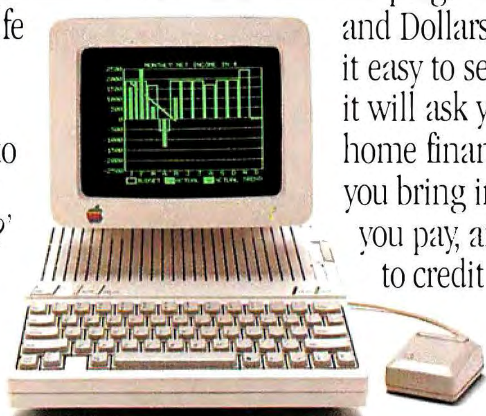
'Civil?'

'Not very. And I think I'm about to be audited. What would I show them? Who keeps receipts for embassy parties?'

At this point, we were disconnected. And although it was too late to teach proper money management to this prominent politician, there is a lesson all of us can learn from his misfortune.

The Apple II and the Home Budget.

With software programs like The Home Accountant™ and Dollars & Sense,™ the Apple II makes it easy to set up household books. First, it will ask you some questions about your home finances. Like how much money you bring in each month, how much rent you pay, and whether you owe money to credit card companies, mortgage holders, or any other surly characters. Then, it will ask you to enter some of the bills you receive each month whose prices may vary:



An Apple II will take care of everything from your household budget to your taxes with software programs like Dollars & Sense, The Home Accountant, and Tax Preparer.


This is an Apple modem. Not much to look at, we admit: but it does let you pay bills and trade stocks by phone. It also connects your Apple II to a wealth of information services, like THE SOURCE℠ and CompuServe®

phone, utilities, and the like. Then, it will ask you where you keep your money, and for the numbers of your various checking and savings accounts.

That's really all there is to it. After that, an Apple II can automatically write checks for all your fixed expenses each month. It will also tell you what other bills you can be expecting, and when you enter their costs, an Apple II will pay them, too.

An Apple II will see to it that your checkbooks remain balanced, and that you'll know when your expenses are about to exceed your income. It can even help you plan to buy a new car. Or a home.

Or a fur-lined boat, if your budget permits.


With our Scribe® color/graphics printer, you can automatically print out your own checks—not to mention reports, papers, almost anything. Except money.

How to avoid your banker.

After the Apple II writes your checks, it can call your bank with the help of your telephone and an Apple modem. And faster than a teller can say "Next window, please," you can find out all your balances, enter deposits, see what checks have cleared, transfer money from one account to another, and even pay off some of your credit cards and other bills electronically—without ever writing a check.

So the only time you'll have to go to the bank is when you want to visit with your money, personally.

Which, when done in moderation, we can recommend most highly.

*It can manage your entire stock portfolio with programs like Dow Jones Investor's Workshop™ and Charles Schwab and Company's The Equalizer™ It can even show you what's going on in your bank account.**

The Apple II and making money.

An Apple II can do wondrous things for your personal finances. With several different software programs, you can become your own stockbroker. Again, by using an Apple modem, you'll gain instant access to financial news sources like *The Wall Street Journal, Barrons,* and the Dow Jones News/Retrieval® service. Find out what they've been saying on *Wall $treet Week.* And in most cases, get up to the minute price quotes on over six thousand stocks, options, and other securities.

An Apple II lets you buy and sell securities right in your home or office, at the moment you want to make the trade. It automatically updates your portfolio and gives you detailed holding reports. It even produces charts and graphs, so you can quickly see how you and your investments are doing.

A little tax relief.

If you become perturbed everytime the subject of doing taxes comes up, an Apple II can do them for you with programs like Forecast™ and Tax Preparer.™

It can store your records, plan for the next year, and calculate your taxes.

You'll be alerted to payments you've made over the year that may be tax-deductible. It even keeps year-round records, automatically updating totals and making corrections for you. It will even print out completed tax forms that the I.R.S. will accept.

And it can do about 10,000 other things totally unrelated to taxes or this ad. So there's no telling how far an Apple II can take you.

"Well, I think that about covers it. And what if, after all of this, you still have some money left over?

Congratulations. You're doing a lot better than the government."

*A note to Dr. Greenspan's relatives: He says, "Don't get excited. This isn't my real bank account."

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FEATURES

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REVIEWS

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THE BYTE INFORMATION EXCHANGE

BYTE will soon become an interactive magazine by founding the BYTE Information Exchange (BIX). The goal of BIX is to set up ideal forums for exchanging information about computers and related topics. If even 1 percent of our circulation owns a specific kind of computer, that translates to several thousand people—enough to constitute a thriving user community.

Although a new product, BIX is also an extension of the BYTE magazine that you read each month. Through the BYTE Information Exchange, you'll be able to get your messages to Steve Ciarcia and Jerry Pournelle more quickly. You'll be able to download program listings from BYTE articles for noncommercial use. In time, you'll find in BIX more product announcements and scheduled events than we're able to print on paper in BYTE's What's New and Event Queue.

BIX has all the functions of an electronic bulletin board but also provides true computer conferencing. "Computer conferencing" fails to express the kind and quality of person-to-person communication that this technology fosters. Printouts of conferences often read like the transcripts of lively face-to-face discussions, and you wish you had been there. You have to remind yourself that the "speakers" weren't "there" either—like you, they were using personal computers in their homes, offices, or hotel rooms and were transmitting messages at whatever hours they found convenient.

Because computer conferencing makes it possible to have a group discussion without gathering everyone in one place or at one time, it is the ideal way to tap distributed resources. BYTE's subscribers are a paradigm of distributed resources. Collectively you possess more information about personal computers and corresponding topics than any other group of people in the world. We think of you as a living database.

Through BIX, you can share not only the knowledge of other subscribers but also their thinking power. Terms like "distributed resources" and "living database" fall short of the real possibilities for information exchange that mechanisms such as BIX can bring about.

HOW BIX MAKES BYTE "SUBSCRIBER-SPECIFIC"

Besides giving you a major new resource for information on computers, BIX will let us customize BYTE for you. How? Once you join a "conference"—just by typing join and the conference's name—you automatically receive all new comments from the conference each time you sign on. You can join all those conferences that meet your individual interests. Suppose you're interested in the Macintosh, FORTH, the 68020, computers in education, and robotics. You can join a conference on each of those topics. When you sign on, you'll find all the new comments on those topics waiting for you to read, and, if you wish, you can enter comments yourself, including queries. Another subscriber may be interested in IBM PCs, C, PC-DOS, XENIX, graphics, the 80286, and scientific computing. Neither of you will have to wade through the comments in topics that don't interest you. BIX will enable BYTE to cover your particular machine, but it will be much better than "machine-specific." Through BIX, BYTE will serve each subscriber's needs.

We will set up conferences and subconferences on any topic of legitimate interest in personal computing and related fields. We'll start with conferences on different computers, programming languages, chips, and operating systems, as well as such topics as graphics, artificial intelligence, and telecommunications.

SOFTWARE AND SIGN-UP

The BYTE Information Exchange is based on CoSy (for conferencing system). CoSy is a powerful and friendly piece of conferencing software developed by friends of ours at the University of Guelph in Ontario. After you first sign on and register, you can see the major groups of conferences by typing show groups. You can see a list of all the conferences by typing show all. If you want to participate in a conference not listed, send a note to the editors proposing the conference. We'll find the right place for the new conference in the BIX structure and let everyone know where to find it. Once you sign up for BIX, we'll send you the BIX user's manual, which has one of Robert Tinney's best covers ever.

CHARTER SUBSCRIPTIONS

Charter subscribers—people who join BIX before January 1, 1986—will receive special low rates. The introductory sign-up fee is $25. If you call through our own communications nodes, you pay evening and weekend charges of $6 per hour of connect time, whether for 300 or 1200 bps. Charter subscribers calling through Tymnet will pay the same $25 sign-up fee plus evening charges of $8 per hour. During the day, our direct rate will be $18 per hour and our Tymnet rate $24 per hour.

In the beginning, there will be direct BIX numbers in four cities: San Francisco, Los Angeles, Chicago, and Boston. You'll be receiving the direct BIX numbers and other information either here in the magazine or through direct mail. The information will include instructions for signing up, which you can do either on line or through the mail. Billing will be through Visa and MasterCard.

Readers who use our free bulletin board to download program listings should rest assured that it will remain available. BIX users will be able to download program listings using either Kermit or XMODEM protocol.

We're excited about the prospect of online interaction with subscribers. It should enable us to do a better job of meeting your needs and should make a stronger community of us all. We hope to meet you on line soon.

—Phil Lemmons, Editor in Chief

Complex High-End Chips Hit Snags

Problems in debugging complex microprocessor chips have caused new problems at Zilog and Intel. Zilog admitted that sampling of its Z80000 32-bit processor, announced in the summer of 1983, has been delayed until early 1986. Zilog had originally planned to start shipping the Z80000 in late 1984.

A newly discovered bug in Intel's newest 80286 processor reportedly has delayed Digital Research's work on the Concurrent 286 operating system. The bug, which Intel says was undetected until the third version of the 80286, apparently affects software in the chip's "protected" mode, used in multitasking and multiuser applications.

Intel has also stopped all manufacturing, marketing, and support activities for its 432 microprocessor. The 432 was Intel's first 32-bit chip set, but it was never used in any large-volume computers. Intel is reportedly working on two other 32-bit chip designs, including the Intel 80386, which will be compatible with its 80286 and earlier designs. Intel will begin shipping samples of the 80386 late this year.

Lotus, Intel Agree on 8-megabyte Memory Standard for IBM PC

Lotus and Intel have announced an expanded-memory specification for addressing memory above the IBM PC's 640K-byte limit and the PC AT's 3-megabyte limit. New versions of Lotus 1-2-3 and Symphony and Ashton-Tate's Framework will be able to directly address up to 4 megabytes of memory.

Intel's new Personal Computer Enhancement Operation division announced the first expansion cards that address and also go beyond the specification. Each of Intel's Above Board expansion cards adds up to 2 megabytes of RAM to the IBM PC and 4 megabytes to the IBM PC AT. The Above Board/PC card, with 64K bytes already installed, is $395; the Above Board/AT card will be available next month for $595 with 128K bytes installed.

New Computers Unveiled at COMDEX

Several companies had plans to introduce computers in May. Compaq announced 80286-based IBM PC AT-compatible versions of its Portable and DeskPro computers late in April. Both machines feature 6- or 8-MHz clocks and 256K bytes of RAM. The Portable can handle 640K bytes of RAM on its main board, while the DeskPro can be equipped with 2.2 megabytes. Additional boards provide the former with 2.6 megabytes of RAM and the latter with 8.2 megabytes. The Portable's storage configurations range from single or dual 360K-byte or 1.2-megabyte floppy-disk drives with a 20-megabyte Winchester drive to a unit with a single floppy-disk drive and a hard-disk drive with a fixed-disk backup. The DeskPro is offered with the same floppy-disk storage arrangements and hard-disk capacities ranging from 20 to 70 megabytes. Pricing will be competitive with the PC AT.

TeleVideo unveiled a computer designed to outperform the IBM PC AT. The system uses an 8-MHz 80286 processor instead of the 6-MHz version used in the AT and reportedly also has faster disk access. The system features four unoccupied AT-compatible expansion slots and two XT-compatible slots, serial and parallel ports, a 1.2-megabyte 5¼-inch disk drive, and an optional 20-megabyte hard disk. TeleVideo said pricing for the system, including MS-DOS 3.1, would be about 15 percent less than prices for comparable IBM products. TeleVideo will also sell a high-resolution 640- by 400-pixel graphics card and monitor for the computer.

Zenith Data Systems was to unveil the Z-171 and Z-138, two IBM PC-compatible portable computers. The Z-171 is a battery-powered 17-pound portable based on Morrow's redesigned Pivot computer. With a backlit 80-character by 25-line liquid-crystal display, two 5¼-inch disk drives, and 256K bytes of memory, the Z-171 retails for $2699. The Z-138 is a 25-pound transportable computer with one expansion slot and color graphics capabilities. With one 5¼-inch disk drive and 128K bytes, it will sell for $2199; with 256K bytes and two

(continued)

drives, it's $2499. Zenith also planned to unveil three new flat-screen monochrome monitors.

Leading Edge Products hoped to reduce supply problems resulting from its dispute with supplier Mitsubishi by offering a new system manufactured by Daewoo of South Korea. The new machine will offer a smaller footprint than its earlier computer. Pricing will range from $1495 for a two-drive 256K-byte system with a monochrome monitor to $2695 with a 10-megabyte hard disk and an RGB monitor.

Columbia Data Products introduced a multiuser system based on its IBM PC-compatible MPC Models 4750 and 4950. Each workstation includes a processor card with an 8-MHz 8088, 256K bytes of RAM (expandable to 768K), and a serial port; the workstation itself features a parallel port and connectors for a color or monochrome monitor. Workstations are connected to the computer via four- or six-wire twisted-pair cables. Up to four $1200 workstations can be added to a standard MPC. Theoretically, up to 31 workstations could be added using optional expansion chassis. Columbia's system uses software licensed from Alloy Computer Systems, which also sells hardware and software allowing multiuser access to the IBM PC.

New Laser-Class Printers

Data Recording Systems Inc., Melville, NY, announced the LaserScribe/8415 laser printer, available to other manufacturers in versions with print resolutions of 600, 800, and 1000 dots per inch at speeds from three to eight pages per minute. Retail products based on the 8415 will probably be priced well above $30,000.

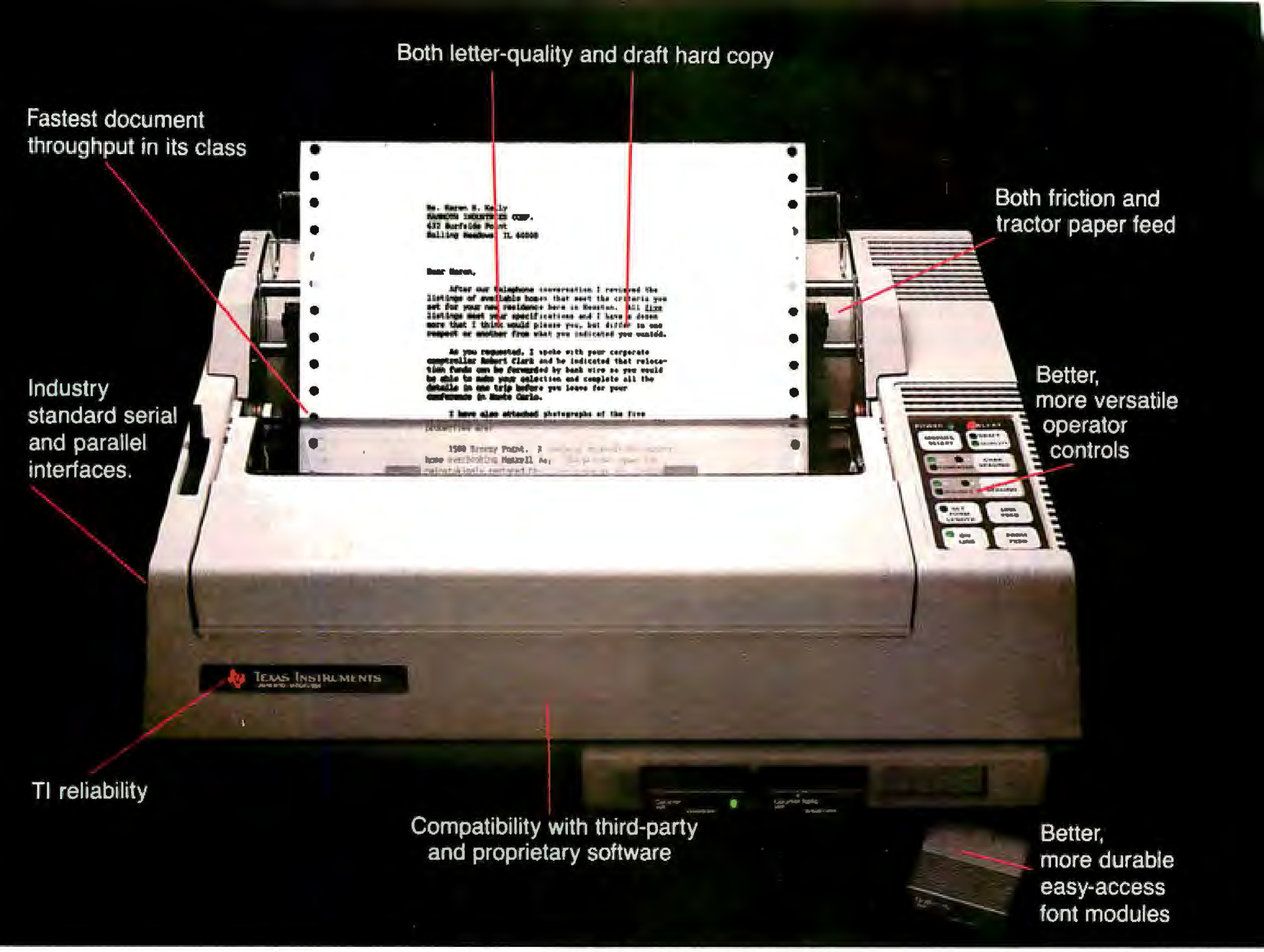
Casio announced the LCS-2400 "electro-photographic" printer, using liquid-crystal shutter technology. The LCS-2400 prints up to nine pages per minute at a resolution of about 240 dots per inch. Casio was unsure of U.S. pricing but said the printer currently sells for about $1600 in Japan. In the U.S., it will be available only to other manufacturers.

Products Will Aid Visually Disabled Computer Users

Computer Aids, Fort Wayne, IN, introduced several microcomputer products for the disabled. One product, Small-Talk, uses a modified Epson HX-20 and a speech synthesizer to allow blind users to perform word-processing tasks. With a printer, microcassette tape drive, and special word-processing software, the computer will cost about $2000.

NANOBYTES

Advanced Micro Devices unveiled several new products, including a 1-megabit EPROM, a bit-mapped color graphics chip, and a data-compression and -expansion chip. AMD also hopes to begin sampling both 1200- and 2400-bps single-chip modems late this year. . . . **Alpha Software** added its name to the list of manufacturers of keyboard-enhancement programs with its new $90 Keyworks. . . . **Microsoft** unveiled Microsoft Access, a $250 communications program. . . . **Hayes Microcomputer Products** announced the Transet 1000, an intelligent printer/communications buffer/port expander. The $399 unit includes a 68008 processor and 128K bytes of memory. . . . In response to customer complaints about copy protection, several companies are dropping software protection or are offering unprotected versions at a higher price. **MicroPro** and **Stoneware** dropped copy protection from their newest IBM PC products. **MaxThink** offers an unprotected version of MaxThink for $60 extra, following the earlier example of **Borland International**. . . . **Scenic Computer Systems Corp.**, Redmond, WA, has introduced a text-composition system that prepares text for laser printers using an IBM PC. Scenic Writer for the Hewlett-Packard LaserJet is $995. . . . **Interstate Voice Products**, Orange, CA, announced a connected-speech recognition system for the IBM PC. A vocabulary of 15 to 20 words can be recognized in continuous speech, while an additional 240 words are recognized when pronounced with silence between words. The $1650 card includes an 80186 processor and 128K bytes of RAM. . . . **Beaman Porter**, Harrison, NY, has unveiled PowerText Formatter, a $50 program that allows users of most popular word processors to print documents in a two-column format with footnotes. . . . **IBM** introduced PC Storyboard, a slide-show graphics package that can reside as a background task and can be used to "capture" screen graphics from other programs. The $250 program can then be used to enhance the graphs and display them in a slide-show-like sequence. . . . **Manhattan Graphics Corp.** has unveiled a $125 page-design program for Apple's 512K-byte Macintosh. Users of ReadySetGo can resize and rearrange blocks of text and graphics on a page for newsletters or other documents.



The TI 855 microprinter. No other printer says better so many ways.

Feature for feature, no other microprinter can match the versatility, compatibility, reliability and productivity of the OMNI 800* Model 855 microprinter. Here's why.

Two Printers In One. With the TI 855 you get the speed of dot matrix draft copy. Plus the precise clarity of the most advanced matrix technology for letter-quality print. It's two printers in one — at one low price.

A Great Family Name. Texas Instruments is known for providing the world with the industry standard for printers — the TI 810. TI builds the same reliability into every 800 series microprinter. Both the 855 and the data processing Model 850 are part of the expanding TI line of high-performance, low-cost microprinters.

Hardware Compatible. The TI 855 microprinter is compatible with all major PC hardware. And it provides both serial RS232C subset and "Centronics-type" parallel as standard interfaces.

Software Compatible. The TI 855 uses industry standard escape sequences for compatibility with virtually all third-party software. And for those with proprietary software needs, a model is available with ANSI standard escape sequences.

Tough Font Modules For Quick Character Change. Three font modules can be inserted into the front of the printer at one time, and are accessed individually. Each contains both draft- and letter-quality character sets. They're easier to use, more reliable and more durable than traditional metal or plastic daisy wheels.

More Productivity Than Any Other Microprinter. The 855 offers both friction and tractor paper feed, to handle all types of word and data processing applications. A quick-change snap-in cartridge ribbon. Raster and mosaic graphics. And intelligent printing which maximizes document throughput — regardless of format.

Get the printer that makes for better information systems. For more information visit your nearest TI authorized dealer or write Texas Instruments Incorporated, P.O. Box 402430, Dept. DPF-082BY, Dallas, TX 75380-9063. Or call toll-free: 1-800-527-3500.

TEXAS INSTRUMENTS
Creating useful products and services for you.

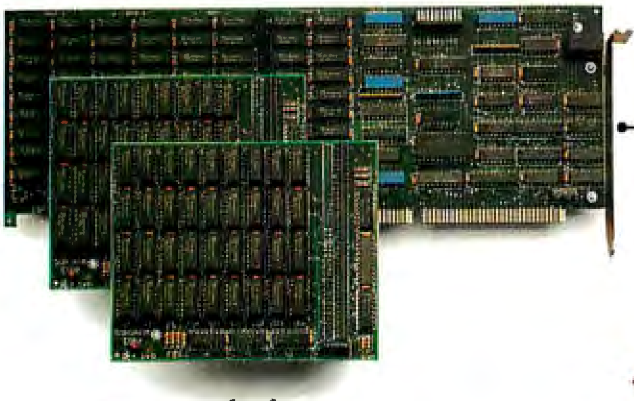
291380-R2

COMBINE POWER AND ENHANCE YOUR PC-AT

Quadram introduces the smart way to enhance your IBM PC-AT. Quadmeg-AT and Quadport-AT. Smart because Quadmeg-AT and Quadport-AT make the most of your AT system today and expand to meet your system's growing needs in the future.

Quadmeg-AT comes socketed for memory expansion from 128K to 2 Megabytes. Harness this power to create megabyte-sized RAM drives, access

QUADMEG-AT™



greater amounts of information, and process data faster and more efficiently than ever before. Plus, with "split memory mapping," Quadmeg-AT lets you expand the AT's base system memory to 640K without buying a space-wasting 128K card.

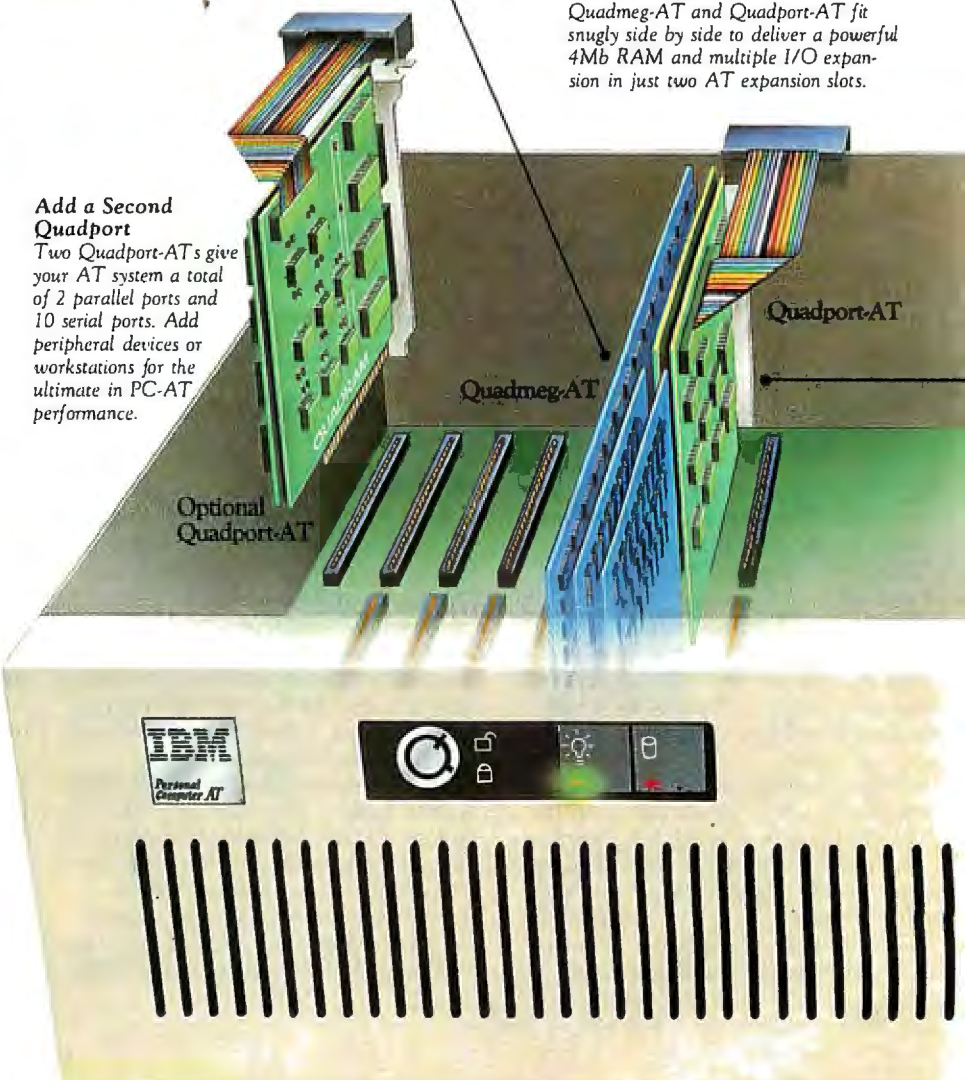
Advance to 4 Megabytes

When you need more than 2Mbytes, Quadmeg-AT adapts with two Quadmeg-AT Expansion Cards. Each packs 512K or 1Mbyte extra RAM.

Both cards filled give Quadmeg-AT a powerful 4Mbyte capacity. Quadmeg-AT delivers the power you need to take full advantage of the AT's capabilities.

Maximum Performance in Minimum Space
Quadmeg-AT and Quadport-AT fit snugly side by side to deliver a powerful 4Mb RAM and multiple I/O expansion in just two AT expansion slots.

Add a Second Quadport
Two Quadport-ATs give your AT system a total of 2 parallel ports and 10 serial ports. Add peripheral devices or workstations for the ultimate in PC-AT performance.



™ Look for this seal. It's the mark of dependability and performance from the leader in microcomputer enhancements.

L·E·T·T·E·R·S

VOTES FOR PROGRAMMING INSIGHTS

This is a complaint. It is no service to your readers to bury very useful articles under "Programming Insight" at the bottom of your table of contents. "Simultaneous Equations with Lotus 1-2-3" by Jan-Henrik Johannson (February, page 399) was the most interesting article in that issue.

You might justify your position by saying that such articles never get mentioned in the BOMB (BYTE's Ongoing Monitor Box). I agree. But the reason is that you exclude them from the ballot! So here's a vote for Johansson—the only way I can do it.

N. C. WEBB, M.D.
Lincoln, MA

Gene Smarte replies:

Thank you for your vote. It will be included in our tabulation. As of May, we are adding all the Programming Insights, Application Notes, and other brief articles that appear at the back of the book to the table of contents and the BOMB.

MAIL-ORDER DELAYS

Regarding Phil Lemmons's editorial "Service and Support" (February, page 6), I have purchased various computer systems and components via mail order, and I have not had any problems except with Priority One Electronics in Chatsworth, California.

Priority One has been sitting on $300 of mine since August 1984. Several phone calls resulted only in assurances that my parts would be mailed "Real Soon Now." That was several months ago. I have never been informed that there would be any delay in delivery of my order.

Priority One Electronics continues to advertise and take orders for the same parts that I have yet to receive!

BOB HARRINGTON
Duquesne, PA

Priority One Electronics replies:

First, allow us to apologize for the delays associated with your order. On August 30, the day after we received your order, we shipped the items that were available. But for Prometheus Products' inability to deliver the balance of your order, the order would have been shipped complete.

As a rule, we advertise only those items we have in stock or for which we have received a firm commitment from the manufacturer that the product will be available by the time our advertisement is published. Our decision to advertise Prometheus's products was based on that company's promise of delivery.

Due to production problems, Prometheus was unable to deliver the options processor and display you ordered as it had promised us some three months earlier. Because we had received numerous broken promises from Prometheus that the processors and displays would ship "any day," we were hesitant to launch a major campaign to notify our customers of a shipping date and instead concentrated our efforts on pressuring Prometheus into expediting our order. When you contacted our customer-service group, we could relay to you only the limited information we had obtained from Prometheus.

Finally, after whatever flaws that delayed production were corrected, at our insistence, Prometheus worked through a weekend to fill our back orders. We are proud to say that we shipped all our customers' orders in only that part of a day that it took for us to receive the product and package the outgoing orders.

We are happy that we were able to complete your order. If Prometheus had not delivered when it did, our next course of action would have been to cancel all our orders for this product.

We regret that these events may have soured your taste for our company. However, we understand your position and appreciate your feelings. It is our sincere hope that this experience does not unjustly bias any future decisions you may make regarding shopping via mail order.

JOHN C. GUNN
Director of Consumer Affairs
Priority One Electronics

NOTES ON THE VU68K

Remember "The VU68K Single-Board Computer" described by Edward M. Carter and A. B. Bonds (January 1984, page 403)? Well, I finally completed it and found it to be an excellent vehicle to learn about the marvels of the 68000 with little expense. BYTE and the authors are to be commended for the article as there are still readers who want to learn about microcomputers from the ground up.

Here are a few suggestions for others who may be having problems with the project. The address lines A21 and A22 are incorrectly connected to the terminal ACIA (IC11) in the wiring diagram and should be reversed. I tied $\overline{BR}$, $\overline{BGACK}$, and $\overline{BERR}$ high although it may not be necessary. Lastly, the monitor program (VUBUG) as I received it was assembled with a one-pass assembler, and therefore all forward references must be resolved before you can use it.

WALTER R. CURTICE
Princeton Junction, NJ

REMOTE DIAGNOSTICS

I found Phil Lemmons's editorial concerning remote diagnostics both interesting and informative ("Service and Support," February, page 6). As more systems are being sold to first-time computer users, the need for better repair service is becoming an even greater factor than the performance features of the system.

We at RACET have long believed that the key to success in the systems-house business is support. Although we're a small company, our customers expect big-company support. Several years ago, we developed a series of diagnostic tests for checkout of the hard-disk subsystems that we sold to the Radio Shack market. The diagnostic was set up so that it could be run via remote (modem) connection, en-

(continued)

LETTERS POLICY: *To be considered for publication, a letter must be typed double-spaced on one side of the paper and must include your name and address. Comments and ideas should be expressed as clearly and concisely as possible. Listings and tables may be printed along with a letter if they are short and legible.*

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abling our support people to check out a reported problem without flying all over the country.

We have since migrated to the IBM PC market, where we offer hard-disk and tape subsystems capable of storing from 100 to 400 megabytes. Our remote-diagnostic program allows us to check out the disk, tape, and controllers and isolate down to the module level. We can then expedite the replacement module or component to the customer before a field technician is sent out. This procedure saves our customers time and money and improves the relationship with *their* customers.

For us, remote diagnostics has been standard practice for several years and we agree totally that the industry should follow suit.

THOMAS S. BERNARD
Vice President, Marketing and Sales
RACET Computes Ltd.
Orange, CA

ICONOCLASM AND THE MAC

Ann Marchant's letter on icons ("Icons Are Arcane," February, page 24) agrees with my own experience, but there's another example of their use that started 4990 years later than hers. We now see rabbits, turtles, and globs of oil used on farm-equipment instrument and control panels where we used to see plain English. The Dymo labeler solved most of the problem, but there were a couple of side effects. First, the suspicion farmers had that agricultural engineers were illiterate was reinforced. The second was more pertinent. Several of my former professors and classmates have worked on projects in the third world. They found that the locals' knowledge of English rarely extended to the fables of Aesop, and there was a problem if rabbits or turtles were not part of the local fauna. Training people who don't know how to drive a car to operate complex modern farm machinery is enough of a problem without having to interpret nonsensical symbols for them.

My own experience with the Macintosh was an exercise in frustration. I was looking for something better than my TRS-80 Model PC-2 pocket computer, and I got the chance to use a relative's Mac for two days. I ran a series of small benchmarks, and I could edit a program on the PC-2 far more quickly than I could on the Mac. The mouse is no substitute for a good set of cursor and function keys. I was so sure this turkey would never fly that I got a bit paranoid and wiped the Apple IIe and IIc off my shopping list as well. I bought a

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Inquiry 374

ProModem 1200... HOT-LINE

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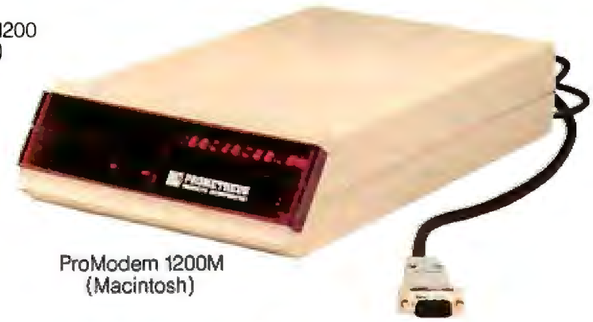
ProModem 1200 (RS-232)



ProModem 1200M (Macintosh)

Send Or Receive 50 Pages Of Text Without Tying Up Your Computer

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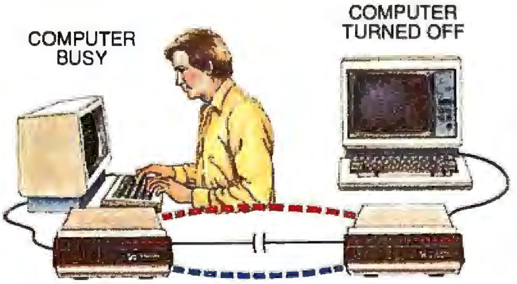
COMPUTER TURNED OFF



No wonder Smart Modems, Cats, and Maxwells cringe when compared to our $495 ProModem 1200, an expandable 1200/300 baud modem for use with all personal computers. It costs less, but is smarter than the rest.

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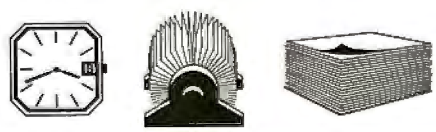
Imagine, you unplug your computer, take it home for the weekend, and while you're gone, ProModem 1200 answers the phone, collects messages up to 50 pages long, sends out electronic mail, and displays all events with the exact time of each. Thanks to ProModem 1200, expensive, hard-to-use communications software isn't needed. The communications is in the modem, and electronic mail becomes a background function, where it belongs.

Simple To Install And Use

Our Communications Buffer is a 4 by 6 card that plugs into the ProModem 1200 motherboard. It comes with 2K of CMOS battery backed-up memory, expandable to 64K. Part of the memory is used as a dialing directory with the balance reserved for storage. For $99 more, a front panel Alphanumeric Display can be added to show time, date, and 24 status and help messages. These two powerful options can be included at time of purchase, or can be added later.

Hayes Compatible

ProModem 1200 is Hayes compatible but that's where the resemblance ends. Our standard $495 modem includes a real-time clock/calendar. Hayes charges hundreds more for a Smart Modem with a time-base. Nor do they have electronic mail capability at any price.



ProModem 1200 contains a battery backed-up real-time clock/calendar, a large dialing directory and can send or receive messages up to 50 pages long without tying up the computer.

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Tandy 1000 and like it so far, although it is still an immature system. The Text word processor of DeskMate, on which this letter is being written, is a lot nicer than MacWrite. Worksheet, Filer, and the BASIC have a few problems. The Radio Shack DWP-210 printer is a bit faster than advertised, running the 60-column Shannon test (discussed on page 207 of Sergio Mello-Grand's "The Art of Benchmarking Printers," February 1984, page 193) at 19.7 characters per second (cps) rather than the claimed 18 cps.

On further reflection, I think the Mac may find a niche in the educational and graphics markets, but it will never challenge the MS-DOS machines for the business market unless someone finds a way to bypass the bells and whistles.

JACK MONTEITH
Balcarres, Saskatchewan, Canada

THE ORIGIN OF Ø

In his review of the book *Alan Turing: The Enigma* (February, page 65), G. Michael Vose mentioned Turing's habit of writing zero as "/" as possibly the origin of the computer habit of writing zero as Ø to differentiate it from the letter O.

I own an ancient Model 17 Teletype that I am sure, judging by its condition, goes at least as far back as World War II, and it uses a "Ø." I think the convention goes back to telegraphers who had to clearly distinguish between the two as they hurriedly transcribed the clicking of the wires.

WILLIAM D. A. GEARY
Deer Park, NY

GPIB VS. HP-IB

I read Thomas R. Clune's article "Interfacing for Data Acquisition" (February, page 269) with great interest. I am involved with standards, both in the IEEE and HP, for devices that use the IEEE-488 bus. He has done a great service in describing the attributes of a communication medium that has eased the construction of instrument systems for years. I do, however, feel that a few points in the article need clarification.

Hewlett-Packard never uses GPIB in reference to any of its products. We always use HP-IB. Our lawyers say the hyphen is important because it protects the HP trademark.

I was a little confused by the way Clune differentiated between command and data modes. I have always thought of the command mode as involving setting up which device would talk and which would listen. Technically, sending messages to a

(continued)

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We've tamed tape. And made it docile. By making it DOS-like.

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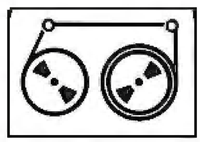
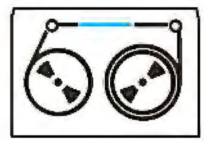
PC/T is a new format that makes tape a more sensible storage solution for personal computers. It puts tape on line, in real time, for instant access. And frees your hard disk for your most current data.

You already know how to use PC/T. Because it responds to standard DOS commands.

Here's the big news: just like any DOS-controlled hard or floppy disk, PC/T enables you to create directories and files on tape. Then you can call up the exact file you need, and change a portion of the tape without having to erase and overwrite the entire cartridge.



Without PC/T, you have to rewrite the entire 60MB cartridge each time you make a single change.



With PC/T, you create and directly access files on tape, just like with floppy or hard disk.

PC/T formats each new tape cartridge, just like you format any hard or floppy disk, locking out bad blocks to assure that every bit of data you write to tape is recorded with utter accuracy.

What's more, PC/T gives tape true error correction capability. 50% redundancy during write operations ensures 100% reconstruction of data lost because of operator error, dust and dirt, or everyday wear and tear.

There is a catch. You can get your hands on PC/T just one way: Buy one of our powerful new HardFile subsystems. With disk plus tape. Or tape alone. Which brings us back to where we started. And gives you a place to start. Just call 1-800-228-DISK for the Tallgrass dealer nearest you.

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Inquiry 399

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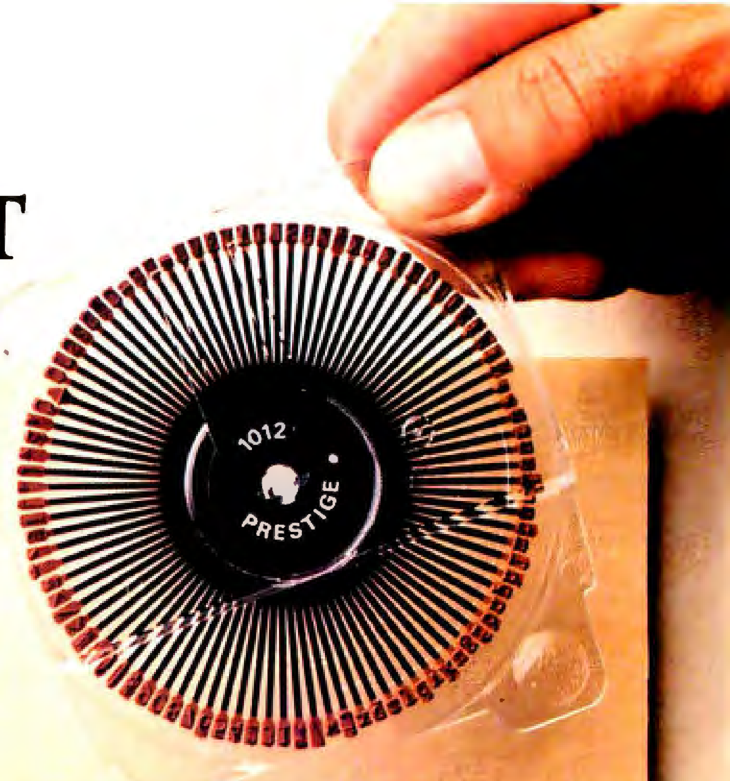

Dear Businessperson:

A good daisywheel printer should work like a pin-stripe suit for your letterhead.

That's why you need a new DaisyWheel 36 from Datasouth. It is, literally, a very impressive machine.

The DaisyWheel 36 is quick, with a top speed of 36 cps. It's more capable than any other daisywheel in its class, with superscripts, subscripts, **boldfacing**, underlining, text reprinting, red & black color printing and proportional spacing, among other impressive features. And with its Diablo 630 compatibility, your DaisyWheel 36 will get along with just about any computer in your office.

Your secretary will get along with your DaisyWheel 36 too--thanks to its sheet and tractor feed options, cartridge ribbon, and a whole garden of distinctive daisywheel type faces, each with its own protective cassette.

Best of all, the DaisyWheel 36 comes from a company with a most impressive name: Datasouth--the name that means high performance.

So wheel over to your Datasouth Dealer and run some of your best letterhead through a new DaisyWheel 36, the high performance daisywheel from Datasouth.

By the way, the DaisyWheel 36 lists for just $995

Which is a pretty good price for the best image around.

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DMM (digital multimeter) to set up its measurement function is done in the data mode. The message is going from the computer (talker) to the DMM (listener). During this time the controller function in the computer is inactive.

While service requests and parallel polls are often used to indicate unexpected conditions, they have applications beyond just indicating problems. A common usage is to synchronize stimulus and measurement devices. A source may take a significant length of time before its output is stable. By asserting SRQ (service request) when everything is ready, the device signals the computer that a measurement can be taken. Some instruments, like swept-spectrum analyzers, take quite a while to complete a measurement. Using polling methods, the computer can process other tasks while waiting.

Table 1 of the article described the bit pattern "N11SSSSS" as a secondary address. Actually, it should be described as a secondary command. A secondary command has meaning after either a parallel-poll configure or a primary address. The secondary command after a parallel-poll-configure command programs which bit the device will drive during a parallel poll.

The other use of secondary commands is for secondary addressing. A device may implement extended talker or extended listener functions. If so, the device must receive its primary address followed by its secondary address in order to be addressed. Using secondary addresses to program device functions is not generally done. A device may have several TE (extended talker) and LE (extended listener) functions to allow access to various parts of the instrument. Conceivably, a device could contain both a power supply and a voltmeter. One secondary address would allow programming messages to go to the voltmeter section and another would allow them to reach the power-supply section.

I'm not sure I would describe REN (remote enable) as a "warm boot." REN gives the controller charge over where the instrument will receive its instructions. While REN is false the front panel is active. If REN is true and the listen address is received, the front panel is deactivated. I think the description of IFC (interface clear) as a "panic button" is very accurate.

The IEEE has a companion document to IEEE-488 called "IEEE Recommended Practice for Code and Format Conventions" or ANSI/IEEE Standard 728-1982. This standard is directed toward program-

(continued)

ming and response messages. The IEEE has also formed a committee, P981, to work on extending and refining the current standards. My article, "Test/Control Update: GPIB Instruments" (*Electronic Engineering Times*, December 17, 1984, page 47), may be of interest.

I think the BYTE article did a good job of communicating the fundamental capabilities and advantages of the IEEE-488 bus. The application example demonstrates the power that is available to the user. I am convinced that this interface will become more widely used with personal computers. I appreciate your efforts in spreading the word.

STEPHEN GREER
Interface Engineer
Hewlett-Packard
Loveland, CO

Thomas R. Clune replies:

I appreciate the clarity of your well-informed remarks. I do, however, think that you have overstated the sharpness of the distinction between command and data modes. For example, a DMM manufacturer would be perfectly free to treat its product as three instruments in one. The voltmeter could be given a different secondary address from the ohmmeter, etc. Thus, addressing the voltmeter to talk would be functionally equivalent to selecting the volts function in data mode on, for example, the HP 3478A. Further, commands like GET are, to my mind, more like programming statements than address information. Having said that, let me thank you for your corrections and additions to my remarks. I look forward to reading your article in Electronic Engineering Times.

CONVERSION UTILITIES

I read with interest Ted Carnevale's "C to Pascal" (February, page 138). Carnevale offered a filter program for converting C source code into a form that requires minimal editing to produce the corresponding Pascal. The author's explication of his problem and the chosen method of solving it were informative and lucid. This article was also valuable as an illustration of program construction. Your readers may be interested to know of an alternative method for carrying out such conversions in a few minutes without programming.

The WP Toolset provides 50 utilities for the IBM PC including a program to make any set of regular substitutions in disk files. This general-purpose filter makes multiple global replacements in one pass, replacing any string of printable or nonprintable characters with replacement strings of your choice. The replacements are stored in an ASCII file with nonprintable characters represented in hexadecimal. The filter can be called from the command line or batch files for conversion of programs, word-processing files, or any data whose line delimiters need modification. The WP Toolset is available for $39 from iRr Software, 28 Ridgewood Rd., Concord, MA 01742.

GAIL JOHNSEN
iRr Software
Concord, MA

ART APPRECIATION

The illustration on page 96 of your March issue, by artist Barrett Root, is without a doubt one of the finest that has ever ap-

(continued)

peared in a computer-oriented magazine.

The symbolism isn't subtle, but how perfectly right the artist was, that demon terminal and computer have become our gods! And that the temple computer is at the summit of the other lesser computers or terminals.

I actually know computerists who virtually worship their computers and who religiously do obeisance to their electronic gods. I'm sure that the Parthenon did not exert the influence on some of its devotees that the microcomputer does today on many of its owners.

My sincere compliments and thanks to Mr. Root.

BERNARD A. MCILHANY
Marble Hill, GA

FACTORING WITH S1

Thanks for Richard B. Leining's interesting article, "Factoring with Hyper" (March, page 396). The method outlined is undoubtedly applicable in certain circumstances. However . . .

Instead of comparing Hyper with a sophisticated program I compared it with the simplest factoring program possible, which I have called S1 (Simple 1). You start with $Qmax=\sqrt{N}$ and try dividing N by each odd number smaller than $Qmax$. Thus for N=96,001, $Qmax$=309.84, and you try Q=309, 307, 305, etc. The most numbers one can ever try with S1 is $Qmax/2$; thus for 96,001 after 154 trials you reach $Q=1$ and conclude (correctly) that 96,001 is prime.

Hyper takes 7846 trials to conclude that 96,001 is prime. But wait! One expects to use Hyper for numbers that can actually be factored. The question is, how long do you have to search before finding the factor? If we define $Qmax$ as equal to $\sqrt{N}$ and Rq as equal to $Q/Qmax$, where Q is the actual factor that will be found by either Hyper or S1, we can calculate how many trials each will require. For S1, Trials= $Qmax*(1-Rq)/2$. For Hyper, Trials=$Qmax*(Rq+1/Rq-2)/4$. If Rq is near 1, Hyper gets the job done faster than S1. But as Rq becomes small, Hyper suffers. Table 1 illustrates some examples.

Table 1: *The number of trials necessary to find a factor.*

N = number to be factored
Q = actual factor to be found
$Qmax=\sqrt{N}$
$Rq=Q/Qmax$

Method	Rq=0.5	Rq=0.2	Rq=0.1
Hyper	0.125*$Qmax$	0.8*$Qmax$	2.03*$Qmax$
S1	0.25*$Qmax$	0.4*$Qmax$	0.45*$Qmax$

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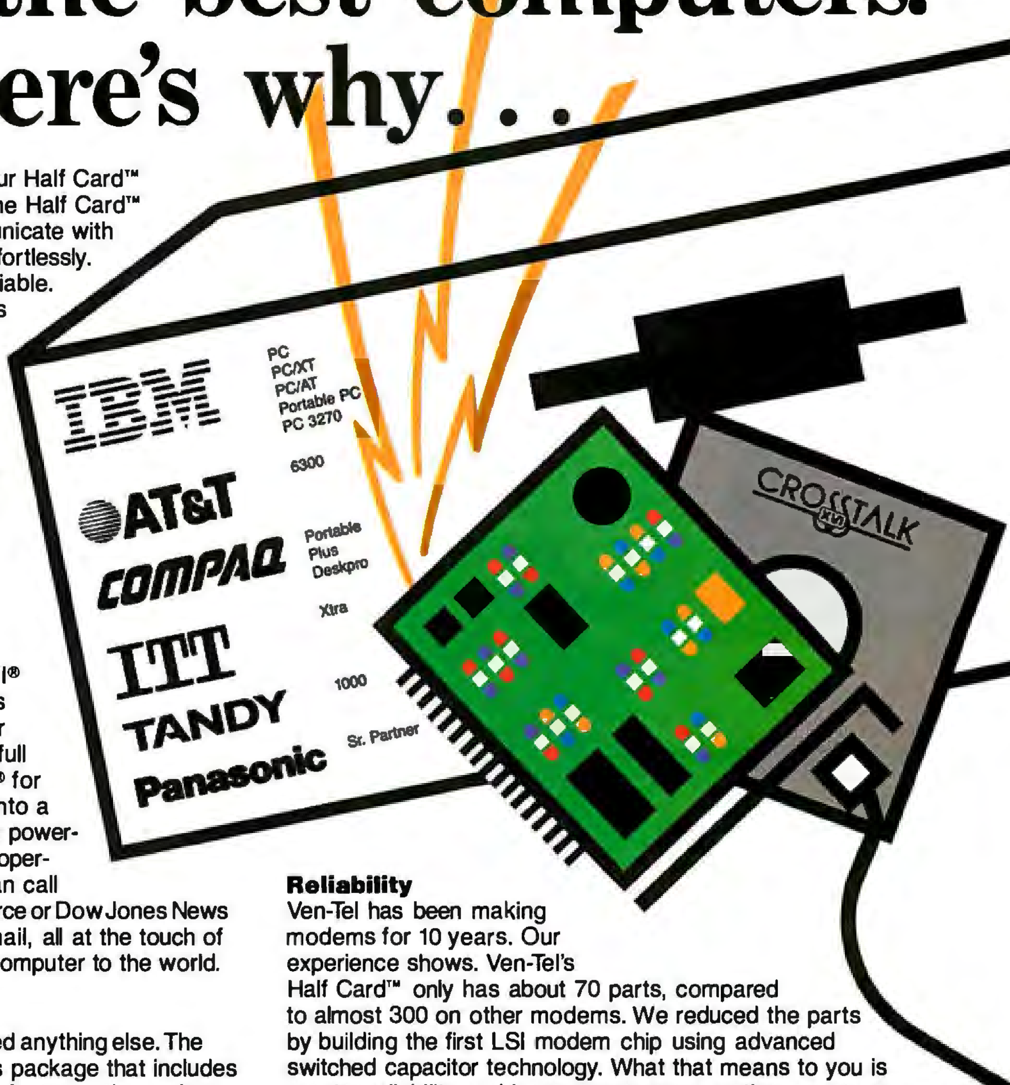

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LETTERS

One can of course use a hybrid search method, using Hyper until $Rq = 1/\sqrt{3}$, then switching to S1. But the fact remains that there will be little relative gain over S1 overall unless Rq is near 1. In public-key encryption, I am not aware of any restriction that would prevent Rq from being quite small—0.1, for example. Hyper or S1 or a combination will still take on the order of $0.5*Qmax$ trials to factor the key. For the oft-quoted 200-digit key, that's about $0.5*10^{100}$ trials. And Hyper doesn't do any better relative to S1 when the keys are smaller.

The above discussion has assumed that a Hyper trial will burn the same computing time as an S1 trial. In fact, a Hyper trial will take perhaps three times as long, involving as it does an expression with numbers on the order of N^2 compared to S1's single computation of *N MOD Q*. Also note that we can swing the balance further by skipping every third odd number in S1, those that are divisible by 3.

JOHN DELAUBENFELS
Duluth, GA

Richard B. Leining replies:

Basically, we agree on the mechanics but not what to make of them. Let's take your comments one at a time.

First, Hyper is too slow for testing the primality of a number like 96,001. Agreed. Although I've not run it, manually I predict 7847 trials, like your 7846.

Hyper is used primarily where factors are expected to exist—yes, and it is efficient near the square root but not far from it. The number of trials is

$$1 + \frac{(1-a)^2}{4a}\sqrt{N}$$

where

$$a = factor/\sqrt{N} = your\ Rq$$

and

$$\sqrt{N} = your\ Qmax$$

*If I drop the first trial at the critical upper bound of $\phi/4$, then my expression is equivalent to your Qmax *(Rq + 1/Rq − 2)/4. This expression for the number of trials was edited out of my manuscript.*

Your searching of odd numbers below the square root is interesting. For small factors, it is not as trivial as it seems at first glance. But for your example of 96,001, I would use a table of primes. There are only 168 primes below 1000. I suspect that there are less than 154 of them below the square root 309.8. But I don't know how many, as my table and

(continued)

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My manuscript assessed the possibility of Hyper breaking a large Rivest-Shamir-Adleman cipher, described in C. E. Burton's "RSA: A Public Key Cryptography System, Part I" (Dr. Dobb's Journal, *March 1984, page 16). I wouldn't want to pay for 10^{27} trials on a big computer. I concluded that Hyper's cryptanalytic virtues were limited to toy ciphers, especially in BASIC. Those comments were edited out along with my observations about numbers the order of $N^2/4$.*

What is the point of Hyper? Well, why does anyone factor? For research, I guess. It fascinates me that two of the equations of the RSA cipher should suggest a new substitute for factoring. It is also interesting that equations (2) and (2A) of my article lead to factoring substitutes that are mirror images of each other, one searching downward from a critical upper bound, the other searching upward from a critical lower bound, and both bounds found in equation (16). Has some mirror image of Euler's totient function been overlooked?

Your interest in Hyper is appreciated. I'm impressed that you figured out the number of trials so quickly.

Other people helped me develop the Hyper factoring program, to the limit of double-precision BASIC. Scaling down the entire computation by a factor of 4, to defer overflow, was a solution suggested by Professor Bill Viavant of the Computer Science Department of the University of Utah.

DEC Rainbow Woes

A few words about some bugs I have found in my DEC Rainbow. So far, I've had little luck with DEC customer support.

- The CP/M-86/80 2.0 command to back up the hard disk apparently eats files at random. All I can advise is that you simply not back up files; or you can spend all day using the PIP command.
- Under CP/M-86/80 2.0, the MAINT command produces erroneous results when large files (50K bytes) are involved or the hard disk is over 50 percent full.
- Under WordStar 3.3 and CP/M-86/80 2.0 (exact source of bug unknown), large files (over 30K bytes) mysteriously cannot be edited at times. You can edit them on screen, but after saving the files, they come back with the old text, not the revisions. Neat trick. One solution is to avoid writing long files and try resaving the file as a block write, under a new name. Backing up a work in progress should be done the same way; the "save-&-resume" command, the "save-&-new" command, and the "save-&-exit" command all seem to have this random bug.
- The MS-DOS operating system comes with a very basic user's guide; it doesn't even explain the directory/subdirectory/path commands. In fact, it tells you very little besides how to boot the system. Is there any other documentation available besides the $250-plus technical manuals?

I also found that "upgrading" to a hard disk means buying a new $1500 system board (the one different chip can't be swapped) or else keeping the operating system on one floppy all the time; it's no simple upgrade, as promised, either.

Jared Sherman
Jackson Heights, NY ■

Inquiry 354

F·I·X·E·S A·N·D U·P·D·A·T·E·S

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As a direct result of the phenomenal response to BYTEnet Listings, we have recently increased the number of telephone lines and microcomputers supporting our new telecommunications service.

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Author to Advise C Group

An independent Lattice C Users' Group has been formed under the guidance of Bill Hunt, author of the book *The C Toolbox*. Although the group will address the needs of users of Lattice, Lifeboat, and Microsoft versions of Lattice C, membership is not limited to those users.

Group members receive a 16-page bimonthly newsletter that explains C's features, provides examples, and offers ways to employ C. A question-and-answer column is featured. Supplementing the newsletter is a disk containing source files, demonstration programs, library functions, and public-domain programs.

A full year's membership is $30. For details, contact the Lattice C Users' Group, POB 271965, Concord, CA 94527.

Upgrade to Lowercase Descenders

Tim Worcester, proprietor of the Electronic Closet in Bainbridge Island, Washington, has developed an upgrade kit that may be of interest to owners of the Gorilla Banana Printer.

The Banana, a low-cost printer from DAK Industries, does not produce true lowercase descenders, which, in turn, hampers its use in serious word-processing applications.

"The software I have developed," says Worcester, "solves the lowercase problem and gives the user true descenders."

The software resides in EPROM, and installation is said to require the removal of the Banana's standard EPROM, which is then replaced by Mr. Worcester's EPROM.

A limited number of Banana upgrade kits are available for evaluation on a first-come, first-served basis from Mr. Worcester. He also has upgrade kits for Axiom's GP100 series and for Tandy's TRS-80 LPVII and DMP-100 printers. For further information, contact Tim Worcester, Electronic Closet, 8187 Blakely Court W, Bainbridge Island, WA 98110.

User-Supported VT Terminal Emulator

PC-VT is a user-supported software emulator that enables the IBM PC to function as a DEC VT-52, VT-100, or VT-102 video terminal. It handles communication over an RS-232C port configured as either COM1 or COM2, and it supports common data-transmission rates and data-bit settings.

PC-VT is suitable for use with null modems for direct connection to a host computer or with a modem that does not require modem-control signals. It sends DSR and RTS.

It supports Hayes dialing commands and has a 10-entry dialing directory. Function keys 1 through 10 can be used as macro keys, and PC-VT supports both numeric and application keypad modes.

It's said to have full-featured uploading and downloading file capabilities. ASCII and XMODEM protocols are supported. The ASCII upload feature has handshaking capabilities.

A copy of the program is available by sending a formatted double-sided double-density disk to Mark C. DiVecchio, 9067 Hillery Dr., San Diego, CA 92126. A stamped, self-addressed mailer must accompany your request. A voluntary contribution is suggested. Contact Mr. DiVecchio for further information at the address above or call him at (619) 566-6810.

BYTE'S BUGS

A Few Points on a Million Points

Several readers have uncovered errors in James Hawley's "A Million-Point Graphics Tablet." (See April, page 120.)

In the caption for figure 1, IC1 through IC4 are inadvertently identified as U1 through U4.

In the parts list, a 100-microfarad capacitor is listed, yet no such device appears in the circuit diagram. Mr. Hawley informs us that this capacitor should be connected between +5 volts and ground near the 7805 voltage regulator.

Two wiring errors mar the circuit diagram. The connection between pins 2 and 10 of IC2 should go between pins 5 and 10. In addition, a connection, omitted on the diagram, should be made between IC1 pin 6 and IC2 pin 13.

Finally, on page 120 there's a reference to a photo that does not appear. We apologize for this oversight.

The following are clarifications of the discussion in the article:

The microcode in listing 1 is not a complete program, nor was it ever intended to be one. This code fragment provides access to the KoalaPad. It is all the necessary programming to obtain the *x,y* values that you need for drawing or for

(continued)

FIXES & UPDATES

cursor movements from the circuit board. If you add a Return at the end of the code, you will convert it into a subroutine that can be used in any graphics program that you devise.

The KoalaPad discussed in the article is the version that's designed to plug into the 16-pin game I/O socket of the Apple computer. The KoalaPad is produced by Koala Technologies Corp., 3100 Patrick Henry Dr., Santa Clara, CA 95050.

Address Correction

On page 370 of the April BYTE, we published an out-of-date address for Multi Solutions Inc., maker of the SI operating system. (See "Computing at Chaos Manor: Over the Moat" by Jerry Pournelle, page 355.)

The correct address for Multi Solutions Inc. is Suite 207, 123 Franklin Corner Rd., Lawrenceville, NJ 08648, (609) 896-4100.

Manufacturer Misidentified

In the April BYTE, we misidentified the manufacturer of KES. (See "The Technology of Expert Systems" by Robert H. Michaelsen, Donald Michie, and Albert Boulanger, page 303.)

On page 306, in the partial listing of domain-independent rule-based expert systems, we identified another company as the manufacturer of KES when, in fact, Software Architecture and Engineering Inc. of Arlington, Virginia, developed and markets the system.

KES, or Knowledge Engineering System, runs on an IBM PC XT and requires IQLISP, an 8087 coprocessor, and 640K bytes of RAM. The IBM PC XT version is $4000, which includes documentation. Versions of KES are also available for the VAX and other machines.

Software A&E maintains offices at Suite 800, 1500 Wilson Blvd., Arlington, VA 22209, (703) 276-7910. In the United Kingdom, address inquiries to Software Architecture and Engineering Inc., 16 New Park Rd., Chichester, West Sussex P019 1XH; tel: 0243-789310.

Bugs Warp Reply

Several typographical errors marred Charles Kluepfel's reply to Martin Kochanski's letter in the March BYTE. (See "The Real RSA Algorithm" on page 26.)

The errors began around the discussion of the subroutine coding on page 30. The text should have read:

In place of the line in listing 1 that says

```
D:QUOTIENT(2*(P - 1)*(Q - 1) + 1,3),
```

put the following coding:

```
D:NXPRIME(P + Q),
LOOP
  D: NXPRIME(D + 1),
  X0: (P - 1)*(Q - 1),
  X1: D,
  A0: 1,
  B0: 0,
  A1: 0,
  B1: 1,
  LOOP
    QU: QUOTIENT(X0,X1),
    X2: X0 - QU*X1,
    A2: A0 - QU*A1,
    B2: B0 - QU*B1,
    X0: X1,
    X1: X2,
    A0: A1,
    A1: A2,
    B0: B1,
    B1: B2,
    WHEN X1 = 1,
      E: ABS(B1), EXIT,
ENDLOOP,
WHEN E>2026, EXIT,
WHEN 2^E>N, EXIT,
ENDLOOP,
```

Benchmark Misstated

In a recent What's New write-up, we incorrectly reported the speed of Systems Management Associates' PROMAL language for the Commodore 64. (See "Structured Programming Language Released for Commodore," page 446, April.)

The benchmarks show PROMAL to be from 70 to 2000 percent faster than BASIC, COMAL, FORTH, and Pascal.

PROMAL, a high-level, structured language that's similar to C and Pascal, is available in versions for the Apple IIe and IIc and the IBM PC. The price is $49.95; a developer's package with an unlimited distribution license is $99.95. Contact Systems Management Associates, 3700 Computer Dr., POB 20025, Raleigh, NC 27619. Technical information is available by calling (919) 787-7703, or, for orders only, you can call (800) 762-7874.

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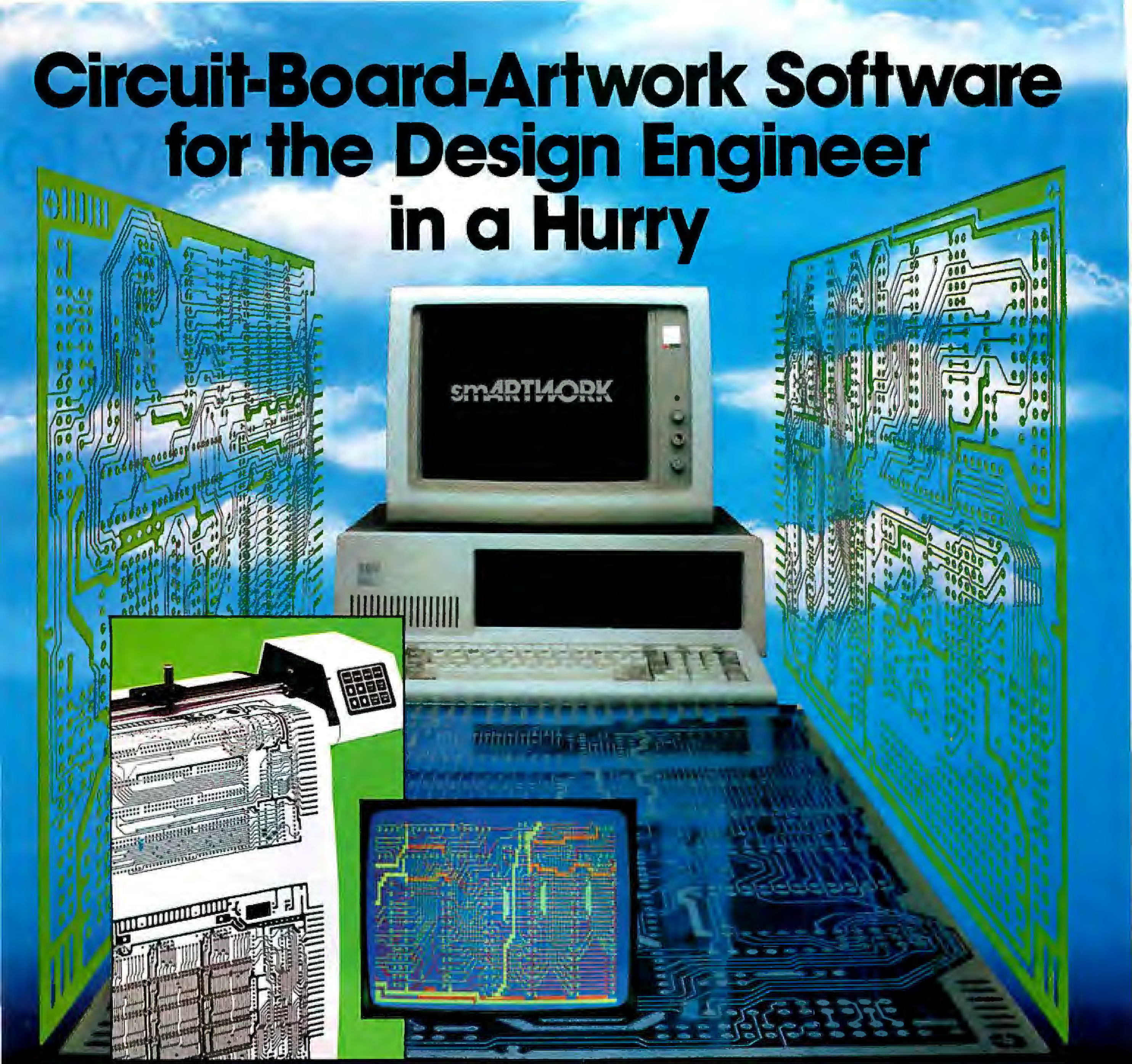

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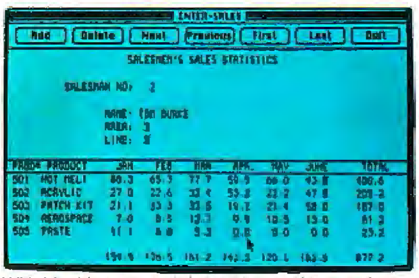

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So instead of trying to jam all your business data into one massive file, you can set up several smaller, more manageable "relations." (Picture them as a series of neat file folders.)

The advantage?

In a sales order entry system, one relation contains biographical data about your customers that doesn't change. Another has their order data that does.

There's no duplication.

So when it's time to update customer orders, you only have to enter in new data. Not re-enter what already exists. And you can develop entirely new applications for your existing database just by adding new relations.

That's the most efficient way to manage your data.

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Or, if you're a programmer at heart, you can also use MacLion's built-in procedural language and add even more specialized functions.

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Inquiry 107

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Macintosh users.

Commodore Exhibits Computer Series

Commodore International exhibited its new 900 series computer at the Hannover Fair in West Germany late in April.

The Commodore 900 series consists of a multiuser, UNIX-like system and a high-performance individual workstation. Commodore spokespeople claim that, although the 900 will sell for "well below $4000," its functionality and performance are similar to workstations costing five times more.

The individual workstation is distinguished by a 14-inch, bit-mapped monitor that has a resolution of 1024 by 800 pixels and a 72-MHz bandwidth. The video controller carries 128K bytes of RAM and will soon employ two-dimensional Bit-BLT technology, which, in short, will give you raster-like, display-screen operations from hardware. With the bit-mapped display, you can mix text and graphics windows on screen. A 17-inch monitor is available.

The multiuser version of the 900 has a monochrome, character-mapped display. Its attributes are similar to those of the IBM Personal Computer's monochrome monitor. The display format is 80 by 25.

An 8-MHz Zilog Z8000, backed by a minimum of 512K bytes of RAM and Mark Williams Company's Coherent, is at the heart of the Commodore 900. A 10-MHz version of the Z8000 is being developed, although the 8-MHz model reportedly provides the speed and performance of a 286 microprocessor running at 10 MHz.

The Commodore 900 *made its debut in Europe.*

Coherent, a multiuser, multitasking system, is fully UNIX-compatible. It is currently being optimized for further compatibility with AT&T UNIX System VII as well as for use on the Commodore 900.

Formatted storage is provided by a 20-megabyte hard-disk drive and a 1.2-megabyte, half-height floppy-disk drive. A second floppy-disk drive, a streaming-tape backup, and 40- or 67-megabyte hard-disk units are available as options.

The Commodore 900 has two RS-232C interfaces, a parallel port, and an IEEE-488 connection for a variety of peripherals and instruments. A VDI interface and a graphics kernel system are provided. An optional eight-port RS-232C board serves as the multiuser link. You can easily access four expansion slots through the back of the machine.

Mounted on the keyboard is a mouse-control pad that can also serve as a standard cursor-control unit. The keyboard itself has 99 keys as well as a separate numeric pad. A three-button mouse is standard with the individual workstation.

In addition to Coherent, the Commodore 900 comes with the new ANSI-standard BASIC and a UUC (UNIX-to-UNIX Copy) package. Pascal and COBOL are among the supported compilers.

User memory can be expanded to 2 megabytes on the main board with 256K-byte dynamic RAMS. Commodore plans color capabilities and will offer a software plotting package.

At press time, Commodore had not made a final decision on pricing for the multiuser version of the Commodore 900; however, sources at Commodore estimated that the base price will be in the $3000 range.

European shipments of the Commodore 900 should start during September. It is uncertain when deliveries in the U.S. will commence. Contact Commodore International Ltd., 1200 Wilson Dr., West Chester, PA 19380, (215) 431-9100.

Inquiry 600.

NAPLPS Board for IBM

The MGB 8024 NAPLPS/graphics board from Electronic Office Systems (Videotex) Limited of Israel is designed to replace or supplement existing IBM PC graphics adapters. It works with both the IBM PC family and its compatibles.

Its software drivers let you select from the following modes: full SRM NAPLPS decoder with 256 by 210 resolution and 16 colors from a palette of 4096; a graphics mode with resolutions of 640 by 200 or 512 by 256 using 4 colors out of the full palette; a 4-color text mode with an 80-column by 25-line display; and a Prestel decoder emulation mode.

The MGB 8024 comes with a dedicated graphics controller. Installed versions

(continued)

The QuadLaser has 256K bytes of memory for image storage.

of popular graphics applications will be available. With a manual and software, the MGB 8024 is $495. Contact Electronic Office Systems (Videotex) Ltd., POB 45266, Tel Aviv 61452, Israel; tel: (972)-3-299908; Telex: 341667 RMYM IL ATT EOS/949.
Inquiry 601.

Quadram's Laser Printer

Quadram's QuadLaser is an 8-page-per-minute laser printer. It comes with 256K bytes of memory (expandable to 2 megabytes) for storage of bit-mapped images, programs, or up to 60 standard and user-developed type fonts.

QuadLaser has ROM software to emulate Epson and Qume printers. You can download user-written software to emulate other printers or provide more advanced features using the controller's Z8001 processor. Quadram supplies 7 fonts on IBM PC disks with the QuadLaser. You can use each font in portrait or landscape modes (horizontally or vertically), and you can also create additional fonts using an editor that comes with the QuadLaser. You can get 13 more fonts from Quadram at extra cost.

The QuadLaser can print up to 10,000 pages per month, and Quadram says it will last for about 600,000 pages. In addition to standard 8½- by 11-inch paper, the QuadLaser can print on transparencies and European-size paper. Its paper cassette stores 250 sheets. You replace toner cartridges and the print belt separately—Quadram claims that this reduces the printer's operating cost. The QuadLaser weighs 85 pounds and measures 14½ by 20⁹⁄₁₀ by 23⅕ inches with the paper cassette and tray installed.

The QuadLaser will be available this month for under $3400. Contact Quadram Corp., 4355 International Blvd., Norcross, GA 30093, (404) 923-6666.
Inquiry 602.

Victor PCs Are Compatible with IBM

Victor Technologies' VPC and VI are compatible with the IBM Personal Computer. Built around Intel's 8088 processor, these computers come with a minimum of 256K bytes of RAM and VBASICA, a Victor-enhanced version of BASICA. The operating system is MS-DOS 2.1, and an upgrade to MS-DOS 3.0 is planned.

Both systems employ Victor-VU, an on-screen guide that translates DOS functions into easy-to-use instructions. This interface gives you single-keystroke help screens, an on-screen application guide, keyboard programmability, and pop-up windows.

Victor offers three models of the VPC. One features twin 360K-byte floppy-disk drives; the others have a single floppy disk and either 15 or 30 megabytes of hard-disk storage.

Seven expansion slots let you add features to the VPC as your needs evolve. Its standard parallel port gives you links with many printers or plotters. High-resolution monochrome or full-color display screens are available, and the 83-key keyboard has 10 function keys and capital- and number-lock LEDs.

VPC pricing begins at $2485, which includes a 14-inch monitor. The 30-megabyte version is $4785.

The Victor VI is offered with a choice of storage arrangements: dual 1.2-megabyte floppy-disk drives or a single floppy-disk unit with either a 10-, 20-, or 30-megabyte hard disk. The VI keyboard, which can be programmed for dual Victor and IBM functionality, has 16 function keys, a numeric keypad, and cursor controls.

In the Victor mode, the nonglare 12- or 14-inch monitor provides high-resolution, 800- by 400-pixel, bit-mapped images. The format is 80 by 25 with a 10- by 16-dot character cell. The display supports IBM PC screen attributes in the IBM mode. Other display features include color emulation with shading and dot pattern supporting 320- and 640- by 200-dot graphics modes and 40- and 80-column PC text modes.

The VI has two independent, full-duplex RS-232C ports and single 36-pin Centronics and 50-pin user-programmable ports. The Centronics port supports IEEE-488 in the Victor mode. Three slots are available for expansion, and you can expand RAM to 1.98 megabytes.

IBM PC programs can be stored on Victor-formatted disks and vice versa. Victor 9000 MS-DOS programs are supported.

The VI with two floppy-disk drives begins at $4295. Contact Victor Technologies Inc., 380 El Pueblo Rd., Scotts Valley, CA 95066, (408) 438-6680.
Inquiry 603.

BDS Laser Printer

BDS Corporation has introduced the BDS Laser 630/8. Like the Hewlett-Packard LaserJet, the 630/8 is based on Canon's LBP-CX print engine and uses the same replaceable toner/belt cartridge.

The BDS printer comes with nine type fonts: two fonts each in normal, italic, bold, and bold italic, and one font in "landscape mode." Using optional ROM or RAM cartridges, you can download type fonts from a microcomputer. A Diablo

(continued)

MOST SIGNIFICANT PRODUCT OF THE YEAR - PC WEEK

They said it couldn't be done. Borland Did It. Turbo Pascal 3.0

The industry standard

With more than 250,000 users worldwide Turbo Pascal is the industry's de facto standard. Turbo Pascal is praised by more engineers, hobbyists, students and professional programmers than any other development environment in the history of microcomputing. And yet, Turbo Pascal is simple and fun to use!

	TURBO 3.0	TURBO 2.0	MS PASCAL
COMPILATION SPEED	8.1	16	206
EXECUTION SPEED	9SEC	13SEC	20SEC
CODE SIZE	12 K	12 K	35 K
BUILT-IN INTERACTIVE EDITOR	YES	YES	NO
ONE STEP COMPILE (NO LINKING NECESSARY)	YES	YES	NO
COMPILER SIZE	39K	35K	300K+
TURTLE GRAPHICS	YES	NO	NO
BCD OPTION	YES	NO	YES
PRICE	$69.95	$54.95	$295.00

(*) **Benchmark** run on an IBM PC using MS Pascal version 3.2 and the DOS linker version 2.6. The 179 line program used is the "Gauss-Seidel" program out of Alan R. Miller's book: *Pascal programs for scientists and engineers* (Sybex, page 128) with a 3 dimensional non-singular matrix and a relaxation coefficient of 1.0.

The best just got better: Introducing Turbo Pascal 3.0

We just added a whole range of exciting new features to Turbo Pascal:

- First, the world's fastest Pascal compiler just got faster. Turbo Pascal 3.0 (16 bit version) compiles twice as fast as Turbo Pascal 2.0! No kidding.
- Then, we totally rewrote the file I/O system, and we also now support I/O redirection.
- For the IBM PC versions, we've even added "turtle graphics" and full tree directory support.
- For all 16 Bit versions, we now offer two additional options: 8087 math coprocessor support for intensive calculations and Binary Coded Decimals (BCD) for business applications.
- And much much more.

The Critics' Choice.

Jeff Duntemann, PC Magazine: *"Language deal of the century . . . Turbo Pascal: It introduces a new programming environment and runs like magic."*

Dave Garland, Popular Computing: *"Most Pascal compilers barely fit on a disk, but Turbo Pascal packs an editor, compiler, linker, and run-time library into just 39K bytes of random-access memory."*

Jerry Pournelle, BYTE: *"What I think the computer industry is headed for: well documented, standard, plenty of good features, and a reasonable price."*

Portability.

Turbo Pascal is available today for most computers running PC DOS, MS DOS, CP/M 80 or CP/M 86. A XENIX version of Turbo Pascal will soon be announced, and before the end of the year, Turbo Pascal will be running on most 68000 based microcomputers.

An Offer You Can't Refuse.

Until June 1st, 1985, you can get Turbo Pascal 3.0 for only $69.95. Turbo Pascal 3.0, equipped with either the BCD or 8087 options, is available for an additional $39.95 or Turbo Pascal 3.0 with both options for only $124.95. As a matter of fact, if you own a 16-Bit computer and are serious about programming, you might as well get both options right away and save almost $25.

Update policy.

As always, our first commitment is to our customers. You built Borland and we will always honor your support.

So, to make your upgrade to the exciting new version of Turbo Pascal 3.0 easy, we will accept your original Turbo Pascal *disk* (in a bend-proof container) for a trade-in credit of $39.95 and your Turbo87 original *disk* for $59.95. This trade-in credit may only be applied toward the purchase of Turbo Pascal 3.0 and its additional BCD and 8087 options (trade-in offer is only valid directly through Borland and until June 1st, 1985).

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15

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Inquiry 55 for End-Users. Inquiry 56 for DEALERS ONLY.

630 emulation mode is provided for offices already using a daisy-wheel printer. The BDS 630/8 can print text at a resolution of 300 by 300 dots per inch.

The printer provides a "screen dump" image from an IBM PC and can enlarge text and screen images from two to eight times. It has two Z80 processors and 64K bytes of local memory to store font information and to buffer up to about five pages of text. Parallel and serial ports let you link the printer to two computers.

The BDS 630/8 laser printer sells for $3495. For more information, contact BDS Corp., 800 Maude Ave., Mountain View, CA 94043, (415) 964-2115.
Inquiry 604.

XTRA XP: An 80286-Based PC

ITT's XTRA XP is compatible with the IBM PC XT but executes programs faster because it uses Intel's 6-MHz 80286 microprocessor. According to ITT, the XTRA XP also features "no-wait-state" RAM, letting it access memory information more quickly than comparable IBM computers. This includes the PC AT, which uses the same processor.

The XTRA XP has 512K bytes of memory (expandable on the main circuit board to 640K bytes), serial and parallel ports, ROM diagnostics software, one 360K-byte 5¼-inch floppy-disk drive, and a 10- or 20-megabyte hard-disk drive. Of the system's five IBM PC XT-compatible expansion slots, one is for the hard-disk controller and another for an optional graphics-display adapter.

You can get an optional

The XTRA XP *has "no-wait-state"* RAM.

card with 1 megabyte of additional "no-wait-state" RAM for use as a virtual disk. Other options include an 80287 numeric coprocessor and the MS-DOS 2.11 operating system.

The ITT XTRA XP with a 10-megabyte hard disk will carry a suggested list price of $3995. With a 20-megabyte drive, the price is $4595. Monochrome or color graphics adapters are $145 and $190, respectively. The 1-megabyte RAM-disk expansion card with 512K bytes of memory on board will sell for $395. Contact ITT Information Systems, 2041 Lundy Ave., San Jose, CA 95131, (408) 945-8950.
Inquiry 605.

AT&T Links MS-DOS and UNIX Micros, Offers PC 6300 Enhancements

AT&T has introduced a local-area network and a number of enhancements for its PC 6300 microcomputer.

STARLAN, slated for release at year's end, links up to 200 computers in a star or ring configuration or a combination of both. Adapter boards tailor the network for computers with IBM PC-compatible expansion slots and for AT&T's UNIX-based systems.

STARLAN uses twisted-pair cabling and can take advantage of existing telephone wiring. The maximum data-transfer rate is 1 megabit per second. Network boards are about $600, and the network software is $125 per machine.

AT&T's PC 6300 Display Enhancement Board lets you display 16 colors at a resolution of 640 by 400 pixels on a standard IBM PC-compatible RGB monitor. On a monochrome monitor, the 6300 can produce 16 shades of gray at this resolution. Color mapping for rapid color changes is supported.

The Mouse 6300 attaches directly to the PC 6300's keyboard and comes with software that allows its use with many programs that were not designed for mice. It comes with a simple word processor and graphics. The suggested price is $150.

A version of XENIX, adapted for AT&T by the Santa Cruz Operation, is available for the PC 6300. This version of XENIX supports two users, allows file transfers between it and MS-DOS, and provides file and record locking. It's divided into three modules: the basic operating system ($395), a software-development package ($450), and a text-processing package ($150).

The AT&T Communications Manager board for the PC 6300 and the IBM PC comes with a 1200-bps modem, three phone jacks, and communications software. It lets you auto-dial up to 200 numbers and, if connected to two telephone lines, can handle simultaneous voice and data connections. The software lets you switch from communications to any other PC application instantaneously. The modem is not Hayes-compatible, but VT-100 terminal-emulation software is provided. It lists for $599.

Other enhancements for the AT&T PC 6300 include a 20-megabyte hard-disk drive and an 8-MHz 8087-2 numeric coprocessor. The coprocessor is $295; the hard disk's pricing was not available at press time. Contact AT&T Information Systems, 100 Southgate Parkway, Morristown, NJ 07960.
Inquiry 606.

GEM Applications

GEM Desktop and GEM Draw are Digital Research's first end-user applications designed exclusively for its Graphics Environment Manager (GEM) operating-system extension. In a related announcement,

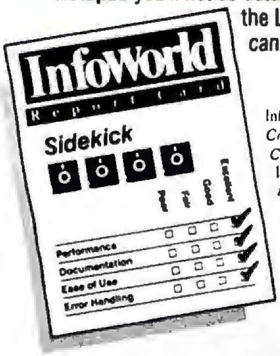
(continued)

Borland's SideKick Software Product of the Year*

SideKick is InfoWorld Software Product of the Year. It won over Symphony. Over Framework. Over ALL the programs advertised in this magazine. Including, of course, all the "fly-by-night" SideKick imitations. SideKick . . . . Simply the best.

Here's **SideKick** running over Lotus 1-2-3. In the SideKick **Notepad** you'll notice data that's been imported directly from the Lotus screen. In the upper right you can see the **SideKick Calculator**.

All the **SideKick** windows stacked up over Lotus 1-2-3. From bottom to top: SideKick's **"Menu Window"**, **ASCII table**, **Notepad**, **Calculator**, **Appointment Scheduler/Calendar**, and **Phone Dialer**. Whether you're running WordStar, Lotus, dBase, or any other program, SideKick puts all these desktop accessories instantly at your fingertips.



InfoWorld *Report Card* 1984 *by Popular Computing, Inc., a subsidiary of CW Communications Inc. Reprinted from* InfoWorld. *1060 Marsh Road, Menlo Park, CA 94025.*

Jerry Pournelle, BYTE: *"If you use a PC, get SideKick. You'll soon become dependent on it."*

Garry Ray, PC Week: *"SideKick deserves a place in every PC."*

Charles Petzold, PC Magazine: *"In a simple, beautiful implementation of WordStar's block copy commands, SideKick can transport all or any part of the display screen (even an area overlaid by the notepad display) to the notepad."*

Dan Robinson, InfoWorld: *"SideKick is a time-saving, frustration-saving bargain . . . ."*

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*Selected by *InfoWorld* as the most significant software product of the year.

Inquiry 57 for End-Users. Inquiry 58 for DEALERS ONLY.

Digital Research introduced GEM Paint and GEM Write, a pair of programs that will be bundled with GEM Desktop in a package called the GEM Collection.

GEM applications feature drop-down menus, windows, and icons. They run on the IBM PC and its compatibles.

GEM Desktop replaces operating-system commands with a visual interface. It produces a graphics representation of desktop functions, including floppy disks, a wastepaper basket, and file folders. You use your mouse or a few keystrokes to open files, run programs, and execute other operating-system commands. As many as six Desktop accessories, such as a clock or a calculator, can run with other GEM applications.

GEM Draw is a graphics editor that produces organizational charts, flow charts, logos, and a variety of pictures. It comes with a library of predesigned graphics that you can integrate into your work. You can also use it to edit and augment graphics and charts produced with GEM applications.

The GEM Collection is made up of GEM Desktop, GEM Paint, and GEM Write. GEM Paint is a graphics-design tool, while GEM Write, said to be a full-function word processor, lets you merge graphics from other GEM applications with written reports.

The GEM Collection is due to be released this month for $199. GEM Desktop is $49.95. Until August 31, GEM Draw will be priced at $149; after that it's $249. Contact Digital Research Inc., POB DRI, Monterey, CA 93942, (800) 443-4200; in California, (408) 649-3896.
Inquiry 607.

Ericsson's Portable PC has a plasma display.

Portable Has Plasma Display

Ericsson says that its Portable PC's plasma display lets you view on-screen information from any angle no matter what amount of ambient light is present. This claim is based on the fact that plasma-display technology generates its own light rather than reflecting light as liquid-crystal technology does. The display resolution is 640 by 400 pixels, and its format is 80 columns by 25 lines, comparable to an 11-inch CRT screen.

A 360K-byte, half-height, floppy-disk drive is built into the Portable PC, as are ports for serial and parallel interfaces. It comes with 256K bytes of RAM and a detachable keyboard. The Intel 8088 serves as the central processor, and the Portable PC operates on either 110- or 220-volt currents. It measures 12⅕ by 15⅗ by 4½ inches and weighs 15 pounds.

User memory can be expanded by 256K bytes, and a 512K-byte solid-state disk will further increase storage capacity. You can install a 40-character-per-second thermal ribbon-transfer printer with graphics capabilities; it adds 2 pounds to the overall system weight.

An expansion box designed to accommodate add-in boards marketed for the IBM Personal Computer is another option. An internal 300/1200-bps modem will soon be available. With keyboard and plasma display, the basic Ericsson Portable PC is $2995. Contact Ericsson Inc., Greenwich Office Park 1, POB 2522, Greenwich, CT 06836-2522.
Inquiry 608.

HP Touchscreen II

Hewlett-Packard's Touchscreen II Personal Computer is compatible with existing Touchscreen products and comes with a variety of storage and communications options designed to address a range of needs.

The Touchscreen II has a 12-inch display screen and four accessory slots that offer a wider choice of memory and communications cards than its predecessor's 9-inch screen and two expansion slots. The display format is 80 by 27. HP 2623 terminal emulation is built in, and VT-100 and IBM 3276/3278 emulation are optional.

An 8-MHz 8088 serves as the Touchscreen II's central processor. Standard hardware includes 256K bytes of RAM expandable to 640K bytes, 160K bytes of ROM, an HP-HIL interface, one RS-232C port, and one port that can be configured for either RS-232C or RS-422.

The Personal Applications Manager (PAM), a shell over the MS-DOS 2.11 operating system, simplifies use by eliminating the need to memorize system or program commands. Eight on-screen command keys also simplify operation.

You can add networking and communications to the Touchscreen II. An extended I/O accessory provides for communications between the Touchscreen II and the HP Portable and offers a Centronics-type parallel interface. Some other options are a touchscreen, mouse, and graphics tablet.

A Touchscreen II with two 710K-byte floppy-disk drives is $3545. A 10-megabyte system with a single floppy drive is $4770. With one floppy and a 20-megabyte Winchester, it's $5570. All floppy-disk drives are 3½-inch microfloppies. The touchscreen interface is $300. Contact your local Hewlett-Packard dealer.
Inquiry 609.

(continued on page 470)

Speed, Power, Price.
Borland's Turbo Pascal Family.

$69.95

The industry standard. With more than 250,000 users worldwide Turbo Pascal is the industry's de facto standard. Turbo Pascal is praised by more engineers, hobbyists, students and professional programmers than any other development environment in the history of microcomputing. And yet, Turbo Pascal is simple and fun to use!

Jeff Duntemann, PC Magazine: *"Language deal of the century . . . Turbo Pascal: It introduces a new programming environment and runs like magic."*

Dave Garland, Popular Computing: *"Most Pascal compilers barely fit on a disk, but Turbo Pascal packs an editor, compiler, linker, and run-time library into just 29K bytes of random-access memory."*

Jerry Pournelle, BYTE: *"What I think the computer industry is headed for: well documented, standard, plenty of good features, and a reasonable price."*

Portability. Turbo Pascal is available today for most computers running PC DOS, MS DOS, CP/M 80 or CP/M 86. A XENIX verison of Turbo Pascal will soon be announced, and before the end of the year, Turbo Pascal will be running on most 68000 based microcomputers.

High resolution monochrome graphics for the IBM PC and the Zenith 100 computers

$54.95 **NEW**

Dazzling graphics and painless windows. The Turbo Graphix Toolbox will give even a beginning programmer the expert's edge. It's a complete library of Pascal procedures that include:

—Full graphics window management.
—Tools that will allow you to draw and hatch pie charts, bar charts, circles, rectangles and a full range of geometric shapes.
—Procedures that will save and restore graphic images to and from disk.
—Functions that will allow you to precisely plot curves.
—Tools that will allow you to create animation or solve those difficult curve fitting problems.
and much, much more . . . . .

No sweat and no royalties. You may incorporate part, or all of these tools in your programs, and yet, we won't charge you any royalties. Best of all, these functions and procedures come complete with commented source code on disk ready to compile!

Searching and sorting made simple

$54.95

The perfect complement to Turbo Pascal. It contains: ***Turbo-Access***, a powerful implementation of the state-of-the-art B+tree ISAM technique; ***Turbo-Sort***, a super efficient implementation of the fastest data sorting algorithm, "Quicksort on disk". And much more.

Jerry Pournelle, BYTE: "The tools include a B+tree search and a sorting system; I've seen stuff like this, but not as well thought out, sell for hundreds of dollars."

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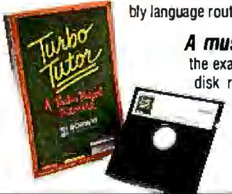

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SPEED UP A MICRO

Dear Steve,

I hope I am not asking for the moon, but how does one speed up a microprocessor? Will doing that cause problems in the operation of the computer?

A. C. POSADA
Charlottesville, VA

Microprocessor instructions require a specific number of cycles to execute. These cycles are timed by a system clock, and the speed of the computer is a direct function of the clock frequency. Increasing the frequency of the system clock, simply by changing a crystal or divider circuit, will increase the overall execution speed, but there are some limitations.

The microprocessor chip itself has a speed limitation, so when the clock frequency is increased, often a higher-speed version must be used. This is usually what the letter at the end of the chip number signifies.

The memory chips are also affected by speed and must be replaced with faster versions. Otherwise, additional wait states, which reduce some of the benefits of the increased speed, will be needed. Some of the peripheral driver chips may become speed-limited, also reducing the overall throughput.—Steve

65816 ATARI?

Dear Steve,

I have been considering upgrading my Atari 800 by installing a 65816 chip in place of the 6502. According to the advertisements, the chip is software- and hardware-compatible with any machine using a 6502. The lure of a 16-bit processor able to directly address 16 megabytes is hard to resist, but I am worried.

If the chip from Western Design Center is all that it is claimed to be, why isn't everybody installing it instantly?

JAMES E. RAINEY
Coos Bay, OR

The new 65816 microprocessor chip has a 6502 emulation mode. In this mode, it is pin- and software-compatible with the 8-bit 6502 that is used in your Atari 800.

When used to its full capability, addressing 16 megabytes requires a 24-bit address bus. The 65816 handles the extra 8 address bits by multiplexing them with the data bus. On one half of a clock cycle, the pins are used for address lines; on the other half cycle, for data lines. This multiplexing requires additional circuitry, which is not readily adaptable to your Atari. This is why it has not become widely used.

A complete description of this new chip can be found in the August and September 1984 issues of BYTE in a two-part article by Steven P. Hendrix, "The 65816 Microprocessor."—Steve

HALF-INCH TAPE BACKUP

Dear Steve,

I've been frustrated for a long time because most microcomputer manufacturers don't offer ½-inch tape drives as an optional accessory. The only one I know of that does is Wicat.

Most of them offer ¼-inch streamer tape for backing up hard disks, but ½-inch tape would seem to be an ideal bridge over a wide gap between many mainframe systems and micros. For instance, my firm, a nonprofit organization, maintains a large mailing list with a data-processing service. I've spoken to the people there, and they have neither floppy-disk nor modem capabilities. The only way they can communicate is via ½-inch tape. I have gone the route of transferring from tape to floppy disk, but that is cumbersome and expensive (not in principle, but in practice); few firms offer this service, at least in this area. We could save a lot of money (in keyboarding time and errors) if we could write ½-inch tapes.

I've resisted purchasing the ¼-inch streamer-tape unit that Molecular, the manufacturer of one of our computers, offers because a ½-inch tape drive would allow me to easily back up my hard disk *and* communicate with the big fellows, assuming enough compatibility were built in. I assume the larger tape drive would cost two or three times as much as the smaller ones do, but it would be worth it to gain both the larger capacity and ability to communicate.

Do you know of anyone offering a solution to this problem or planning to address it? Would a controller have to be built for each type of micro, or could something be set up to run from a serial port?

STEVE GOLDFIELD
San Francisco, CA

Overland Data Inc. sells a 9-track tape controller for the IBM PC. It is capable of reading and writing industry-standard ½-inch tape and is compatible with most 9-track formatted tape drives. It operates with tape-drive speeds up to 120 inches per second and allows data transfer at rates up to 192,000 bytes per second. It sells for $880 and can be purchased from Overland Data Inc., Suite A, 5644 Kearny Mesa Rd., San Diego, CA 92111, (619) 571-5555.—Steve

TALL ORDER

Dear Steve,

I make my living writing software, and my only exposure to hardware has been through building several Heathkits. I would like to build a computer system from board level, since it would enable me to create a system to suit my needs. Also, it would probably be cheaper than purchasing a Heath H-100, for example. Just about all I know hardware-wise is the difference between an S-100 bus and a DB-25 connector—I could not tell you the difference between a switching and nonswitching power supply.

How hard is it to get an operating system/software for a machine that I put together myself? What are other major advantages and disadvantages that I should be aware of? Can you recommend some books that can get me up to speed with hardware?

JEFFREY SHULMAN
Highland Park, NJ

Building your own computer from scratch is quite different from assembling Heathkits. If you want to get some idea of the scope of the job of designing and building a computer with capabilities on the order of the H-100, read my articles on the MPX-16 in the November and December 1982 and January 1983 issues

(continued)

of BYTE. You could build that yourself and save some money, but I recommend that you buy the circuit board. Wire-wrapping a project such as this is not *recommended.*

If you want to start with something more modest to learn something about microcomputers, you could build The Little Board from Digital Research Computers (POB 461565, Garland, TX 75046) or any of the other small computer systems advertised in the back pages of BYTE.

A practical, though not the least expensive, way to build a computer to meet your requirements is to assemble an S-100 system using commercially available boards. You can build your own special-purpose cards using the S-100 prototyping boards, and many of the common functions like serial I/O, video, and printer-interface boards are available in kit form. The book Interfacing to S-100 IEEE 696 Microcomputers *by Sol Libes and Mark Garetz (Osborne/McGraw-Hill) gives good information on interfacing to things such as memory and I/O for the S-100, and in a general way for most computers.*

Operating systems like Digital Research's CP/M and Microsoft's MS-DOS are readily available, either directly from the manufacturer or from computer stores and advertisers in BYTE.—Steve

STICKY KEYS

Dear Steve,

I would appreciate any advice you might give on remedies for sticking keys. I have found them to be a minor but distracting problem on my TI Professional computer, and, after consulting with friends who use other micros, I think the problem is fairly widespread. Is it possible to apply a dry lubricant or a Teflon spray on key mechanisms without interfering with electronic circuitry?

A second question has to do with cleaning the magnetic heads of floppy-disk drives. There seems to be no consensus about the use or the frequency of use of cleaning kits. Can you offer an opinion?

RICHARD S. MOORE
Huntsville, AL

Sticking keys can be a real nuisance, and a spray lubricant may or may not be effective. One of the main causes of the sticking or binding is an interference between the key plunger (the stem under the key top) and the switch housing. Often, the clearance between these parts is very small to preclude dust and dirt from entering, but some dirt particles can cause binding. In this instance, a control cleaner (available at most electronic supply stores) or some alcohol may successfully flush away these particles.

Swelling of the plastic is another cause, but lubricants have little effect since they are quickly scraped away. A Teflon spray or control cleaner can be tried, but replacement of the switch is often the final solution.

Disk-drive cleaning kits should be used as required and not as regular maintenance. These kits are abrasive and will, over a period of time, damage the read/write head of the drive. The in-out motion of the head on the rotating disk provides a self-cleaning action for most contaminants. Frequency of use will depend mainly on the quality of the disk medium. Some brands seem to have more loose oxide than others. As a general rule, use a disk-cleaning kit when an occasional read error is noted.—Steve

BIGGER BUFFER

Dear Steve,

I own a Dynax DX-15 printer with a built-in 3K-byte buffer that is expandable to 5K bytes. This additional 2K bytes hardly seems worth fooling with. Is there any way this internal buffer can be expanded to something more worthwhile, such as 16K bytes or more, without radical surgery? It seems to me that since the buffer is already present, it shouldn't be too complicated to expand it to 64K bytes. Yes or no?

Thank you for any suggestions you have that might make my Dynax more useful or save it from needless slaughter.

GERRY L. TURNER
Quincy, IL

I have no circuit data for the Dynax printer, so I am unable to determine if it is possible to expand the buffer beyond the 5K bytes that Dynax provides. It is a function of the address decoding that is utilized. Since the control-program and character-generator ROMs require a substantial amount of the controller's address space, it is doubtful that 64K bytes of memory can be obtained. Even if compatible memory chips of higher capacity could be used, decoding limits may cause the controller to ignore anything over the 5K-byte limit.

If you need more buffer space, consider one of the external buffers (spoolers) like the Microfazer from Quadram Corp. or the Spool/64 or Spool/64SP from Apparat Inc. These pro-

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ASK BYTE

vide 64K bytes or more and features like multiple copies and the ability to cancel printing. Such buffers are available to match almost any printer/computer combination for around $150 and up, depending on memory size and features.
— Steve

PRINTER TROUBLE

Dear Steve,

We are having trouble printing graphics with our Toshiba P1350 dot-matrix printer, which is hosted by a Zenith Z-100 Model ZW-110-32 desktop computer. The printer has graphics characters and dot-image graphics printing capability. However, it does not respond to any Printgraph commands or any Escape sequence printer setup commands while using Lotus 1-2-3. In Z-BASIC the printer accepts a few Escape sequence commands but not those that enable the graphics mode. We'd appreciate any help you can provide.

DOMINIC AU
Calgary, Alberta, Canada

If the inability to get your Toshiba P1350 to print graphics were limited to Lotus 1-2-3, I would suspect that the printer driver was not properly installed in the program. Since it doesn't work in BASIC either, it appears that you have a printer problem. The graphics option may be defective or missing, or there may be a bad or incorrectly wired cable. The latter is not too likely since you don't mention any other problems. Toshiba says you need the PaperScreen and the color/graphics adapter to print graphics with Lotus 1-2-3 on the IBM PC, so maybe you are encountering a minor incompatibility with the Zenith graphics board.

There are two other possibilities. If you are using a serial interface, the protocol must be set for 8-bit data to use graphics. Also, check your manual to see if there are any switch settings that could be disabling the graphics. If none of these suggestions help, the printer is either not working properly or does not have the correct options installed. Take it to your dealer or a Toshiba service center for diagnosis.—Steve

INTERCABIN TELEPHONES

Dear Steve,

I am part owner of a summer resort with 11 cabins. The main cabin has the only telephone line out of camp, and the other cabins have no communication lines. I would like to build a telephone system for

(continued)

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AZTEC C68K-c requires a 128K Macintosh, and two disk drives (frugal developers can make do with one drive). AZTEC C68K supports the 512K Macintosh and hard disks.

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—Steve ■

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(616) 739-3395

Alternate Computer Supply
6034 East Street
Twin Lake, MI 49457
(616) 458-7649

Personalized Computers
12350 Natural Bridge
Hazelwood, MO 63044
(314) 739-0263

Mid West Computing
201 North Pine
Rolla, MO 65401
(314) 364-1998

The Computerworks
121 West Mission
Bellvue, NB 68005
(402) 291-7804

Computer Ark
1921 New Road
Northfield, NJ 08225
(609) 641-4300

Bayonne Computer Center
618 Broadway
Bayonne, NJ 07002
(201) 436-8555

Computerland
2076 E. Route 70
Cherry Hill, NJ 08003
(609) 424-8100

AFC Electronics
Salem Industrial Park Rt. 22
LeBannon, NJ 08833
(201) 534-6343

Round Valley Computer
Box 448 US HWY, 22 East
LeBannon, NJ 08833
(201) 236-9575

Computer Discount of New Jersey
280-B Hwy. 17
Mahwah, NJ 07430
(201) 529-4026

Medford Computer Center
Route 7 Hartford Road
Medford, NJ 08055
(609) 953-0823

Family Computer Centres
154 Valley Street South
Orange, NJ 07079
(201) 762-6661

Family Computer Centers
154 Valley Street
South Orange, NJ 07079
(201) 762-6661

Computer Pro's Inc.
West Belt Mall
Wayne, NJ 07470
(201) 256-7070

Computer Discount of America
31 Marshall Hill Road
W. Milford, NJ 07480
In NJ - (201) 728-8082
Out NJ - (800) 526-5313

Sandia Micro Systems
812 Charleston N.E.
Albuquerque, NM 87110
(505) 266-7410

47th Street Photo
115 W. 45th Street
New York, NY 10036
(212) 260-4410

Tec Computer Products Inc.
56 West 45th Street
New York, NY 10036
(212) 944-1166

Byte General Dist.
3 Siierks Lane
Roslyn Harbor, NY 11576
(516) 625-3020

Upstate Computer Shop
99 Commercial Drive
Whitesboro, NY 13692
(315) 768-8151

Computer Store of Laurenburg
1023 South Main
Laurenburg, NC 28352
(919) 276-4424

Audio Buys
1700 Glenwood Ave
Raleigh, NC 27608
(919)821-1776

Computer Utility Corp.
808 East Main
Ada, OK 74820
(405) 332-4858

Dowling Inc.
3017 N. Stiles Ave
Oaklahoma City, OK 73105
(405) 528-2933

Conroy LaPointe
12060 Southwest Garden Place
Tigard, OR 97223
(800) 547-1289

Edu-Care Micro Computer
The Learning Source
Hills Shopping Plaza
Camp Hill, PA 17011
(717) 761-7487

East Coast Software
49 Derrytown Mall
Hershey, PA 17033
(717) 533-8125

Software Hut
2534 South Broad Street
Philadelphia, PA 19145
(215) 462-2268

Opus II
747 Brook Haven Circle
Memphis, TN 38117
(901) 683-0117

Inacomp Computer Center
330 Franklin Road
Brentwood, TN 37027
(615) 373-5667

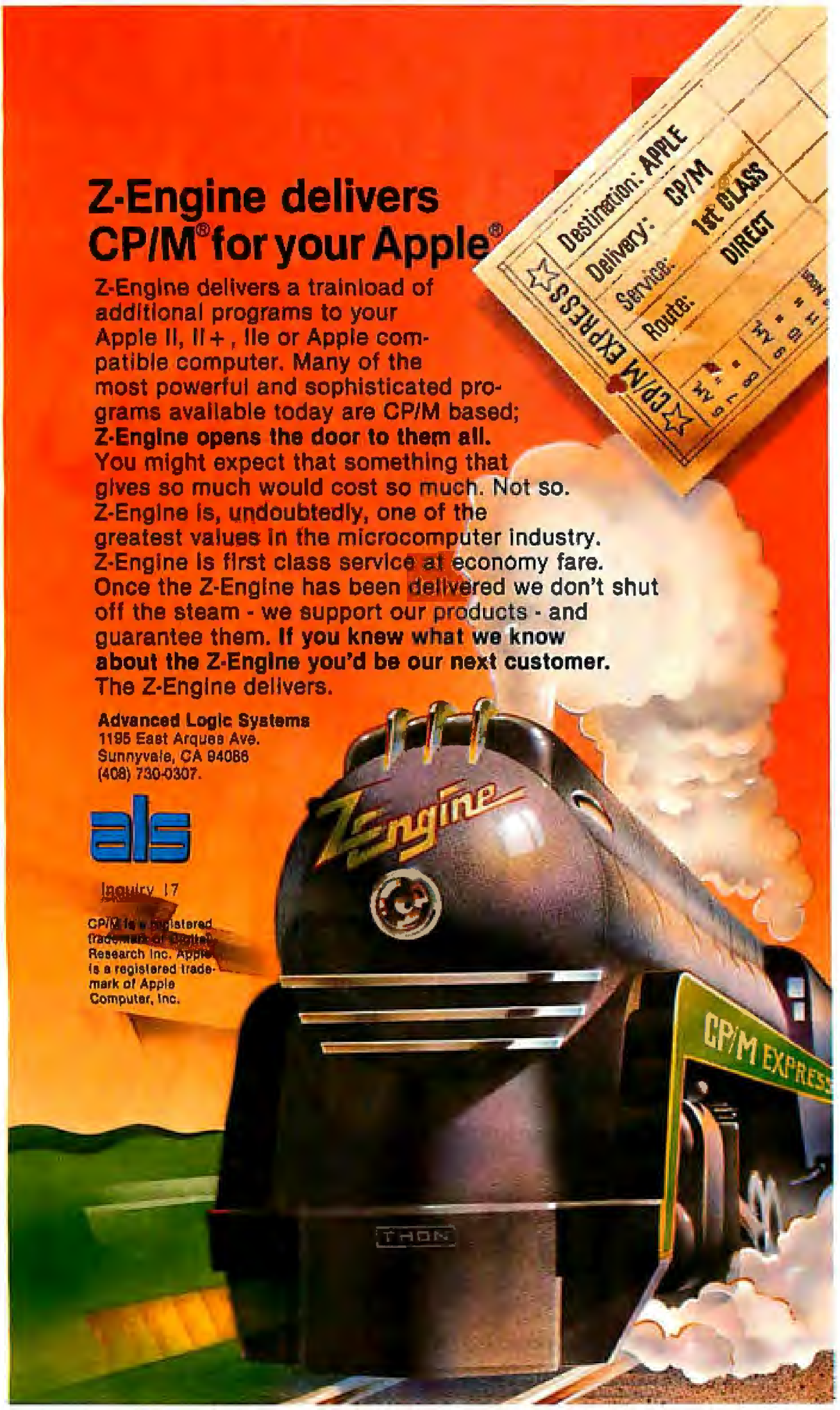
Software Centre
5545 Richmond Avenue
Houston, TX 77056
(713) 783-9857

Computer Office
22025 61st Ave SE
Bothell, WA 98021
(206) 481-2600

A.P.P.L.E
290 S.W. 43rd Street
Renton, WA 98055
Orders - (800) 426-3867
Info - (206) 251-5222

Computer Horizons Inc.
West Virginia
Morgantown, Wheeling, Beckley
(304) 594-1855
(304) 233-2484
(304) 255-7474

Oryx Systems
425 First Street
Wausau, WI 54401
(715) 848-1374



Dealer inquiries are invited — please contact one of the following distributors. If a distributor or dealer is not in your area please contact us directly.

The Computer Connection
17121 S. Central Ave.
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Carson, CA 90746
(213) 514-9019

Softeam
900 West Walnut Street
Compton, CA 90220
(800) 847-6383

Softsel Computer Products
546 Oak
Englewood, CA 90312-6080
(800) 847-6383

Caltek Components
4079 Glen Coe Ave
Marina Del Rey, CA 90292
(213) 827-1851

First Software
17-21 Ballard Way
Lawrence, MA 01843
(617) 689-0077
(800) 343-1290

PC Micro Dealers Co-op
12216 Marc Lane
Glen Arms, MD 21057
(301) 592-5110

Jersey Micro Systems
1200 B Haddonfield Road
Cherry Hill, NJ 08002
(609) 665-7611

Specialists Financial Planning
160 Washington South East
Alb. New Mexico, 87108
(505) 265-8308

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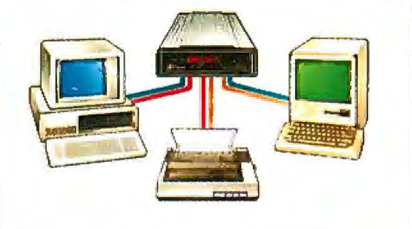
Introducing The Single Solution To Many Problems That Can Tie Up Your Personal Computer.

Transet 1000™ The print buffer, communications buffer, port expander, printer sharer and I/O switcher. All in one.

Anyone with a personal computer and one or more peripherals has faced the all-too-familiar dilemma. You need your computer to do an important job. But you're forced to wait for the system to finish one job (printing, communicating, whatever) before you can go on to the next one. Or you need to stop what you're doing to switch cables when you want to use another peripheral.

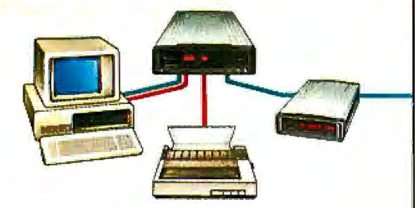
Wait no more. Now Hayes introduces an innovative new device that lets you perform many jobs—at the same time—independent of your computer. Transet 1000. It works with a wide range of systems and configurations. And it allows you to continually expand your system as your needs grow.

Transet 1000 frees your computer from waiting on your printer or modem—so you and your computer can go on to another task. It even lets you print out documents in pre-set formats without having to go back into your computer. At the same time, Transet 1000 can operate unattended mailbox communications—24 hours a day—even if your computer is turned off.



Two computers can share one printer with Transet 1000. Or, you can use Transet 1000 to let two computers communicate with each other.

In addition, Transet 1000 is a port expander and software-controlled I/O switcher. Now files can be easily directed and redirected to different peripherals, without physically changing cable connections.

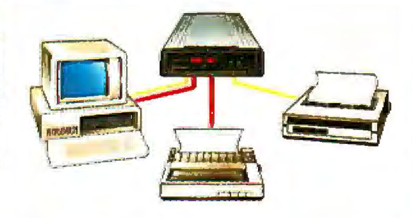


Even while printing, Transet 1000 acts as a communications buffer and 24-hour mailbox. And I/O switching lets you route information among peripherals, without switching cables.

Transet 1000 contains a stand-alone microprocessor, and comes with 128K of memory. It operates with any RS-232 interface computer, and has optional accessory kits available for the IBM® PC and PC XT, Macintosh™ and Apple® IIc. Kits contain the necessary host cable, a user guide and menu-driven software that lets you graphically set up or customize port parameters and printing formats. Cables available for IBM PC AT, other computers and peripherals.

Like all Hayes products, Transet 1000 combines sophisticated capabilities with easy operation. Just as Hayes set the standard in personal computer communications, now Hayes is taking the lead in computer task management.

Contact your authorized Hayes dealer to see how Transet 1000 can help you get a lot more productivity out of your computer system—without tying up your computer or you.



Transet 1000 allows printing on both a dot matrix printer and letter quality printer, while freeing your computer for other tasks.

Hayes Microcomputer Products, Inc., P.O. Box 105203
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Innovative products for enterprising people

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● GARDENING ON LINE
Interviews with gardening experts adept at using microcomputers to benefit their yards are included in *The Online Gardener*, a quarterly newsletter that covers news, trends, and product and software reviews relevant to home-garden applications. Subscriptions are $8 a year. Contact *The Online Gardener*, 1287 McLendon Ave., Atlanta, GA 30307.

● NEWS FROM RIVER CITY
The Sanyo MBC-2000/3000 Forum is designed to provide technical support and an exchange of information without meetings for Sanyo MBC 2000 and MBC 3000 users. Membership includes a subscription to the monthly newsletter, access to a public-domain software library, and nationwide communication by mail and modem. The annual fee is $15. Contact William Pletcher, Sanyo MBC-2000/3000 Forum, River City Datamation, 2653 Yuma Circle, Sacramento, CA 95827, (916) 362-1537.

● TELESAT INTERNATIONAL
Members of Telesat International benefit from a BBS featuring computing reviews, databases, and international yellow pages. The board is operational 24 hours a day for an annual fee of $25. For a free membership kit and details, contact Customer Service, Telesat International, POB 2334, Elizabeth, NJ 07207-2334, (201) 352-2319.

● A DENVER GEM
An organization that provides geologists with access to a BBS with extensive public-domain geological programs also produces a catalog, monthly newsletter, and member directory and holds conferences and exhibits. Further, experts in geological-applications software and databases present technical papers at the monthly meetings of the Computer Oriented Geological Society (COGS) held in Denver, Colorado. Contact COGS, POB 1317, Denver, CO 80201.

● ACTIVE ON LINE
Users of the Commodore 64 can link into an electronic newspaper, search its database, exchange messages with other users, and upload and download all on line from Ontario, Canada, for a $20 annual fee. The Stelex Sector BBS, available 24 hours a day at (416) 766-3038, also provides an on-line typing service, bulletins, and products available for sale. The BBS manual sells for $5. Send an SAE to The Stelex Sector BBS, POB 6238, Station A, Toronto, Ontario M5W 1P6, Canada, or call Roman Kowalczuk at (416) 769-8226.

● DISK ANSWERS
Chicago's First Osborne Group (CFOG) gives new members a disk that contains an explanation of meetings, copies of public-domain programs, a list of members who offer help, and instructions on how to operate the group's 24-hour RCP/M, which operates on an Osborne 1, a 1200-bps Hayes Smartmodem, and a Design One 10-megabyte hard disk. A $2 initiation fee is required. Contact Benjamin Cohen, CFOG, POB 1674, Chicago, IL 60690.

● SEE BASIC CLEARLY
null-Babel/CBNews, a newsletter for CBASIC programmers, is published monthly by the CBASIC Users Group. The group also maintains a public-domain library. A subscription is $18; $28 overseas. Sample and back issues are $2. Contact Ric Allan, POB 40690, Cincinnati, OH 45240-0690.

● INVESTORS JOURNAL
The MicroComputer Investor, the semiannual journal of the MicroComputer Investors Association (MCIA), furthers the group's intentions to facilitate communications for investors who use microcomputers. Contact Jack Williams, MCIA, 902 Anderson Dr., Fredericksburg, VA 22405.

● INTERACTIVE NEWS
The Society for Applied Learning Technology produces a quarterly newsletter that contains information on scheduled events concerning interactive videodiscs and microcomputers in education. Annual membership is $30. Members are invited to subscribe to the *Journal of Educational Technology Systems* for an additional $31. Contact the Society for Applied Learning Technology, 50 Culpeper St., Warrenton, VA 22186, (703) 347-0055.

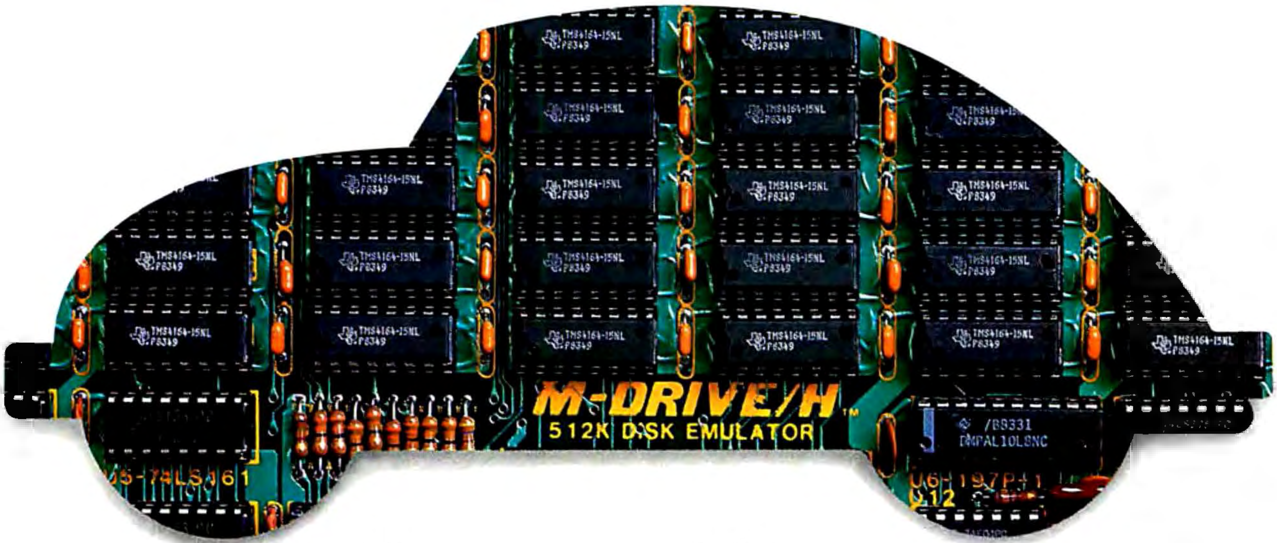
● A DIRECT LINE
The Long Island NEC Users Group (LINECUG) is a nonprofit organization that distributes public-domain software to users of the NEC PC-8000 and PC-8800. A $5 annual membership includes biannual updates of the club's software. Contact Jerry Worthing, LINECUG, 75 Weaving Lane, Wantagh, NY 11793, (516) 735-2952.

● PRO FORMA
Transcripts of the C-Pro Users Group's bulletin-board messages at (703) 491-1852 are published in the newsletter, as well as public-domain programs, hardware and software reviews, and technical information for CompuPro and other S-100 bus systems. Membership is $24 per year. Contact the C-Pro Users Group, POB 1474, 14057 Jefferson Davis Highway, Woodbridge, VA 22193, (703) 690-3312.

● SIGCC TAKES ROOT
The International Council for Computers in Education (ICCE) seeks local chapters for the Special Interest Group for Computer Coordinators (SIGCC), for people with any computer-coordinator responsibilities. A public-message bulletin board, The ICCE Forum, is available on CompuServe at GO EDU18; otherwise ICCE's number on CompuServe is 70014,2117. ICCE houses SIGs for special educators, administrators, and teachers and publishes *The Computing Journal* and a quarterly

(continued)

CLUBS & NEWSLETTERS *is a forum for letting* BYTE *readers know what is happening in the microcomputing community. Emphasis is given to electronic bulletin-board services, club-sponsored classes, community-help projects, and other activities. We will continue to list new clubs and newsletters. Allow at least four months for your club's mention to appear. Send information to* BYTE, *Clubs & Newsletters*, POB 372, *Hancock*, NH 03449.



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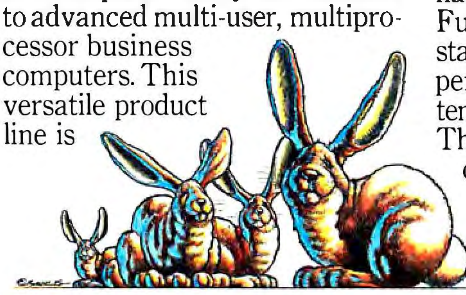

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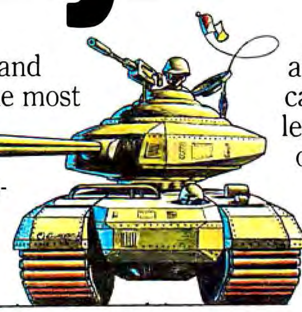

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This toll-free number connects you with your nearest Full Service CompuPro System Center (in California, dial 800/VIASYN-2). It can supply all of the products highlighted in the following pages—and more. If you are looking for a product designed for your particular application, you'll find it at your local CompuPro center. Their staffs are trained to provide quality solutions to your problems, now and in the long run. At values that are truly exceptional in our competitive marketplace.

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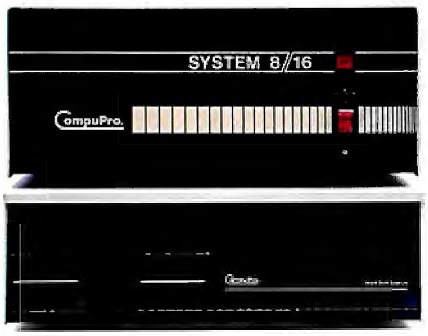

The CompuPro 816 (A1 through Z1).

A whole family that offers you exactly what you want in a computer. Dependable performance. Flexibility to grow. Increased productivity over a wide range of applications. You can expand from single to multi-user systems by simply adding more boards and peripherals. Use just as much power as you need—for over 3,000 industry standard business applications, as well as a wide variety of scientific and industrial programs. And this multi-user computer system lets you link as many as 255 systems for networks of more than 1000 users.

Our systems offer you many standard features that give you more functionality and value from the start. Operating system and selected applications programs are part of each system. All systems adhere to the IEEE 696/S-100 bus standard and may be easily expanded or upgraded with S-100 boards available from VIASYN. And each system is equipped with an 800 Kbyte double-sided, double-density 5¼″ floppy disk drive.

In addition, we give you a wide choice of options that increase your system's power and versatility. You can add 5¼″ or 8″ floppy disk drives. Put on 40-Mbyte or 80-Mbyte hard disks, and get a 10-Mbyte tape backup. Instead of selecting our standard desktop models, you can choose our 19″ rack mount option.

No matter which system or what options you choose, you can count on getting optimum performance for your money.

CompuPro 816/A1.™ Ideal start-up system. Based on 8085/8088 CPU. Includes 128K RAM and our CP/M® 8-16™ operating system. $3995.

CompuPro 816/C1.™ Advanced 8085/8088 multi-user system. Equipped with 512 Kbytes of RAM. Bundled with Concurrent DOS™ 8-16.™ $6895.

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CompuPro 816/E1.™ Powered by Motorola's 10-MHz 68000 chip, this 16-bit engine gives you 512 Kbytes of RAM, plus CP/M-68K™ for high-level languages, like mapForth and C. $6495.

CompuPro 816/F1.™ A 16-bit computer that uses Intel's 80286 processor. Features 512K of RAM and operates with Concurrent DOS 8-16. $7995.

CompuPro 816/G1.™ Outfitted with National Semiconductor's 16/32-bit 32016 microprocessor. This system offers you 512 Kbytes of RAM and is designed to run FORTH and UNIX.™ Fast, dependable, efficient. $6895.

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CompuPro 10 Plus 2. Equipped with 2 800 Kbyte floppies, 2 Z80 slave processors, each containing 64K RAM. Features the 8088 processor with 256K RAM. Options let you increase RAM in 256K increments to a maximum of 768K. You can add a second set of 2 slave processors, our MDRIVE®/H and our Net 10 board that facilitates network connections. $3995.

CompuPro 10 Plus 40. In addition to an 800 Kbyte floppy, this system includes a 40 Mbyte hard disk and increases the number of Z80 slaves to four, at 64K RAM per board. The 10 Plus 40 also operates with 256K RAM for the 8088 processor and features the same options as the basic 10 Plus 2 system above, but adds a tape backup to the list. $6995.

CompuPro 816 makes networking easy.

This multi-user, multiprocessor option lets you share data and peripherals via the nodal cluster concept. Each node consists of one CompuPro 816 and its tied-in workstations. Connecting nodes is as easy as installing one of our Net 100 or Net 10 boards in each computer, and running standard RG 62 cables between them. Network hubs allow you to connect three or more computers. In this way, the CompuPro 816 network can support 255 nodes and cover distances to four miles. You work with speedy 2.5 megabit/second transfer rates and get individual, transparent on/off node operation. Thus, nodes can run without involving the entire network and do not affect overall network performance.

Operating Systems for the CompuPro 816 Family.

CP/M 2.2. An 8-bit high-performance, single-user operating system. Works with all CompuPro systems based on Intel's 8085 or Zilog's Z-80 CPUs. Uses the entire family of CP/M application software. Requires minimal hardware configurations.

CP/M 8-16. Single-user 8-bit and 16-bit operating system based on Digital Research's CP/M-86.™ Downward compatible with most CP/M 2.2 software. Supports a variety of application software and languages as well as many more productivity tools.

CP/M-68K. 16-bit operating system supports Motorola's 68000 CPU. Similar to our CP/M 2.2 because it allows easy information transfer and convenient file manipulation. Lets you utilize all peripherals in your computer system.

Concurrent DOS 8-16. A high-performance, true multi-user, multi-tasking operating system for the CompuPro 816 series. Can be configured in either single- or multi-tasking mode for simultaneous 8- and 16-bit operation. This operating system supports DR/NET™ allowing peripheral sharing among work stations and facilitating full local processing when used with the CompuPro Net 100 network board. Supports Digital Research's GSX graphics

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software and includes modem software. Features single-stroke, virtual screen switching (terminal-dependent). It can support more than eight users and a number of printers in a multi-user mode.

More power and flexibility across the board.

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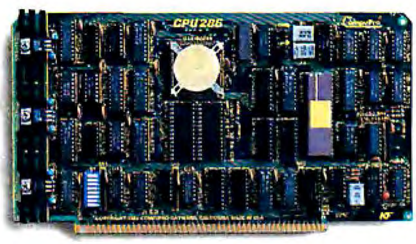
CPU-Z.™ 8-bit board with all standard Z80 features. Can be run at slower clock speeds when necessary, generating MWRITE for such operations. Includes plug that takes the connector from IMSAI type front panel. Equipped with 8 MHz Z80. $275.

CPU 8085/88.™ Includes two processors: the 10 MHz 8088, which is an 8-bit bus version of the 8086 16-bit CPU, and the 6 MHz 8085, an advanced 8-bit processor to run existing 8-bit software. Can be run at 2 MHz to accommodate timing-dependent software. $350.

CPU 86.™ Operates with Intel's high-performance 10 MHz 8086 processor. Includes socket for 8087 math processor. Compatible with 8-bit and 16-bit memory. $395.

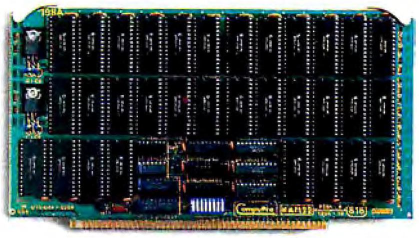
CPU 68K.™ Based on Motorola's 68000 10 MHz processor. Socket for 68451 Memory Management Unit and sockets for up to 16 Kbytes of EPROM (8K x 16 bit organization). $425.

CPU 32016.™ This true 32-bit 6 MHz processor brings mainframe power to desktop micros. Includes sockets for on-board memory management and floating point units, plus up to 32 Kbytes of ROM. $895.



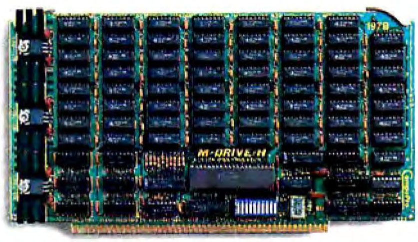
CPU 286.™ Intel's iAPX™ 80286 16-bit processor shifts into high gear for you. C-Step 6 MHz version that offers sockets for 16 Kbytes of on-board EPROM and for 80287 math processor. Compatible with both 8- and 16-bit memory, mixing both in the same system. Includes our unique clock switching circuit for bus sharing by special slave processor boards. This feature lets you run alternate 8- and 16-bit software libraries with ease. $995.

A lot of memory for a lot less.



Ram 22.™ 256K x 8 bit or 128K x 16 bit organizations of low power static RAM. High-speed, high-density board automatically works with 8- or 16-bit processors. Smooth handling of fully static operations (e.g. DMA transfers). Draws half the power of dynamic equivalents. Operates with all our CPUs. $1250.

Ram 23.™ Same features as RAM 22 above in 128K x 8-bit or 64K x 16-bit configuration. $395.



MDRIVE/H. Can increase operating speeds to 3500%! Greatly enhances disk-intensive performance. Emulates disk drive operation but runs at RAM speed. All of CompuPro's operating systems — including CP/M 8-16 and Concurrent DOS 8-16 — support our MDRIVE/H. 512K $695. 1 Mbyte $1350 (10 Plus). 2 Mbyte $2450. 4 Mbyte $4500 (10 Plus).

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Our disk controller boards drive for efficiency.

Disk 1A.™ This floppy disk controller is geared for 8″ and 5¼″ drives. Reads and writes most popular formats. Uses the most advanced LSI floppy controller available. $495.

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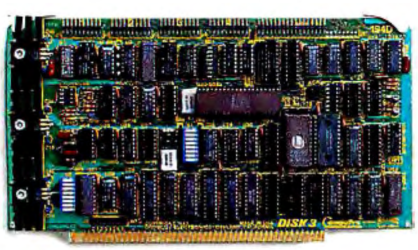
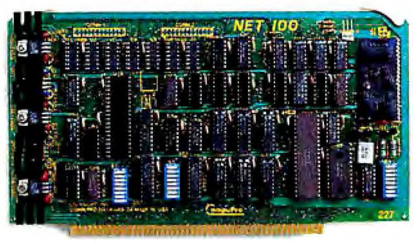


Disk 3.™ Winchester controller for up to four 5¼″ hard-disk drives. Unprecedented high performance for multi-tasking systems. The disk's channel processor seeks, reads and writes without external prompting. The host can transfer large data blocks between disk and memory on single command, designating source, destination and length. Disk sectors are transferred in high-speed "burst mode" DMA. ST 506 interface standard; SA 1100 available on special order. $595.

More options for the growing CompuPro 816 network.



CompuPro Net 100 Board. Meets all IEEE 696/S-100 requirements, featuring eight switch-selectable I/O ports, on any 8-port boundary in the 64K I/O space. Supports 8-bit or 16-bit addressing. Also supports the ARCnet® token passing local area network protocol under Digital Research's DR/NET. Mainframe communication option available. $395.

CompuPro Net 10. Has all the features of our Net 100 board but is used in CompuPro 10 Plus only. Mainframe communication option available as well. $395.

Net Passive Hub. Connects up to four CompuPro 816 Computers. $65.

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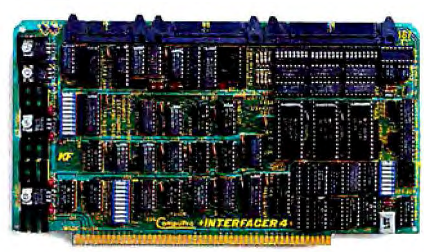

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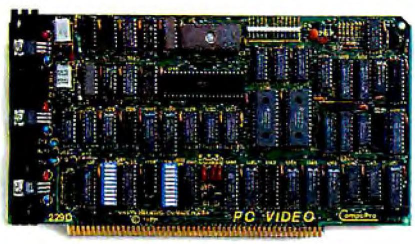

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called *The SIG Bulletin.* SIG membership ranges from $10 to $17 annually, depending on ICCE membership and location. Contact the International Council for Computers in Education, University of Oregon, 1787 Agate St., Eugene, OR 97403, (503) 686-4414.

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The bulletin boards of the Sanyo National Users Group (SNUG) at (509) 884-0613 and 335-1652 in Wanatchee and Pullman, Washington, provide technical assistance for users of the Sanyo MBC. In addition, a public-domain library is maintained, a monthly newsletter is produced, and group-purchase discounts are organized. The annual fee is $15. Contact Michael Russell, SNUG, POB 2084CS, Pullman, WA 99163.

● BCS KAYPRO
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The East Carolina CP/M-MS/DOS Group welcomes an exchange of newsletters, public-domain software, and other information relevant to the CP/M and MS-DOS operating systems. The club produces a newsletter that is published every other month, and a bulletin board is in the works. The annual dues are $10. Contact East Carolina CP/M-MS/DOS Group, 707 Edge Hill Rd., New Bern, NC 28560.

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Source notes. *Yankee Group. The Technical Office, Vol.III 1983
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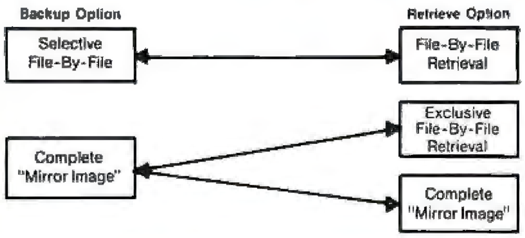

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PROGRAMMER PRODUCTIVITY: ACHIEVING AN URGENT PRIORITY
Girish Parikh
Reston Publishing
Reston, VA: 1984
236 pages, $31.50

APPLYING SOFTWARE ENGINEERING PRINCIPLES
David Marca
Little, Brown
Boston, MA: 1984
288 pages, $29.95

CP/M-86 USER'S GUIDE
Jonathan Sachs
Osborne/McGraw-Hill
Berkeley, CA: 1985
568 pages, $18.95

COMPUTER ANIMATION PRIMER
David Fox
and Mitchell Waite
McGraw-Hill
New York: 1984
522 pages, $22.95

THE COMPLETE HOME EDUCATOR: A COMPREHENSIVE GUIDE TO MODERN HOME-TEACHING
Mario Pagnoni
Larson Publications
Burdett, NY: 1984
248 pages, $10.95

PROGRAMMER PRODUCTIVITY: ACHIEVING AN URGENT PRIORITY

Reviewed by Michael Martinez and E. Francis Avila

In the world of data processing, systems managers will tell you software development and maintenance are the most expensive costs incurred in running a large system. While computer-hardware costs have dropped, software-development costs have risen. The issue, then, is finding useful, reliable methods of increasing programmer efficiency, crucial to stemming the climbing costs of developing and maintaining software.

In *Programmer Productivity: Achieving an Urgent Priority*, Girish Parikh, an experienced data-processing programmer and manager, tackles this difficult but vital task head-on. He offers practical solutions that promise to increase productivity while reducing maintenance costs.

Be forewarned that *Programmer Productivity* is not intended for hobbyists, although amateur programmers would do well to adopt good programming practices. Parikh has written this text primarily for professional programmers and data-processing managers working in large-systems environments with teams of programmers, designers, and analysts developing applications software that often encompasses thousands upon thousands of lines of code.

Consequently, the book's technical nature often makes for dry, sometimes ponderous reading. Additionally, Parikh assumes the reader possesses more than a casual knowledge of professional programming operations. He does not shy away from technical prose.

Parikh begins each chapter by quoting either his own experiences or those of other data-processing experts. He follows this with a presentation of some of the more

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ILLUSTRATED BY KATHERINE MAHONEY

popular (and not so popular) theories and practical methods that promise to increase programming efficiency and lower maintenance costs.

Throughout the book, the author intersperses details of personal successes and failures, as well as other case studies, encountered during the process of implementing and testing the various productivity techniques. Generally, Parikh does not hesitate to show his support for one technique over another.

'IMPROVED TECHNOLOGIES'

The book's central hypothesis revolves around what Parikh calls "improved programming technologies." If these technologies are adopted, dramatic increases in the productivity of programming projects can be realized, according to Parikh. In the first chapter, he lists these technologies: HIPO (hierarchy plus input-process-output), top-down program development, chief-programmer teams, development-support libraries, structured programming, and structured walk-through.

Unfortunately, Parikh does not go into any great detail about any one technique; he leaves that for further research by the reader. Instead, he offers a quick overview of each technique, sometimes listing the good and bad points. With HIPO and structured programming design, for example, he provides simplistic models of these different approaches, mixing each with comments and his own experiences.

Of course, many techniques employed to increase programmer output, such as Warnier-Orr diagraming and structured design, are subjects of books themselves. Parikh cannot be expected to treat them in depth in a book designed as an overview of programmer productivity.

The success of any one of Parikh's recommendations depends on the size and nature of the project. But of the six technologies outlined by Parikh, you'll get the impression that structured programming technique is the method most capable of producing the most success. And indeed it has been our experience that structured programming methods have proven more successful in increasing productivity as well as long-term maintainability of software than many other methods devised.

You might get the impression that the author is addressing only COBOL programmers. However, this is not the case. While a chapter is devoted specifically to COBOL using a preprocessor, the wealth of material Parikh covers is not bound by any language and could be just as easily applied to FORTRAN, C, Pascal, or BASIC.

PEDANTIC

Parikh occasionally drops his guard and comes across sounding a little pedantic, at times condescending. This is unfortunate because it detracts from an otherwise good treatment of material. There are times when Parikh writes more like a crusader waving the banner of improved programming technologies than a professional sharing his

(continued)

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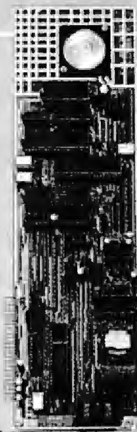

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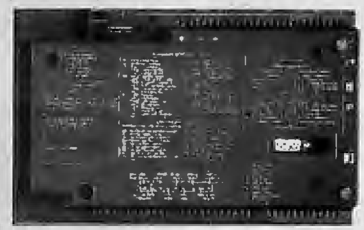

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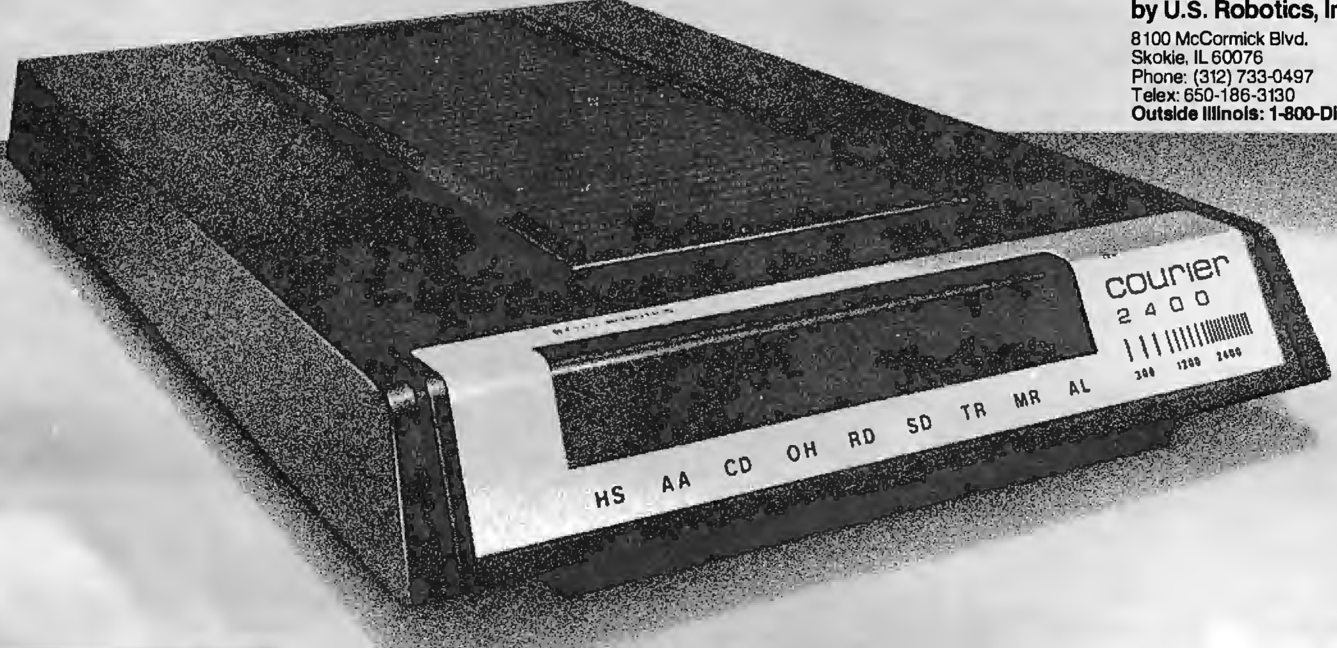

knowledge and experience. Obviously, he feels very strongly about his subject matter.

THE EGOLESS PROGRAMMER

One intriguing subject that Parikh suggests needs more attention is his idea of "egoless programming." He devotes an entire chapter to this ignored topic.

Parikh urges programmers and managers alike to abandon egocentric attitudes and pull together as a team on projects. He asserts that the key to self-fulfillment is to become "egoless." Only then will programmers (and managers) get a clearer picture of the task at hand. He cautions programmers not to take criticism personally but to instead be open to suggestions from peers and accept "humbling tasks."

To merge ego into the programming team may sound a bit offbeat for the average software-development group in this country. Given the prevailing attitudes of most American workers, we doubt that this philosophy would stand much of a chance of being taken seriously, but Parikh's discussion is interesting nevertheless.

Programmer Productivity opens several doors that potentially lead to increasing both the quantity and the quality of computer-programmer output. The author freely acknowledges that the programmer's craft as an intellectual endeavor is very difficult to measure, let alone improve upon. But, he insists, with the proper use of "improved programming technologies" it can be done. Parikh leaves it to the reader to choose which technology is best.

Michael Martinez (7475 San Bergamo Dr., Goleta, CA 93117) is a systems programmer. E. Francis Avila (POB 4401, Auburn, CA 95604) is a contract programmer working on a degree in mathematics.

APPLYING SOFTWARE ENGINEERING PRINCIPLES

Reviewed by Annette Hinshaw

With questions and exercises at the end of every chapter and a dry academic style that tends to obscure the important material it contains, *Applying Software Engineering Principles* looks like a textbook. However, the exercises suggest individual study rather than classroom use. Every problem requires access to a library of programs used in business. The questions ask the reader to analyze both successful and unsuccessful software in light of the principles covered in that chapter. They also suggest ways to implement the ideas from the chapter in upcoming programming projects.

These exercises are excellent, but they seem pertinent only to people working in programming shops large enough to require multiperson projects. On the other hand, the exercises may require more time to complete than most working programmers can spare for self-improvement.

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David Marca has divided his book into four sections: general concepts, engineering with a computer language, engineering using existing software, and engineering with regard to human and machine environments.

Marca researched this book extensively; he supports many important ideas with numerous citations. The book is long on general principles, but it never quite makes it to the "applying" of the title. For the most part, these general principles are not related to concrete, real-world issues. Although he promises early in the book that he will help software engineers make specific design choices, Marca does not fulfill this promise. The book contains the pieces to develop decision guidelines, but they are like unstrung beads. I wanted walk-through examples showing how to apply principles to specific situations. And I had trouble making the obviously sound ideas in the book jell into a set of rules for making decisions.

Marca defines software engineering as "the act of an individual who learns to develop software in a practical setting." He emphasizes that engineering is different from writing program code. Just as most of the engineering on a bridge is complete before construction begins, so software engineering is largely a series of planning decisions on what to include in a software system and how to arrange the program for easy use and maintenance. This planning comes in stages: analysis, design, implementation, and installation. Marca devotes most of the book to the implementation stage, where actual code is generated.

All programming examples are in FORTRAN. The author's decision to use only one language limits coverage on some topics. He mentions recursion but does not discuss it because FORTRAN does not support this technique. He uses FORTRAN's poor string handling as an example of a need to extend a computer language, but he does not address strings as a data type because most versions of FORTRAN do not use text. He touches on the difficulty of using files in FORTRAN but does not provide examples of this function from another language.

Marca discusses designing software with parameters such as cost-effectiveness, timely production, and simplicity. He recommends organizing activities into analyzing a problem, designing a system that can solve the problem, writing a program to the design, and installing the finished program. His principles are not original, but they are a sound basis for operation.

MODELS

The chapters on modeling are a good example of my frustration with this book. Obviously a good model for a system is central to good software design. Marca begins by analyzing what makes a model and then explains limitations. He talks about form and language and offers an algorithm for creating a model. Instead of providing something concrete, he moves on to validating a model. The exercises at the end of the chapter do offer concrete examples, but this makes the book useless for anyone who

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lacks access to records of large programming projects.

The rest of the material on modeling consists of truisms. Marca provides names for types of software engineering models. He sets up principles like, "Selecting the proper form for a model minimizes error" and "A model is either static or dynamic." He never quite advises how to find the best form for a given model. He doesn't tell you where to choose static or dynamic models.

Anyone not familiar with the principles of structured programming can profit from the second section of the book. In the most cogent part of his text, Marca explains simply and clearly how isolating data, subroutines, and subprograms makes software easier to debug and maintain. He discusses complex data structures and search techniques. This section does not include much advanced material, but it is well organized, and it shows the advantages of careful planning and structuring in all aspects of writing a program.

One section addresses recycling software. Software engineers may wish to lift subprograms from existing software to meet the needs of a new design. Well-designed software (i.e., structured, with each function complete and isolated) makes such reuse easy. Marca reprises some of the material from the previous section and discusses integrating and testing subprograms. He also talks about software utilities, such as debugging tools.

Marca presents a FORTRAN string-handling facility as an example of extending a computer language to meet design needs. In a chapter on software filters he discusses separation and testing of data. He also shows how to analyze the "behavior" of a system. A list of possible inputs is matched to possible outputs. Marca uses this list to derive a table of states of the system for all possible I/O (input/output) configurations. This table can be translated to a set of values, which can in turn control the program. The purpose of all this is to engineer a finite-state machine, which Marca says offers superior program control. In an appendix he includes the FORTRAN listing that implements the example of a finite-state design.

The last part of the book talks about separating diverse concerns and dealing with them as distinct problems. Marca covers hardware factors and the user interface. I found the material in the chapters on human limitations in data handling and on building user interfaces the most interesting in the book. But again, the author offers a lot of valuable information and stops just short of making it really useful. For example, he says that the control for an operation can reside mainly with the machine, mainly with the person, or be shared between the two. Then he fails to discuss when to use which for most effective engineering. The chapter on user interfaces contains more pertinent information, but it is hidden under an unnecessarily academic prose style.

Applying Software Engineering Principles is heavy on general principles but light on nitty-gritty applications. If Marca revised its excellent application exercises for classroom

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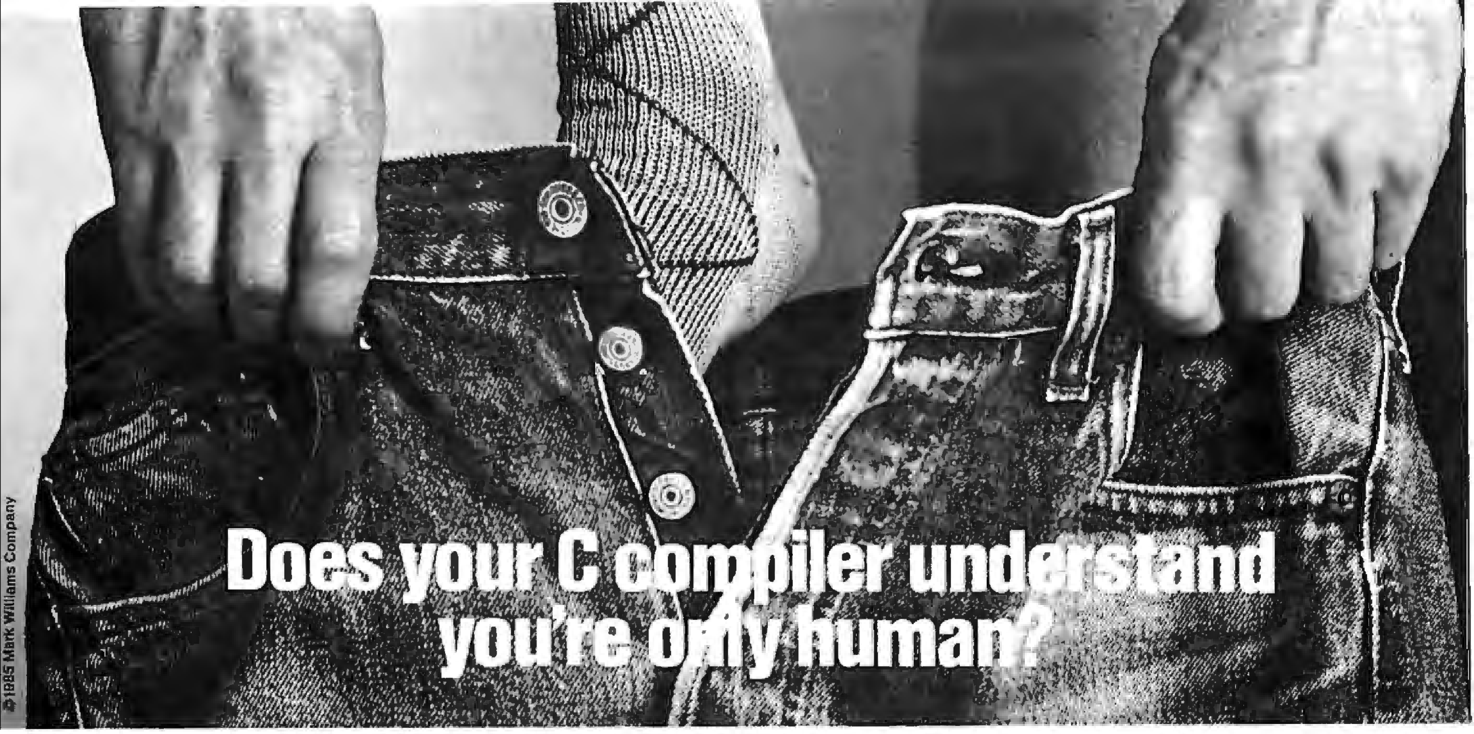

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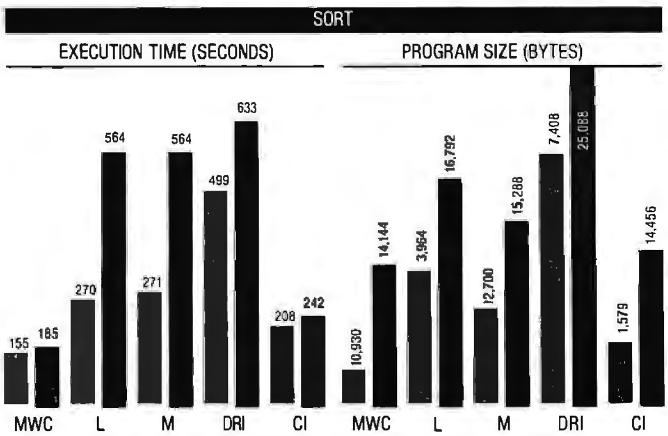

■–Small Memory Model
■–Large Memory Model

NOTE: Sort program as in Byte, August 1983, p. 91. Register declaration added. Further information on these benchmarks available from Mark Williams Company upon request.

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use, it could be a reasonable basic textbook. As a guide for software engineers in the field, the book is seriously lacking. Engineers will still have to derive most of their own specific application guidelines.

Annette Hinshaw (POB 580635, Tulsa, OK 74158) *is a freelance technical writer.*

CP/M-86 USER'S GUIDE
Reviewed by Paul W. Lowans

This guide covers Digital Research's CP/M-86 family of operating systems, including MP/M-86, Concurrent CP/M-86, and Concurrent DOS. In the beginning of *CP/M-86 User's Guide*, author Jonathan Sachs, a computer consultant on technical writing and software development, suggests how to set up your system, discusses hardware, and introduces a basic implementation of commands. The rest of the book explains CP/M's more advanced features, covering in more detail the commands and utilities. An additional "Note to the System Manager" describes how to assist a CP/M novice in using the guide with hands-on experience. Sachs has written this book for people at different levels of expertise.

Appendixes cover the differences in various releases of CP/M systems. The book also contains a resource guide of names and addresses of computer-related publications, products, and accessories, as well as a listing of bulletin boards. Also included are specific notes for users of CompuPro, DEC Rainbow, and IBM PC and PC XT computers.

Sachs points out in the acknowledgments that he wrote the book while Concurrent CP/M-86 and Concurrent DOS were still being developed; thus, the syntax he explains could be in error. Since I work strictly with CP/M-86, I cannot determine any such errors; you should check this out before you buy the guide.

A main drawback in the book is its organization by operation, not by family member. It is fragmented by having a little bit of material on each command for each system. Sachs jumps from one system to another, which can cause confusion. He begins one section with how to boot each system, then explains how to format a disk for each system, then how to manipulate files, and so on.

This fragmentation forces the reader who wants to get the full story about an operating system to read the book from cover to cover, but jumping from system to system forces the reader to skip portions that do not apply to his CP/M family member.

CONCLUSIONS

Sachs uses plain English and simple examples to explain the operations of each system. Throughout the book are boxes titled "Things That Might Go Wrong"; they explain error messages and how to recover. Sachs begins the guide simply and moves on to the more complex. It is similar to taking a programmed book course whereby the user is encouraged to try examples that build on each other in the learning process.

Because the guide covers the family of CP/M, it is good for people who want to use more than one version. The appendixes are not only well written but prove to be good references for the user who has some familiarity with CP/M. However, Sachs does not explain the CP/M-86 assembly language or the 8086 instruction set other than the syntax for ASM-86.

Paul W. Lowans (2709 South Union St., Spencerport, NY 14559) is an electronics engineering technician at Xerox Corporation in Rochester, New York.

COMPUTER ANIMATION PRIMER
Reviewed by Jeff Campbell

Computer Animation Primer provides the armchair programmer and would-be computer animator with a fascinating overview of a technology capable of bringing the illusion of reality to our most abstract imaginings. From the high-tech marvels of *Star Wars* special effects to BASIC programs to run on your personal computer, David Fox and Mitchell Waite explore how to become involved in computer animation today.

Fox and Waite begin with a brief history of animation. Antique animation devices with such exotic names as Thaumatrope, Phenakistoscope, and Zoetrope almost seemed to anticipate their computerized futures. The discussion highlights the major advances by animation pioneers like Walt Disney, Walter Lantz, Max Fleischer, et al. The perspective concludes with an examination of how computer animation is used today in the film industry, medical research, sports, education, engineering, advertising, and arcade games.

One section extensively describes the basic hardware used in computer animation. Brief explanations cover everything from the mechanics of creating movement and color on a cathode-ray tube to the light pens, digitizing tablets, and joysticks used to create and manipulate graphics images. The authors conclude this section with the observation that the "trickle-down" effect will continue to allow increasingly sophisticated equipment to become available to the personal computer user.

In a chapter on computer-animation software and applications, Fox and Waite focus on techniques for defining graphics objects in ways that a computer can understand. Some rather complex algorithms come into play when images are rotated, translated, and scaled, yet these discussions do not bog down. The text is lucid, and the authors are not above an occasional humorous touch.

SAMPLE PROGRAMS

The bulk of the book deals with actual programs for animating on a personal computer. The authors have

(continued)

BOOK REVIEWS

chosen to work with Atari BASIC because they think it has high potential for graphics and animation. The programs themselves are widely adaptable for use on other microcomputers. Fox and Waite provide instructions for creating customized character sets (or making do with the ones you have) and then animating them. They cover animation loops; with this information you can create galloping horses, a walking man, or an exploding bomb. Movement can also be suggested by changes in color. This is covered in a section on color-register animation.

Separate chapters deal with player-missile graphics, employed in many arcade games, and using machine language in BASIC programs. The final chapter offers the information necessary to create scrolling backgrounds. By applying this knowledge, it's possible to create some very impressive animated graphics.

VISUAL EFFECTS

The layout of this book deserves special mention. Wide margins on the outside of each page not only contribute to an uncluttered page but allow the inclusion of four "flip book" computer-animation movies. By flipping through the upper corners of this book—both forward and backward—you can view approximate real-time segments of the animation discussed in the book. Fox and Waite use one of the oldest animation techniques to elucidate one of the newest.

The book also has a 16-page color section. Appendixes include a compilation of all program listings reproduced in larger detail, a character-set grid, listing conventions for representing hidden (or invisible) characters, methods for storing machine-language routines in strings, parameter-table entries for black-box routines, source-code listings of assembly-language routines, and Atari hardware and shadow registers.

Computer Animation Primer is the book for people who want action livening up their computer screens.

Jeff Campbell (9296 West 98th Place, Broomfield, CO 80020) is president of Campbell Photo/Graphics.

THE COMPLETE HOME EDUCATOR: A COMPREHENSIVE GUIDE TO MODERN HOME-TEACHING

Reviewed by Hunter Holmes Alexander

Many parents despair of the public schools but few act to set things right. *The Complete Home Educator: A Comprehensive Guide to Modern Home-Teaching* is a step-by-step handbook for teaching youngsters at home. It is also a book about the mediocrity of schools and how microcomputers can be used to improve education.

Mario Pagnoni, a teacher for 13 years, decided to leave his school in order to teach his two sons math, computer skills, writing, spelling, and problem solving at home. He

(continued)

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  - Floating point emulator (utilizes the 8087/287 if installed).
  - 8087/287 coprocessor support.
  - Alternate math package—extra speed on systems without an 8087/287.
- Link routines written in Microsoft FORTRAN (V 3.3 or higher), Microsoft Pascal (V 3.3 or higher) or Microsoft Macro Assembler.
- Supports MS-DOS pathnames and Input/Output redirection.
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- Do source level debugging, with the Symbolic Debug Utility, available separately with the Microsoft Macro Assembler Package.*

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'C' Benchmarks—done on a Compaq Plus with 512k memory with no 8087. Program "SIEVE," with register variables.

	Exec Time	Code Size	EXE Size
Microsoft C	:9.39	141	5,914
Lattice C	:12.24	164	20,072

*Purchase both Microsoft C Compiler and Microsoft Macro Assembler and get a $25 rebate direct from Microsoft. See package for details.

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used an Apple II+ as an aid in instruction.

What tricks did he discover? Pagnoni advises home-schoolers to be the educational consultant for their children rather than the traditional pedagogue. He cites test scores to show that his sons, ages 7 and 10, learned more in the year he tutored them at home than in the years they endured in the traditional school with its regimentation and instructors who are sometimes underqualified.

This book is written primarily for parents who want to take their children out of the school system or those who want to tutor their children after school. But it could benefit computerists who don't know about teaching, people who aspire to teach about computers, and computer businesspeople, as well as sociologists, salespeople, politicians, and people interested in school-board positions. Mostly it is for parents who know little about computers, as was the case with Pagnoni only a few years ago.

PARENT/CHILD BOND

Pagnoni advises against forcing youngsters to learn something the way you learned it. He suggests that home-schoolers write to a private school for its curriculum. He recommends a list of read-aloud books and encourages parents and children to read aloud together.

One advantage of home-schooling, Pagnoni says, is that it strengthens the parent/child bond since the parent and child spend more time together. Also, teaching will make parents feel more in charge of their children's education. Children taught at home generally test higher than those in public schools and have more self-esteem; Pagnoni says that students who have been taught at home can get into Harvard.

The disadvantages of home-instruction include the possibility of failure. Also, children could miss out on some peer-group experiences, although the author suggests ways to prevent this.

Pagnoni discusses BASIC programming and word processing for novices. Appendixes cover sources for legal information, correspondence courses, and resources for learning programming. A subject index is included.

The introduction endorsing Pagnoni's work is by John Holt, author of *Growing Without Schooling* and editor of a newsletter on home-schooling.

The Complete Home Educator is entertaining and useful. Pagnoni shows how to put the fun back into schooling. More and more court cases are going in favor of home-schoolers, and "unfriendly" school boards seem to be getting poor publicity. Home education is a growing social movement and no longer seems as radical as it once did. About 40,000 Americans teach their children at home. Pagnoni's book provides them with a good model for home education with high technology. ■

Hunter Holmes Alexander (4520 King St. #404, Alexandria, VA 22302) is BYTE's Washington correspondent, belongs to the Washington Apple Pi users club, and is a former teacher.

June 1985

● C STUDIED
C Language Workshops, various sites throughout the U.S. Workshops and seminars on C programming and issues. Contact Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770. *June*

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● CONFERENCES FOR MANUFACTURERS, USERS
Conferences for Manufacturers and Users from the Institute for Graphic Communication, various sites throughout the U.S. Planned are "Slidemaking with Computer Graphics" and "Digital Facsimile." Contact Richard D. Murray, Institute for Graphic Communication, 375 Commonwealth Ave., Boston, MA 02115, (617) 267-9425. *June*

● SEMINARS FOR MANAGERS, PROFESSIONALS—Datapro Seminars, various sites throughout the U.S. Among the topics covered are microcomputer communications, telecommunications, and local-area networks. Contact Datapro Research Corp., 1221 Avenue of the Americas, New York, NY 10020, (800) 257-9406. *June*

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● AI, EXPERT SYSTEMS BRIEFING—Artificial Intelligence and Expert Systems: What Users and Suppliers Must Know Today to Deploy These Technologies as Profitable Strategic Corporate Resources Tomorrow, Boston and Framingham, MA. A one-day executive briefing. The fee is $790. Contact Ms. Lee Burgess, Professional Development Programs, Rensselaer Polytechnic Institute, Troy Building, Troy, NY 12180-3590, (518) 266-6589. *June–July*

● DATA SWITCHING
Distributed Data Switching Seminar, various sites throughout the U.S. A one-day seminar on the technology and application of distributed data switching in telecommunications. The fee is $395. Contact Timeplex Seminars, 400 Chestnut Ridge Rd., Woodcliff, NJ 07675, (201) 930-4600. *June–July*

● INFO MANAGEMENT SEMINARS—NYU Seminars on Information Management, various sites throughout the U.S. On the agenda are "Legal Issues in Acquiring and Using Computers" and "Networking Personal Computers." Contact School of Continuing Education, Seminar Center, New York University, 575 Madison Ave., New York, NY 10022, (212) 580-5200. *June–July*

● CAD COURSE
Computer-Aided Design, Colorado State University, Fort Collins. Three one-week courses with participants using a high-performance dynamic graphics machine. The fee is $800. Contact Professor Gearold Johnson, Center for Computer-Assisted Engineering, Colorado State University, Fort Collins, CO 80523, (303) 491-5543. *June–August*

● ENGINEERING CONFERENCES—Engineering Summer Conferences,

(continued)

IF YOU WANT *your organization's public activities listed in* BYTE's *Event Queue, we need to know about them at least four months in advance. Send information about computer conferences, seminars, workshops, and courses to* BYTE, *Event Queue,* POB 372, *Hancock,* NH 03449.

EVENT QUEUE

Chrysler Center for Continuing Engineering Education, University of Michigan, Ann Arbor. Conferences in such areas as biomedical, chemical, civil, computer, electrical, and environmental engineering. Contact Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490. *June–August*

● COMPUTER SHORT COURSES—The Fifteenth Annual Institute in Computer Science, University of California, Santa Cruz. Among the offerings are "Relational Database Management," "Data Storage," and "Computer-Aided Geometric Design." Contact Sally Thomas, University of California Extension, Santa Cruz, CA 95064, (408) 429-4534. *June–August*

● SOFTWARE COURSES Software Short Courses, various sites throughout the U.S. Among the courses are "UNIX: A Hands-on Introduction," "Programming in C: A Hands-on Workshop," and "Software Requirements, Specifications, and Tests." Contact Integrated Computer Systems, 6305 Arizona Place, POB 45405, Los Angeles, CA 90045, (800) 421-8166; in California, (800) 352-8251 or (213) 417-8888; in Canada, (800) 228-6799. *June–August*

● DEVELOPMENT SEMINARS—Professional Development Seminars, various sites around Boston, MA. A brochure describing one- and two-day seminars on computer competence, management, sales, and finance is available. Contact Boston University Metropolitan College, 735 Commonwealth Ave., Boston, MA 02215, (800) 255-1080; in Massachusetts, (617) 738-5020. *June–September*

● SME CONFERENCES, EXPOS—Conferences and Expositions from the Society of Manufacturing Engineers, various sites throughout the U.S. For a calendar, contact the Society of Manufacturing Engineers, Public Relations Department, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777. *June–November*

● SNA SEMINAR IBM's Systems Network Architecture (SNA) Seminar, various sites throughout the U.S. Covers such topics as local-area networks, SNA distribution services, and personal computer connections. Contact Communications Solutions Inc., 992 South Saratoga-Sunnyvale Rd., San Jose, CA 95129, (408) 725-1568. *June–December*

● PICK EDUCATION Pick System Educational Series, various sites throughout the U.S. and Europe. Seminars and workshops on the Pick operating system. Contact JES & Associates Inc., POB 19274, Irvine, CA 92714, (714) 786-2211. *June–December*

● MUMPS MEETING The Fourteenth Annual Meeting of the MUMPS Users' Group, McCormick Center Hotel, Chicago, IL. Tutorials, workshops, site visits, discussions, and exhibits. Contact MUMPS Users' Group, Suite 510, 4321 Hartwick Rd., College Park, MD 20740, (301) 779-6555. *June 10–14*

● ROBOTIC STRATEGIES Robot Manipulators, Computer Vision, and Intelligent Robot Systems, University of Stirling, Stirling, Scotland. The emphasis is on developing strategies for solving robotic-sensing, spatial-reasoning, and manipulation problems. Contact Director of Summer Session, Room

(continued)

EVENT QUEUE

E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139. *June 10–14*

● CARACAS EXPO
The First International Communications and Computer Exhibition and Technical Conference: VenCom '85, Caracas Hilton Hotel, Caracas, Venezuela. Contact VenCom '85, Suite 219, 3421 M St. NW, Washington, DC 20007, (703) 685-0600. *June 11–14*

● UNIX, C CONFERENCE
USENIX Conference and Vendor Exhibition, Marriott Hotel, Portland, OR. USENIX is a nonprofit organization promoting UNIX, UNIX-like systems, and C-language programming. Contact USENIX Conference Office, POB 385, Sunset Beach, CA 90742, (213) 592-3243. *June 11–14*

● NETWORK CONTROL AND MANAGEMENT—Network Management/Technical Control, Santa Clara Marriott, Santa Clara, CA. Diagnostic and test instruments will be displayed. Contact Louise Myerow, CW Conference Management Group, 375 Cochituate Rd., POB 880, Framingham, MA 01701, (800) 225-4698; in Massachusetts, (617) 879-0700. *June 12–13*

● COMPUTERS IN CLINICAL LABS—Clinical Laboratory Computers: Symposium 1985, The Towsley Center, University of Michigan, Ann Arbor. Contact Dove Margenau, Office of Continuing Medical Education, The Towsley Center, Box 057, University of Michigan Medical School, Ann Arbor, MI 48109-0010, (313) 763-1400. *June 12–14*

● CLINICAL COMPUTING
Computing in Clinical Laboratories: The Fifth International Conference, Stuttgart, Federal Republic of Germany. Topics include databases, data presentation, and expected developments. Demonstrations and exhibits. Contact PD Dr. Chr. Trendelenburg, Katharinenhospital KCI, Kriegsbergstrasse 60, D-7000 Stuttgart 1, Federal Republic of Germany; tel: (07 11) 20 34-4 82. *June 12–14*

● INFO MANAGEMENT
INFO/West: The Western Information Management Exposition and Conference, Convention Center, Anaheim, CA. Trade show for executives and data-processing and management-information system managers. Contact INFO/West, 999 Summer St. Stamford, CT 06905, (203) 964-8287. *June 12–14*

● FORTH CONFERENCE
The 1985 Rochester FORTH Conference, University of Rochester, Rochester, NY. The focus will be on software engineering and management. Contact Ms. Maria Gress, Institute for Applied FORTH Research, 70 Elmwood Ave., Rochester, NY 14611, (716) 235-0168. *June 12–15*

● ELECTRONIC PUBLISHING
Pages That Fly, New York University, New York. Sessions of interest to telecommunications experts, publishers, and corporate and educational professionals. Contact Arlene Krebs, New York University, 51 Press Building, New York, NY 10003, (212) 598-3993. *June 13–14*

● LOGICAL MACHINES
The Second Annual Conference on Logic, Logic Machines, and Public Education, University of Houston–Clear Lake, Houston, TX. Formal and informal sessions, symposia, and work-

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shops. Contact the Institute for Logic and Cognitive Studies, University of Houston–Clear Lake, Box 269, Houston, TX 77058, (713) 488-9274. *June 13–15*

● INTERNATIONAL SHOW The International Computer Show, Trade Fair Center, Cologne, West Germany. More than 350 manufacturers from more than 18 countries are expected to display their wares. Contact Messe- und Ausstellungs-Ges.m.b.H. Köln, Messeplatz, Postfach 210760, D-5000 Köln 21, West Germany; tel: (0221) 821-1; Telex: 8 873 426 mua d. *June 13–16*

● SYSTEM/38 SEMINAR The IBM System/38: Standards and Practices, Halloran House Hotel, New York City. The fee is $595. Contact DGC Inc., 1450 Preston Forest Square, Dallas, TX 75320, (214) 991-4044. *June 17–18*

● BIO RESEARCH RESOURCE—Introduction to BIONET: A National Computer Resource for Molecular Biology, Rutgers University, Piscataway, NJ. Workshops on using computers for molecular biology research. Contact Selma Gitterman, Continuing Professional Education, Institute of Microbiology, Rutgers University, POB 759, Piscataway, NJ 08854-0759, (201) 932-4258. *June 17–19*

● PC IN BIG APPLE PC Expo, Coliseum, New York, NY. Seminars and product displays. Contact PC Expo, 333 Sylvan Ave., Englewood Cliffs, NJ 07632, (800) 922-0324; in New Jersey, (201) 569-8542. *June 17–19*

● INTRO TO FORTH Beginning FORTH Programming, Humboldt State University, Arcata, CA. A hands-on, introductory course for those wishing to learn FORTH and write applications in it. The fee is $150 or $200 with three credit hours. Contact Claire Duffey, Office of Continuing Education, Humboldt State University, Arcata, CA 95521, (707) 826-3731. *June 17–21*

● ENGINEERING SOFTWARE—Engineering Software: Engsoft '85, The Fourth International Conference and Exhibition, Kensington Exhibition Centre, London, England. Exhibits and sessions. Contact Elaine Taylor, Computational Mechanics Centre, Ashurst Lodge, Ashurst, Southampton SO4 2AA, England; tel: (042 129) 3223; Telex: 47388 Attn. COMPMECH. *June 18–20*

● COMPUTERS AND MANUFACTURING—Successful Implementation of Computer Integrated Manufacturing, Constellation Hotel, Toronto, Ontario, Canada. Topics covered include components of computer-integrated manufacturing, methods of implementation, and planning and management. Contact Computer and Automated Systems Association, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500. *June 18–20*

● DATA COMMUNICATIONS UPDATE—Data Communications: A Complete Overview and Update, Newport Beach, CA. The managerial, operational, and technical aspects of data communications and facilities are covered. Contact Data-Tech Institute, Lakeview Plaza, POB 2429, Clifton, NJ 07015, (201) 478-5400. *June 19–21*

● TIPS FOR NET MANAGERS—Network Management/Technical Control,

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EVENT QUEUE

Convention Center, San Jose, CA. A conference and exposition. Contact CW Conference Management Group, 375 Cochituate Rd., POB 880, Framingham, MA 01701, (800) 225-4698; in Massachusetts, (617) 879-0700. *June 24–27*

● WORK WITH A COMPUTER—Using a Personal Computer, Breckenridge Concourse Hotel, St. Louis, MO. A hands-on course for those who want to use integrated software packages. The fee is $965. Contact The Center for Professional Advancement, POB H, East Brunswick, NJ 08816, (201) 238-1600. *June 24–27*

● ADVANCED FORTH Using FORTH Effectively, Humboldt State University, Arcata, CA. An advanced, hands-on workshop in applying FORTH to real-world problems. The fee is $150 or $200 with three credit hours. Contact Claire Duffey, Office of Continuing Education, Humboldt State University, Arcata, CA 95521, (707) 826-3731. *June 24–28*

● ADVANCED LOTUS CLASS—Advanced Lotus 1-2-3, Georgia Institute of Technology, Atlanta. A concentration on macros, macro menus, and multiple linked worksheets. The fee is $390. Contact Trish Stolton, Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332, (404) 894-2547. *June 25–26*

● GRAPHICS IN SUNSHINE Computer Graphics '85 West, Los Angeles, CA. Contact National Computer Graphics Association, 8401 Arlington Blvd., Fairfax, VA 22031, (703) 698-9600. *June 25–27*

● UNIX FOR MANAGERS UNIX Overview for Managers, City University, Bellevue, WA. For managers considering a UNIX system for office automation or software development. The fee is $100. Contact David Cheyette, Specialized Systems Consultants, POB 7, Northgate Station, Seattle, WA 98125, (206) 367-8649. *June 26*

● CAD TECHNOLOGY CAD 2001: The Countdown, Boston, MA. Presentations on the future of computer-aided design. The fee is $900. Contact CAD Seminars Inc., Suite 400, 150 East Riverside, Austin, TX 78704, (512) 445-7342. *June 26–28*

● DATA COMMUNICATIONS UPDATE—Data Communications: A Complete Overview and Update, Philadelphia, PA. See June 19–21 for details. *June 26–28*

● COMPUTERS IN AUSTIN The Third Annual Austin Computer Fair, Municipal Auditorium, Austin, TX. More than 150 exhibits and seminars are planned. Contact David Orshalick, Austin Seminars Inc., POB 4531, Austin, TX 78765, (512) 451-2954. *June 27–29*

July 1985

● COMPUTER TRAINING Computer Training Programs, Wintergreen Learning Institute, Wintergreen, VA. Hands-on training in word processing, information management, spreadsheets, and graphics. Contact Dr. M. D. Corcoran, Wintergreen Learning Institute, POB 7, Wintergreen, VA 22958, (804) 325-1107. *July–September*

● AUTOMATION DOWN UNDER—AutoMach Australia '85, Melbourne. An automated manufacturing conference and exhibition. Contact SME World Head-

(continued)

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THE RESULTS ARE IN

We found the printer which has all the features anyone could want. The winner is the Aprotek Daisy 1120, a real heavy-duty workhorse printing at 20 characters per second. The manufacturer is Olympic Co. Ltd., a highly respected Japanese firm.

FEATURES GALORE

This printer has it all. To start with, it has a front panel Pitch Selector button with indicators which allows 10, 12, 15 characters per inch (CPI) or Proportional Spacing. There is a Select (Online) button (with indicator) and a Line Feed button. You can also set Top-of-Form or Form Feed with the touch of the TOF button. Other front panel indicators include Power and Alarm.

To load a sheet of paper, simply place it in the feed slot and pull the paper bail lever. PRESTO! The paper feeds automatically to a 1 inch top margin and the carriage aligns to the selected **left** margin. In this manner, each page can have identical margins automatically. You can continue to compute while the Daisy 1120 is printing. The built in 2K buffer frees up your computer while printing a page or two allowing you to go to your next job.

To really put your printer to work, the Cut Sheet Feeder option is great for automatic printing of those long jobs. Also available is the adjustable Tractor Feed option. Compare our option prices! Best of all the Daisy 1120 is quiet: only 57 dB-A (compare with an average of 62-65 dB-A for others).

COMPLETE COMPATIBILITY

The Daisy 1120 uses industry standard Diablo® compatible printwheels. Scores of typeface styles are available at most computer or stationary stores. You can pop in a 10, 12, 15 pitch or proportional printwheel and use paper as wide as 14". At 15 CPI you can print 165 columns—great for spreadsheets.

The Daisy 1120 uses the Diablo Hytype II® standard ribbon cartridges. Again universally available.

Not only is the hardware completely compatible, the control codes recognized by the Daisy 1120 are Diablo 630® compatible (industry standard). You can take advantage of all the great features of word processing packages like Wordstar®, pfs: Write®, Microsoft Word® and most others which allow you to automatically use superscripts, subscripts, automatic underlining, bold-face (shadow printing) and doublestrike.

The printer has a set of rear switches which allow the use of standard ASCII as well as foreign character printwheels. Page length can be set to 8, 11, 12, or 15". The Daisy 1120 can also be switched to add automatic line feed if required.

THE BEST PART

When shopping for a daisy wheel printer with all these features (if you could find one), you could expect to pay $600 or $700 dollars. The options would add much more. *Not now!* We have done our homework. We can now offer this printer for only $353. Order yours today!

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EVENT QUEUE

quarters, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500; in Australia, Mr. Greco, Integrated Project Management Services, POB 1399, Crows Nest 2065, New South Wales, Australia; tel: 02-439-4014; Telex: AA25468. *July 2–5*

● ADVANCED AUTOMATION—Robot Manipulators, Computer Vision, and Automated Assembly, Cambridge, MA. Contact Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139. *July 8–12*

● COMPUTATIONAL LINGUISTICS—The Twenty-Third Annual Meeting of the Association for Computational Linguistics, University of Chicago, IL. Papers, demonstrations, and tutorials. Contact Don Walker (ACL), Bell Communications Research, 445 South St., Morristown, NJ 07960, (201) 829-4312. *July 8–12*

● SYMPHONY TIPS Advanced Symphony, Georgia Institute of Technology, Atlanta. Areas covered include auto-dialing to remote computers and "smart" spreadsheets using AI concepts to preanalyze numeric outputs. The fee is $390. Contact Trish Stolton, Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332, (404) 894-2547. *July 9–10*

● AWC CONFERENCE The Fourth Annual National Conference of the Association for Women in Computing, Allerton Hotel, Chicago, IL. Workshops and sessions on technical and career-enhancement topics. For more information, contact Joan Wallbaum, AWCC '85, 407 Hillmore Dr., Silver Spring, MD 20901. *July 13–14*

● THE NCC The 1985 National Computer Conference: NCC '85, McCormick Place, Chicago, IL. Exhibits, technical sessions, and development seminars. This year's theme is "Technology's Expanding Horizons." Contact Helen Mugnier, AFIPS, 1899 Preston White Dr., Reston, VA 22091, (703) 620-8926. *July 15–18*

● iRMX USERS MEET The iRUG Annual International Conference, Palmer House, Chicago, IL. The theme is "The Future Direction of Real-Time Software Applications." iRUG is a a nonprofit organization made up of Intel iRMX operating system users. Contact Catherine Moon, MS/HF2-57, Intel Corp., 5200 Northeast Elam Young Parkway, Hillsboro, OR 97123, (503) 640-7038. *July 17*

● SIMULATION The 1985 Summer Computer Simulation Conference: SCSC '85, Westin Hotel, Chicago, IL. Contact Charles Pratt, Society for Computer Simulation, POB 2228, La Jolla, CA 92038, (619) 459-3888. *July 22–26*

● COMPUTER WORKSHOPS—Personal Computer Workshops, Aspen and Colorado Springs, CO. Tutorials, including an introduction to personal computers, word processing, spreadsheets, and database management. Contact Rocky Mountain Institute of Software Engineering, 1670 Bear Mountain Dr., POB 3521, Boulder, CO 80303, (303) 499-4782. *July 22–26*

● SIGGRAPH SIGGRAPH '85: The Twelfth Annual Conference on Computer Graphics and Interactive Techniques, Moscone Center, San Francisco, CA. Contact SIGGRAPH '85,

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EVENT QUEUE

Conference Services Office, Smith, Bucklin and Associates Inc., 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610. *July 22–26*

● INTELLIGENT MACHINES Logic Programming & Expert Systems, The Turing Institute, Edinburgh, Scotland. Lectures, demonstrations, and sessions on programming techniques, system structure, and Prolog. Contact The Turing Institute, 2 Hope Park Square, Edinburgh EH8 9NW, Scotland; tel: 031-668-1737. *July 24–25*

● TECH CONFERENCE Semi-Official Get-together: SOG IV, Central Oregon Community College, Bend, OR. Sponsored by *Micro Cornucopia*, this conference features forums on communications and single-board systems design. Admission is free. Contact Micro Cornucopia Inc., POB 223, Bend, OR 97709, (503) 382-8048. *July 25–28*

● CHEMICAL ENGINEERING The Seventh C.C.C.E. National Computer Workshops-East, Clarkson University, Potsdam, NY. Sponsored by the American Chemical Society Division of Chemical Education's Committee on Computers in Chemical Education and Project SERAPHIM. Advanced registration is $100. Contact Dr. Donald Rosenthal, Department of Chemistry, Clarkson University, Potsdam, NY 13676, (315) 268-6647. *July 28–August 1*

● PUBLIC COMPUTING The Twenty-Third Annual Conference of the Urban and Regional Information Systems Association, Westin Hotel, Ottawa, Ontario, Canada. The conference theme is "Computers in Public Agencies, Sharing Solutions." Contact URISA Secretariat, Suite 300, 1340 Old Chain Bridge Rd., McLean, VA 22101, (703) 790-1745. *July 28–August 1*

● COMPUTERS AND EDUCATION—The 1985 World Conference on Computers in Education, SCOPE Convention Center, Norfolk, VA. Exhibits, papers, panel sessions, tutorials, and preconference workshops. Contact WCCE/85, AFIPS, 1899 Preston White Dr., Reston, VA 22091, (800) 622-1985; in Virginia, (703) 620-8900. *July 29–August 2*

August 1985

● ENGINEERING CONFERENCE, EXPO—The 1985 ASME International Computers in Engineering Conference and Exhibition, Sheraton Boston Hotel, Boston, MA. The theme is "Expert Systems: A New Dimension in Computer Engineering." Contact The American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017, (212) 705-7100. *August 4–8*

● EVENT FOR TRAINERS COMTRED '85: The National Computer Training and Education Conference and Exhibition, Civic Center, Philadelphia, PA. Seminars and conferences for educators, computer trainers, retailers, and distributors. More than 50 exhibits. Preconference workshops on August 6. Contact National Computer Education Expositions Inc., Suite 200, 1411 Walnut St., Philadelphia, PA 19102, (215) 972-8792. *August 7–9*

● TOMORROW'S COMPUTERS—International Symposium on New Directions in Computing, Norwegian Institute of Technology, Trondheim,

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EVENT QUEUE

Norway. Contact New Directions in Computing, IEEE Computer Society, POB 639, Silver Spring, MD 20901. *August* 12–14

● GRAPHICS
Ausgraph '85, Brisbane, Queensland, Australia. Australia's first international conference and exhibition on computer graphics. Contact Conference Secretariat, Ausgraph '85, POB 29, Parkville, Victoria 3052, Australia; tel: (03) 387 9955; Telex: AA 33761. *August* 12–16

● COMPUTER SWAP
Northwest Computer Swap Number 9, Fiesta Exhibit Hall, San Mateo County Fairgrounds, San Mateo, CA. Admission is $5. Contact Northwest Computer Swap, 4883 Tonino Dr., San Jose, CA 95136, or call Robert Kushner, (408) 978-7927. *August* 17

● AI INVESTIGATED
IJCAI-85: The International Joint Conferences on Artificial Intelligence, University of California, Los Angeles. Topics include AI architectures and languages, intelligent CAI, automated reasoning, and expert systems. Tutorials. Contact IJCAI-85, American Association for Artificial Intelligence, 445 Burgess Dr., Menlo Park, CA 94025, (415) 321-1118. *August* 18–24

● FOR EDUCATORS
Innovative Applications of Microcomputer Technology in Vocational Education, University of Wisconsin, Madison. The emphasis will be on interactive video, networking, hard-disk systems, and telecommunications for agriculture, education, and health applications. Contact Dr. Judith Rodenstein, Vocational Studies Center, 964 Educational Sciences Building, University of Wisconsin-Madison, 1025 West Johnson St., Madison, WI 53706, (608) 263-4367. *August* 19–21

● INTERFACING WORKSHOP—Personal Computer and STD Computer Interfacing for Scientific Instrument Automation, Washington, DC, area. A hands-on workshop with each participant wiring and testing interfaces. The fee is $450. Contact Dr. Linda Leffel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 961-4848. *August* 22–24

● OFFICE AUTOMATION EVENT—INTECH '85: The Integrated Information Technology Conference and Exposition, Moscone Center, San Francisco, CA. An office-automation forum. Contact Jill Nieman, National Trade Productions Inc., Suite 400, 2111 Eisenhower Ave., Alexandria, VA 22314, (800) 638-8510; in Virginia, (703) 683-8500. *August* 26–29

● VIDEODISC CONFERENCE—The Fifth Annual Nebraska Videodisc Symposium, University of Nebraska, Lincoln. The theme is "Videodisc—The Industry Comes of Age." Panel discussions, presentations, and exhibits. Registration is $375. Contact Videodisc Design/Production Group, KUON-TV/University of Nebraska-Lincoln, POB 83111, Lincoln, NE 68501, (402) 472-3611. *August* 27–30

● NEW ZEALANDERS CONVENE—The Ninth New Zealand National Computer Conference, Sheraton, Auckland, New Zealand. Speakers, panel sessions, and exhibits. For details, contact Conference Committee, POB 3839, Auckland, New Zealand. *August* 27–31 ■

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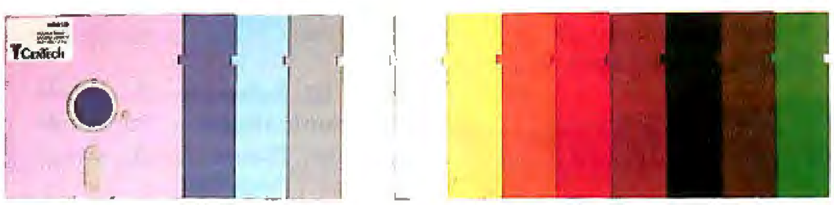

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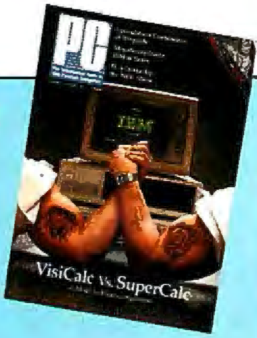

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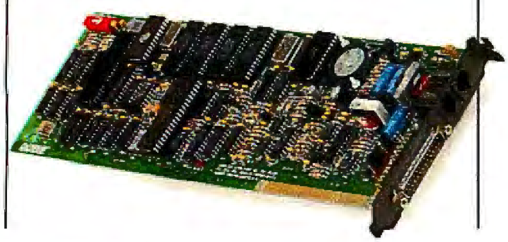

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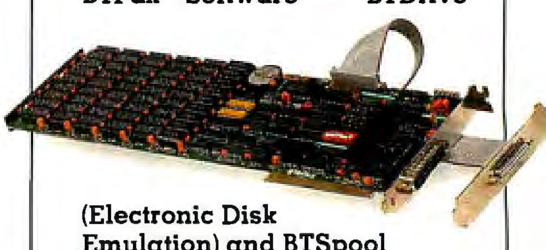

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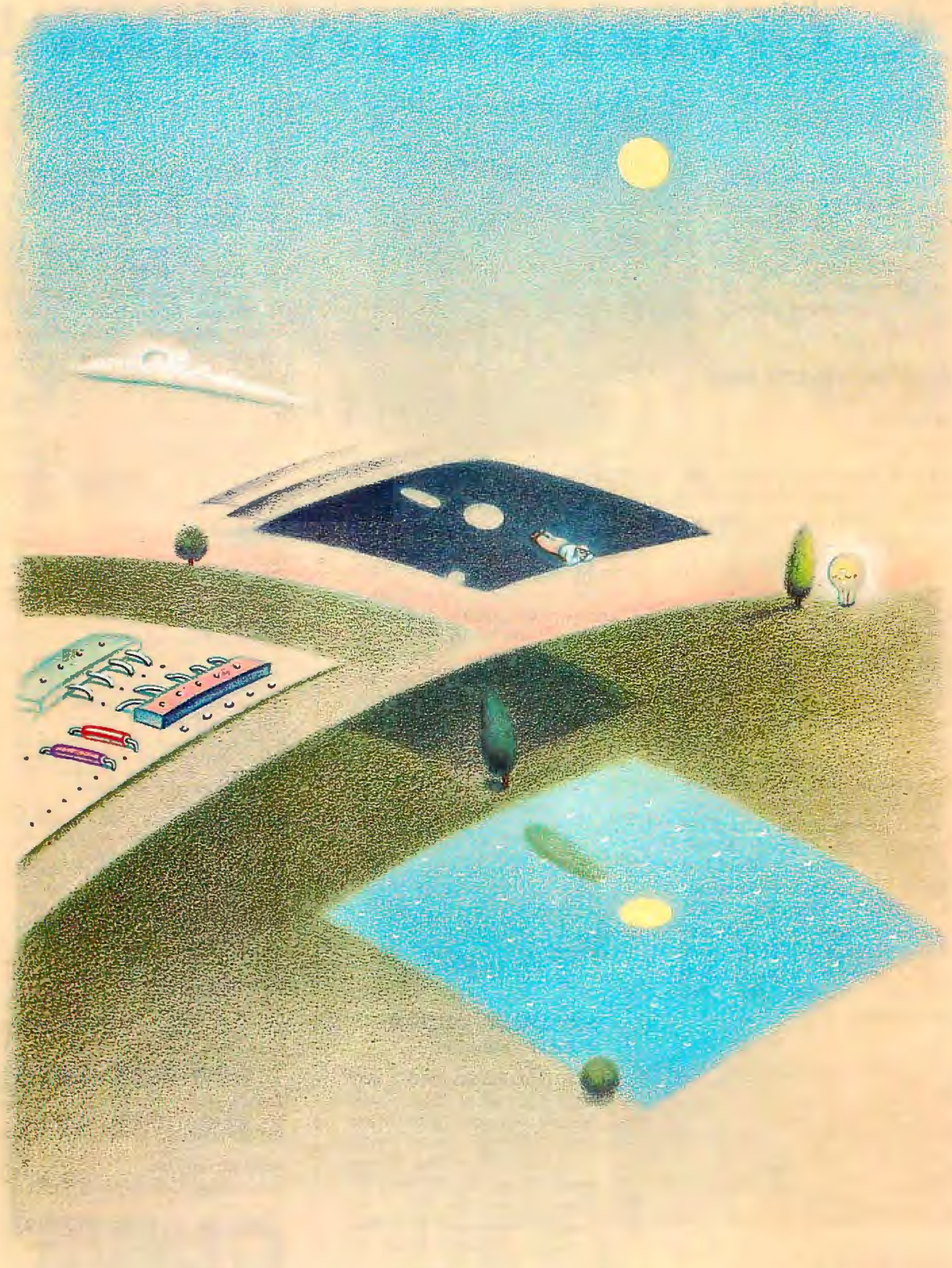


Features

LAST JULY OUR THEME was computers and video. This month we present a different aspect of this interesting topic. John Lawler, Paul Hairsine, and Albert Miller explain the design and operation of the Search 400-R audio box, which transfers sound from a cassette recorder to videodisc systems.

June also sees Steve Ciarcia finishing up his Home Run Control System (HCS) project by describing the system's software. The heart of the HCS is an interrupt-service routine. All of the system's other functions are subroutines that are called from this main routine.

Prior to the development of their SALT language, Samuel Fenster and Lincoln Ford spent a lot of time developing programs that would accommodate their work in research laboratories. SALT is a threaded interpretive language that performs repetitious procedures rapidly and does not use much memory space.

Phillip Robinson, a senior technical editor in our Palo Alto office, looks at the SUM coprocessor, which is being developed for computers geared toward AI programming. Originally, the SUM research team planned to develop a unification chip, but it became clear that at present levels of integration a single chip would be impractical; therefore, the group decided to design a full-blown processor.

In February our BYTE West Coast staff previewed AppleTalk in "The Macintosh Office" (page 120). This month David Ushijima takes a closer look at Apple's new local-area network (LAN), which is designed to let Apple and non-Apple products communicate and share resources. AppleTalk is extremely flexible and can be used in three ways: as a peripheral bus, as a small LAN, or as a path to a more complex network.

Imagine your computer taking the place of your car mechanic. Michael Fichtelman presents an expert mechanic program written in Logo. The expert mechanic analyzes problems with knowledge-base searches—probing until the source of the mechanical problem is found. This program could serve as a model for many areas of expertise.

Switch is a BASIC program for IBM PCs that enables you to use both monochrome and color monitors at the same time. Werner F. Grunbaum shows you how to write graphic instructions on your monochrome monitor and display the results on your color monitor—a neat idea.

Converting negative numbers on a computer can be difficult. Gary Bronson and Karl Lyon show us a new two's-complement conversion method using the "value box," which simplifies the process by visually connecting a two's-complement binary number to its decimal value.

—*Phil Lemmons, Anne Fischer, and Joan Roy,* BYTE

INTERACTIVE AUDIO IN A VIDEODISC SYSTEM

Create various sound tracks for your videodisc show

Microcomputer-driven videodisc teaching systems usually consist of a microcomputer, such as an Apple IIe or an IBM Personal Computer (PC), and a videodisc player controlled externally by computer. Some systems also use an input device like a TSD (touch-sensitive display) or a mouse. The system described in this article consists of a microcomputer (which controls the videodisc player), a TSD, and an external audio system that uses ordinary cassette tapes. (For an in-depth discussion of videodiscs, see "Videodiscs and Computers" by Stan Jarvis, July 1984, BYTE, page 187.)

While you can use videotape players interactively, videodiscs are more readily controlled by computer, have much faster interimage access times, and can store up to 54,000 frames on one side. You can also connect a TSD so that the computer can determine what action to take depending on the area of the screen you touch.

Such a system needs computer control. While some videodisc players have a small amount of memory and therefore can have rudimentary programs encoded on the actual videodisc, a microcomputer-driven system is infinitely more versatile.

Software written for the computer can easily drive not only the videodisc player but other connected devices as well. These programs offer you higher levels of interactivity because most computers are not limited to small amounts of memory. Keep in mind that the interactivity of such a system comes not from the media (videodisc, etc.) but from the computer program. How well it uses the various parts of the system and the techniques of an effective presentation determines the success of your videodisc system.

You can create teaching packages with slides and videotaped motion sequences that have been transferred onto the videodisc and mixed with computer text and graphics either on the videodisc or overlaid on the videodisc image on the display. The resulting system is not merely an expensive, glorified slide show. You can have as interactive a teaching tool as you want as long as it is controlled by computer. You can easily program as many help buttons, quizzes, etc., as you need using the information on the videodisc. There are many applications for such a system in all phases of education—lab work, review, remedial help, self-paced courses, etc.—and at any grade level.

While pictures and animation may serve many purposes, speech and sound are often invaluable. Most videodiscs have an audio track for recording sound. But while sound can accompany a sequence of frames (animation), such as a space-shuttle launch, it cannot accompany a single still picture because a single frame does not have enough space to hold it. There are two ways around this. One is to show many copies of the same picture, one after the other, or, in other words, animate it. This is the same as showing a sequence, and sound can accompany it. But even a 15-second use of videodisc-recorded sound uses 450 copies (30 frames = 1 second of motion) of one picture, an obvious waste of space. Sony has

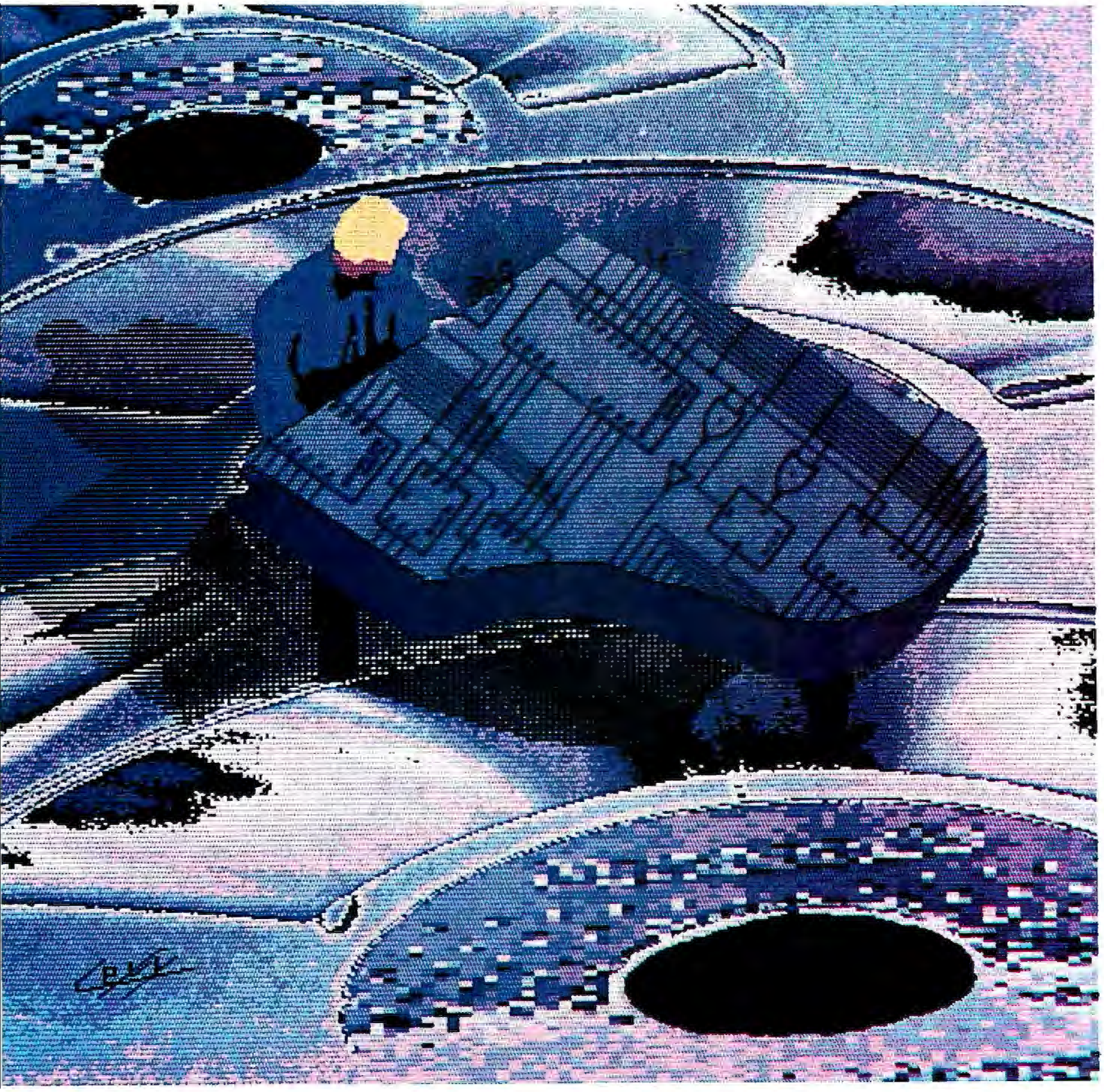
(continued)

John Lawler is currently a junior at the University of Notre Dame majoring in electrical engineering with a concentration in computer engineering.

Paul Hairsine, who designed the board described in this article, has both a B.S. and an M.S. in electrical engineering from Notre Dame and is currently working at McDonnel Douglas.

Albert E. Miller is a graduate of the Colorado School of Mines and has a Ph.D. from Iowa State University. He is a professor in the Department of Metallurgical Engineering and Materials Science at Notre Dame and directs a group involved with interactive videodisc systems for training purposes. All authors can be reached at the University of Notre Dame, Department of Metallurgical Engineering and Materials Science, Notre Dame, IN 46556.

BY JOHN LAWLER, PAUL HAIRSINE, AND ALBERT E. MILLER



ILLUSTRATED BY FRANK LEVY

The Operation of the Search 400-R

The Search 400-R is a self-contained box consisting of a cassette deck mounted on an electronics board, a keyboard control with a light-emitting diode (LED) display, and a 16-pin dual-inline-package (DIP) cable connected to a computer interface. You can operate the unit manually or by computer.

The main difference between the Search 400-R audio system and a normal cassette player is in the way you record sound on the tape. Normal cassette tapes have only one track, or one recording surface, on which to record sound. The Search 400-R audio box, however, divides the tape into four tracks, each of which can be recorded on separately. It sections each track further into either 25, 50, or 100 locations. Therefore, you can divide a standard C120 (2-hour) tape into as many as 400 locations. However, tracks have a finite amount of recording surface, so the more locations you have per track, the less sound you can fit into each location. With 100, 50, or 25 locations per track, you can have 0.5, 1.1, or 2.3 minutes of audio per location, respectively. A by-product of this recording scheme is an increased tape capacity—from the original 2 hours to as much as 3.83 hours (4 tracks × 25 locations per track × 2.3 minutes per location).

The Search 400-R is especially useful in a computer system because the tape locations are accessed randomly. This shortens the time between requesting a location and playing it. Accessing a location 25 minutes away from your current position takes about 12 seconds; the search time between adjacent locations is substantially less—approximately 1 second for each location; i.e., it takes 10 seconds to jump 10 locations. These locations are indexed from 00 to 99 while track selections are 1 through 4.

One by-product is a greater tape capacity: as much as 3.83 hours on a 2-hour tape.

The deck finds various sections of audio by counting the number of times the tape reel turns. This indirect method of addressing specific tape locations results in high-speed searches without tape-to-head contact. There are up to 100 locations per track, and each needs a particular number of reel turns to be found; these numbers are stored in the Search 400-R's onboard ROM (read-only memory). The deck counts the number of reel turns optically and saves it in an up-down counter, which is then compared to the number stored in ROM. Then the deck fast forwards or rewinds itself as necessary to find the desired location.

One inherent source of error in such reel-count methods is the variable packing density of different tapes. How tightly or loosely the tape is wound around the reel can distort the reel count enough to compare incorrectly with the number stored in ROM. This results in selecting the wrong audio location. Differences in packing density arise because the take-up reel winds the tape more tightly during fast forward than during normal play. The reverse reel, however, maintains a consistent packing density regardless of the operation. The Search 400-R, therefore, counts the number of times the reverse reel turns to minimize the differences in reel counts.

Another possible source of error is uneven braking. To stop the tape, the deck sends equal amounts of braking currents to the two reels. However, momentum causes the reel containing the larger amount of tape to stop more slowly. The Search 400-R alleviates this problem by boosting the braking current to this reel, so both reels stop at the same time.

Counting errors can also occur if the deck goes directly from, for example, fast forward to rewind. This doesn't always allow enough time to properly update the reel count. The Search 400-R avoids this by not allowing the audio deck to switch modes (i.e., play to rewind) until it stops completely and updates the reel count. Therefore, the deck can search for specific audio locations with a great deal of accuracy.

The audio deck has more than one format of operation, that is, 25, 50, or 100 locations per track. A small rotary switch inside the audio box selects the mode. You can access this switch by removing the four screws on the back of the unit and sliding the deck out of its housing. The switch simply selects which portions of the ROM will be addressed, either manually or by computer.

The longest piece of audio any location can hold is 2.3 minutes. However, this does not preclude a 5-minute explanation. If the audio content in a particular location exceeds the defined length, the deck continues to record, but it erases whatever is in the next location; likewise, it is erased if you record another piece of audio in that next location.

To facilitate manual operation of the Search 400-R, the audio box is equipped with a 16-button keypad, an LED readout, a manual track selector, a volume control, and status lights. The keypad contains the following keys:

0–9	address digits
A	run
B	fast forward
C	stop
D	rewind
*	search
#	record

The front panel also contains three side switches: auto run, auto search, and auto repeat. When you set auto search on, the deck begins to search as soon as you enter the two location digits. When auto run is turned on, the deck doesn't wait for the actual run command but plays the message as soon as it is found. Auto repeat continues repeating the message until you enter a stop command. These three functions are useful in manual mode, but you should turn them off if you are running under computer control to prevent messages from playing before you want them to.

The deck also has a silence-sense circuit that detects the end of the audio and automatically stops the deck after 2.5 seconds of silence. This circuit senses the sequence of audio then silence, so that the silence before the audio doesn't stop the deck.

The following operating procedure applies to both manual and computer control of the Search 400-R. It is important to remember that you can manually override computer control. When you insert a new tape into the audio deck or turn the deck on, you (or the computer) first issue a rewind command to properly reset the reel counter. Then you enter the appropriate track and location information followed by a search command. After the search completes, the bulb next to the search button lights up to tell you that the audio deck is waiting for a new command. If the box is under computer control, the bulb lights up, and the computer is informed of its status. Then you enter the run command so the message found by the search will begin to play. When the message ends, the deck stops and the bulb next to the stop button lights up, indicating that it is ready for new selections and commands. If any of the side switches, such as auto run, are on, some steps will be done automatically. It is important that the track and location entered be consistent with the internal settings of the machine. In other words, you can't effectively search for location 78 when the system is set up for 50 locations.

The audio deck can record tapes as well as play them. When you press the # button—or the computer sends the record command—the system enters record mode provided the record-protect tab on the tape has not been removed. The deck does have some idiosyncrasies that you need to understand. It has a four-track format but only two tape heads. Each head covers a pair of tracks (tracks 1 and 2 and tracks 3 and 4). When recording in stereo, this causes no problem because you are recording two tracks simultaneously. When recording in mono, however, you must be careful not to erase locations. The circuitry of the audio deck requires that you select track 2 or 4 to activate the tape heads. This means that you should record track 2 before track 1, and track 4 before track 3. Otherwise, while you are recording one track, you will be erasing the other. You also have an automatic volume control when you record a tape. The Search 400-R user's manual contains instructions on how to adjust it.

The general operating procedure for recording a tape is basically the same as for playing it. After you insert the tape in the deck, you fast forward it to the end and then completely rewind it. This resets the reel counter and ensures proper packing density. (It is not necessary to fast forward and rewind the tape just to play it, but it won't hurt either.) After the tape stops, you give it the record command, either programmatically or manually with the # button. Then you enter the track and location you wish to record. A search command advances the tape to that location, and when the search status light goes on, you enter the run command to start recording. A built-in delay mutes the recording for two seconds to provide a gap between locations; this allows for small deviations in searching for a location. When the commence light appears, you speak your message into a microphone; when you finish, you enter the stop command. Pressing the # button returns the deck to playback mode, where you can check the location and message you have just recorded.

a way of recording sound on a videodisc while showing only one frame, but it too uses a great deal of space.

Another problem with recording sound on a videodisc is that once recorded, it is permanent. At the present time you cannot erase videodiscs. This is not a problem unless you decide that some recorded sound sequence isn't very clear; how can you change it? You could make another videodisc for a few thousand dollars, or you could use an external audio box.

The audio box described in this article uses cassette tapes, so if the sound is not right, you can simply record over it, allowing greater presentation flexibility. Indeed, the combination of a computer and a separate audio box means that you can make one videodisc master and use it for two completely different groups. Assume, for example, that you want to use a videodisc about the space program for both grammar school students and aerospace engineering students. Since the two groups have different comprehension levels, you would gear a different program and audiotape to each group—an easier one for the grammar school students and a more difficult one for the college students.

Recording sound onto cassette tapes is not enough; you must integrate the audio box into the system—it must be controllable by the computer. It must also have facilities for random access—given the location, to quickly find some piece of sound without searching the entire tape. And there must be some sort of interface between the computer and the audio box.

We decided to include audio capabilities in our interactive video system and to begin with something simple and inexpensive. And we wanted an easily erasable, readily available recording medium—essentially a computer-controlled cassette tape recorder. This need was met by the Search 400-R by Phi Technologies.

The Search 400-R is a self-contained box consisting of a cassette deck

(continued)

mounted on an electronics board, a keyboard control with an LED (light-emitting diode) display, and a 16-pin DIP (dual-inline package) cable connected to a computer interface. The unit can be operated either manually or under computer control. There are, however, differences between a normal cassette player and the Search 400-R audio system, which are described in the text box "The Operation of the Search 400-R" on page 110.

The 16-pin DIP connector lets you interface the cassette deck with a personal computer from which you can enter all necessary track and location data, as well as any desired commands. However, you must build an interface for the two machines to communicate with each other. The text box "Designing an Interface Card" at right describes this process.

Software Support

To make the hardware described in the text boxes useful, it must be supported by software. Luckily, simple BASIC programs can provide such support. Operating the Search 400-R with an Apple IIe is a simple process. The peripherals are plugged into internal expansion slots—called I/O (input/output) slots—numbered 0 through 7. The Apple IIe treats its I/O slots like memory locations (addresses); therefore, to communicate with a peripheral device plugged into an I/O slot, the software program must merely access the address that corresponds to the slot it wants. Table 1 provides the slot numbers for the Apple IIe, along with their corresponding addresses in decimal form.

If the interface card between the Apple and the Search 400-R is present in slot 3, for example, the program must address location 49328. Since the Apple IIe accesses the I/O slots as memory locations, you can establish communication with the audio box by using the BASIC statements PEEK(x) and POKE(x) where x is a memory address such as 49328.

To function properly, the program

(continued)

Designing an Interface Card

To design an interface card to control the Search 400-R with a microcomputer, you must first understand the microprocessor interface on the audio deck. On the back of the deck you will find a 16-pin connector that attaches it to the computer. The pins are all 5 volts and compatible with TTL (transistor-transistor logic), Schottky, and CMOS (complementary metal-oxide semiconductor). (For more information, see table A.)

The first seven pins are used to enter track and location data into the audio deck. If you want to use an address, you enter two binary-coded-decimal (BCD) numbers sequentially into pins 1 through 4, the most significant digit (MSD) first. Then you send a strobe pulse through the address strobe at pin 5 to inform the audio deck that an address, rather than a command, has been entered. The track number is entered into pins 7 and 8 and must be there when you input the first number of the address. Remember that counting starts at 0 in this system: 0 represents the first track, 1 the second, etc. Therefore, you must enter the location's MSD and the track information into the appropriate pins before you activate the strobe. Then you can input the location's least significant digit (LSD) and strobe it as well.

You enter commands to the audio box in exactly the same manner but you don't activate the address strobe. Commands are entered as BCD numbers with decimal values 10 through 15, as follows:

search	10
record	11
run	12
fast forward	13
stop	14
rewind	15

These numbers must stay on the input pins for at least 1 millisecond to register the commands properly.

Pins 10 through 15 are known as the status outputs and are used for data coming from the audio box. They are connected directly to the LED (light-emitting diode) display on the Search 400-R and can tell the computer what the audio box is doing at any given time. They are active low, so finding the pins at ground determines the status of the unit. (The start run pin is used by remote-control devices such as timers and therefore is not applicable for computer control.)

Controlling the Search 400-R

Both the Apple IIe and IBM Personal Computer (PC) have internal expansion slots for plug-in circuit boards that are directly connected to the I/O (input/output) channels. Each slot consists of a bidirectional data bus, address lines, and interrupt and DMA (direct memory access) control lines. The channels have I/O read or write lines, clock and timing lines, and power and ground for the circuit boards. You can put information on or take it off the I/O channel's data lines by connecting them to the clock's input lines, which allows the computer to control the deck, and by connecting them to the deck's status-output lines, which allows the computer to monitor the status of the deck. Thus, by connecting the Search 400-R unit in this manner, you can—with the appropriate software—have two-way communications between the deck and the controlling computer.

The Apple Interface

We purchased an interface card made by Phi Technologies for the Apple IIe rather than designing one from scratch. It uses only the data lines, a read/write line, a clock line, and the device-select line from the Apple's I/O channel to control the audio box. It is available as item #9000-009 from Phi Technologies Inc. (4605 North Stiles, Oklahoma City, OK 73105) for $160.

Each I/O slot in the Apple IIe has a specific address and uses the device-select line for decoding instead of the

(continued)

Table A: *The functions and active levels of the 16 pins in the 16-pin connector found on the back of the Search 400-R and used to connect it to the computer. (LSB stands for least significant bit, and MSB stands for most significant bit.)*

Pin 1	data bit 1 (LSB)	active high
Pin 2	data bit 2	active high
Pin 3	data bit 3	active high
Pin 4	data bit 4 (MSB)	active high
Pin 5	address strobe	active high
Pin 6	track bit 1 (LSB)	active high
Pin 7	track bit 2 (MSB)	active high
Pin 8	ground	
Pin 9	start run	active high
Pin 10	search OK status	active low
Pin 11	rewind status	active low
Pin 12	fast forward status	active low
Pin 13	run status	active low
Pin 14	stop status	active low
Pin 15	record status	active low
Pin 16	+5 volts	

Table B: *The addresses you can use to activate two channels if you wish to attach two audio boxes.*

	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
Channel 1	1	1	0	0	0	X	X	0	0	0
Channel 2	1	1	0	0	0	X	X	0	1	1

address lines. When you wish to either send or receive data from the I/O slot's address, you activate that slot's device-select line. Its data lines are connected to the status-output lines, and to the deck's two input lines (pins 1–7) via seven clocked D-type flip-flops. Of the seven data bits sent through the input lines, the four LSD bits are the address bits, the next two the track bits, and the seventh the address strobe. Note that the MSD bit is not used. The clock inputs to the seven D-type flip-flops are connected to the output of another clocked D-type flip-flop that is further connected to the output of the decoding circuitry. When you activate the device-select line, and the read/write line is in the write state, the input to the lone D-type flip-flop goes from low to high.

The corresponding clock line is connected to a system clock that goes high halfway through the I/O cycle. If the input to the lone D-type flip-flop has been set high by the decoding circuitry, when the system-clock line goes high, the output of this flip-flop goes from low to high. This is seen as a clock pulse that initiates the data transfer from the data lines to the input lines.

A series of three-state gates connects the status-output lines to the data lines. These gates act as buffers and prevent the data from the status lines from entering the data lines

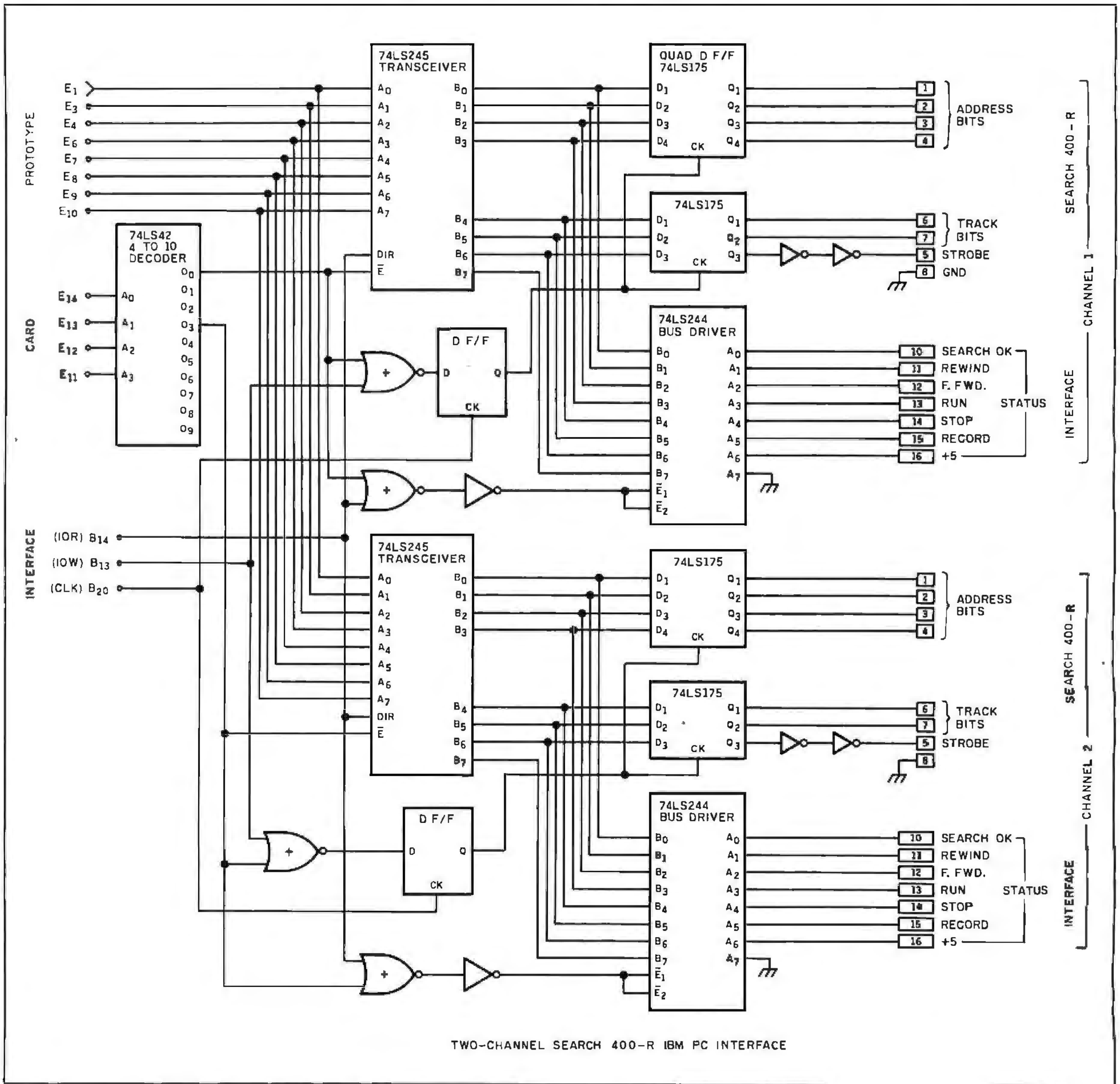


Figure A: A *logic diagram of* Paul Hairsine's *interface card for the* IBM PC.

unless the interface card requests a read. When the computer asks for the status of the Search 400-R, the device-select line is activated and the read/write line goes to the read state, activating the three-state gates. This action puts the data from the status line onto the I/O channel's data line. It remains there until the end of the I/O instruction cycle, at which time the three-state gates deactivate. In this manner, the computer can monitor the status of the audio box.

THE IBM INTERFACE

Although there was an interface for the Apple IIe, there was none for the IBM PC, so we had to design one. We used an IBM prototype card that plugs into an expansion slot. The logic diagrams for the designed interface and the prototype card are included in figure A.

The prototype card contains a voltage bus (+5 volts) that borders on its back and a ground bus on its front. It has a system-interface design that ensures that you only use the I/O address assigned for user design and protects the computer from faulty circuit designs. The prototype card's interface has five address lines not used as part of its decoding circuitry, allowing you to assign different addresses to different cards or to different circuits on the same card. The rest of the address lines are decoded into an I/O decode line, which activates the circuitry on the card. The prototype card's interface also has eight data lines that are used for its circuitry.

Because the IBM PC's I/O channel can address two different circuits on the same board, we designed the interface card with two channels so you can drive two Search 400-Rs with it. Two audio boxes on the same system provide faster access time to tape locations and allow two separate videodisc systems to share the same computer. Having only one interface card instead of two also leaves one of the IBM PC's few expansion slots free for other uses. Its design is similar to the Apple's to allow easy software transfer between the two systems.

We used a 4-to-10 decoder to create the two channels. It uses the last three address bits, E_{14}–E_{12}, and the I/O select bit, E_{11}, from the prototype card for its four input lines (see figure A). The output lines that activate the two channels also determine their addresses. Outputs O_0 and O_3 are used with the interface card and provide the possible addresses for each channel shown in table B. The Xs can be either 0s or 1s. If you use all possible combinations and convert these binary numbers to decimal, you can address channel 1 with 768, 776, 784, and 792 and channel 2 with 771, 779, 787, and 795. If you use these addresses properly, you can easily transfer data to or from the appropriate audio deck. The two channels are identical except for the addresses that activate them.

Table C: *The chips required to build the* IBM PC *interface card.*

1	74LS42 4-to-10 decoder
2	74LS245 octal-bus transceivers
2	74LS244 octal-buffer line drivers
4	74LS175 quad D-type flip-flops
1	74LS74 dual D-type flip-flop
1	74LS04 hex inverter
1	74LS02 quad NOR gate
12	chips total

Each channel uses an octal transceiver to connect its data lines to the prototype card's data lines. A transceiver is a device that allows one of three possible actions between the two points it connects: Data can flow from A to B or from B to A, or A and B can be isolated from each other. This is ideal for the interface card; each channel can be bidirectional when activated or it can be isolated from the computer. The direction of the data transfer through the transceiver is determined by the I/O read line: If the line is active, the data is sent to the computer; if it is not, the information is sent only to the audio deck.

The deck's input lines for each channel are connected to its transceiver through seven clocked D-type flip-flops, with the pin assignments identical to those of the Apple IIe interface. The clock of all seven D-type flip-flops is connected to the output of another clocked D-type flip-flop, which in turn is connected to the output of the decoding circuitry. The decoding circuitry is simply a NOR gate whose inputs are connected to the I/O write line and the decoder output corresponding to that channel. Both inputs are active low, so when both lines activate the input, the control D-type flip-flop goes high. Its clock is connected to the system clock, so after the I/O write and the decoder output both activate, the output of the control D-type flip-flop goes from low to high on the next system clock pulse. The track and location data are on the data lines when the I/O write line is activated; when the decoder output activates, the transceiver is activated. The seven D-type flip-flops see this low-to-high transition as a clock pulse and pass the data on the data lines from the computer to the Search 400-R.

An octal-buffer line driver connects the status-output lines for each channel to its transceiver. This driver allows only two possible states: Data is transmitted from A to B, or A and B are isolated. When the computer requests information from the audio box, the I/O read line and its corresponding decoder line are activated. Both are active low, and since the line driver activates on a low signal, you must OR the two inputs to enable it. Since we used inverters and NOR gates to design the interface board, we used an inverted NOR to implement the OR gate. This saved us from having to add an OR gate to the board. After the line driver activates, data from the status outputs appears on the I/O channel's data lines and remains there until the end of the instruction cycle. This provides the computer with enough time to fetch the data and to monitor the status of an audio box on either channel.

We built the interface card with the chips shown in table C. The card is connected to the Search 400-R through a 16-line flat cable. Each end of the cable has a 16-pin DIP (dual-inline package) connector, which plugs into the 16-pin wire-wrapped sockets on the interface card and into the audio deck's interface receptacle. You can find a layout of the card in figure A. The pin assignments of the 16-pin wire-wrapped sockets correspond to the numbers of the Search 400-R's receptacle shown in table A.

needs the track and location of the desired sound sequence. These two numbers, track and location, first must be converted to binary-coded-decimal (BCD) numbers and then output to the audio box through the interface card. The most significant digit (MSD) is output first and the least significant digit (LSD), last. If you set the Search 400-R audio box for computer control, you must set bits 4 and 5 of the input data to the track number used when the MSD is output; you must set bit 6 high on both the track and location address outputs. The Search 400-R has six commands, and each has a two-digit code. Issuing a command to the audio unit is simply a matter of implementing a POKE to insert its code into the address of the audio system. The following is a list of the commands and their codes:

Command name	Code
search	10
record	11
run	12
fast forward	13
stop	14
rewind	15

You must follow each POKE of a command code with a POKE of 0, which prepares the interface card to accept another command. For example, to tell an audio box connected to I/O slot 3 (address 49328) to rewind the tape (code 15) you would have to send the commands POKE 49328,15: POKE 49328,0.

Listing 1 provides a simple but workable example of how to tell the audio box to search for a certain location on the tape. Lines 100 and 110 ask for the track and location of the piece of sound desired. Line 120 sets A to the location's MSD and B to its LSD. Line 130 sets up the data for proper output. This is done by setting the address strobe (bit 6) high (+64) for both A and B. T*10 sets bits 4 and 5 of the first address digit to the track number. Lines 140 and 150 output the address to the interface, and line 160 gives it the search command. These few lines can fully control the Search 400-R audio box.

Occasionally, you might want to check for proper operation of the audio deck by reading the status lines. Essentially, the status information works like a stoplight that tells the computer when the next command can continue to its destination. The status line can tell you if everything is running smoothly. If it is, you can have the next command sent. If not, the computer delays the command until it is ready for it. Reading the status is easy with BASIC's PEEK command. Seven status lines provide information on the audio deck's operation. Combined, they make up a status byte. The Apple IIe is an 8-bit machine, and it reads 8-bit bytes, such as the status byte of the audio box.

The status lines are all considered *active low* except for the power on line.

Table 1: *The slot numbers for the Apple IIe along with the corresponding decimal addresses. (Note: Slot 0 is not present in the Apple IIe but is present in the Apple II and the Apple II+.)*

Slot	Decimal Address
0	49280
1	49296
2	49312
3	49328
4	49344
5	49360
6	49376
7	49392

Listing 1: *The Apple IIe code required to tell the audio box to search for a specific location on the tape.*

```
100 INPUT "Enter track number: ";T
110 INPUT "Enter location: ";L
120 A = INT(L/10): B = L-(A*10)
130 A = A+(T*10)+64: B = B+64
140 POKE 49328,A: POKE 49328,0
150 POKE 49328,B: POKE 49328,0
160 POKE 49328,10: POKE 49328,0
```

Listing 2: *This section of Apple IIe code contains a* search *followed by a wait for the* search OK *before issuing the* run *command.*

```
10 POKE 49328,10: POKE 49328,0
20 IF PEEK(49328)<>110 THEN 20
30 POKE 49328,12: POKE 49328,0
```

Listing 3: *The code required to establish communications between the audio box and the* IBM PC *and the Apple IIe, respectively.*

IBM PC

```
100 INPUT "Enter track: ";T
110 INPUT "Enter location: ";L
120 A=INT(L/10): B=L-(A*10)
130 A=A+(T*10)+64: B=B+64
140 OUT 768,A: OUT 768,0
150 OUT 768,B: OUT 768,0
160 OUT 768,10: OUT 768,0
170 IF INP(768)<>110 THEN 170
180 OUT 768,12: OUT 768,0
```

Apple IIe

```
100 INPUT "Enter track: ";T
110 INPUT "Enter location: ";L
120 A=INT(L/10): B=L-(A*10)
130 A=A+(T*10)+64: B=B+64
140 POKE 49328,A: POKE 49328,0
150 POKE 49328,B: POKE 49328,0
160 POKE 49328,10: POKE 49328,0
170 IF PEEK(49328)<>110 THEN 170
180 POKE 49328,12: POKE 49328,0
```

This means that if a certain status is *on*, its particular bit in the status byte is equal to 0—just the opposite of what you would expect—and if the status is off, the bit equals 1. The exception lies in the status of power on, which follows the more common usage; i.e., 1 means on and 0 means off. The following list shows what functions the various status bits imply:

Status	Data bit
search OK	0
rewind	1
fast forward	2
run	3
stop	4
record	5
power on	6

Consider the status byte shown in figure 1. Bits 0 through 6 are the status bits, and each provides some piece of information; for instance, bit 4 tells you whether the audio deck has stopped. Therefore, if you need information about the current status of the audio box, your program must access the status byte. This can be done by looking at the address of the interface using the PEEK command, which is the same process as using POKE to enter a command. However, PEEK(x) reads a *decimal* number x, while the status information is in binary form. You must, therefore, convert the binary number to decimal form. Consider the status byte in figure 2. The binary number is 1101110, telling us that the power is on, the search for a piece of sound was successful, and the audio unit has stopped doing anything and is ready to accept another command. The decimal equivalent of 1101110 is 110, so the PEEK command would retrieve the number 110. Line 20 in listing 2 demonstrates how you can make the computer wait until a search OK appears after having issued a search command.

The software used to control the Search 400-R from the Apple IIe is straightforward. Controlling the audio box from an IBM PC requires basically the same process; however, the IBM PC doesn't treat the I/O addresses as memory locations, so the chart of slot numbers and addresses given above is not applicable. POKE and PEEK won't allow communication between the IBM PC and the audio box either. Instead, you must use the commands OUT x,y, and INP(x).

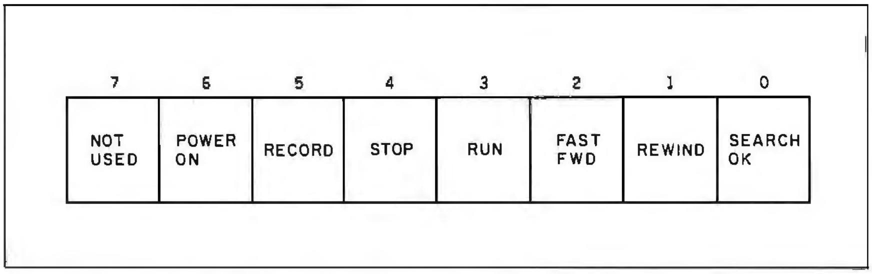


Figure 1: *The layout of the audio deck's status byte.*

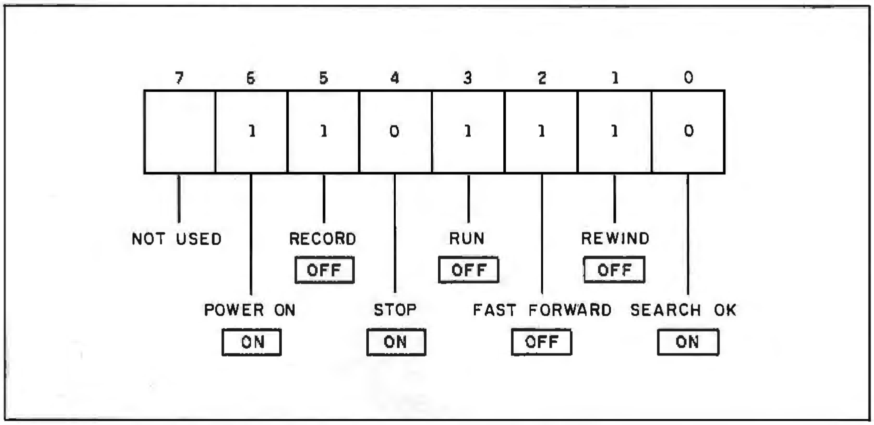


Figure 2: *An example of the status byte for the audio deck.*

Listing 3 contains the programming necessary to establish communications between the audio box and the IBM PC and the Apple IIe, respectively. Both programs need to have the track and location of the desired piece of sound, a search (code 10) for the sound, a check of the status byte for search OK, and if found, a run command (code 12). You can see from the similarity of the two programs that you can transfer BASIC programs written on either machine to the other with a minimum of translation.

While we have used BASIC in the example, you can use any computer language to accomplish the same thing, as long as you know how to output data to the I/O channel and accept input from it. Furthermore, after the audio box rewinds the tape to the beginning, approximately 100 milliseconds must elapse between stopping the tape and entering a command to move it. This allows the counting circuits in the audio box to reset. In addition, the IBM PC changes its data bits too quickly when trying to input address locations. This means that data doesn't stay on the lines long enough to properly activate the audio deck. You can correct this by writing a software delay into the program.

CONCLUSION

By using an interactive audio system, such as the Search 400-R, you can create more versatile interactive-videodisc training packages. While this article describes using interactive audio in conjunction with interactive video, the concept can just as easily be used in normal computer-based teaching packages. ■

ACKNOWLEDGMENT

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BUILD THE HOME RUN CONTROL SYSTEM

PART 3: THE SOFTWARE

BY STEVE CIARCIA

Energy management, convenience, and security in one package

Over the past few months I've been describing the Home Run Control System (HCS), my rendition of a sophisticated yet cost-effective home-control system. Briefly, the HCS is a single-board computer with the hardware and software needed to control lights and appliances in a home or a specific production process in a small business. The system uses BSR home-control modules that are activated by signals superimposed on the house wiring and can also directly control the process through hard-wired inputs and outputs. Home Run can accommodate 48 BSR modules, 16 digital inputs, 8 TTL (transistor-transistor logic)-compatible outputs, and 16 messages.

In the first two parts, I introduced you to the overall system concept and the hardware. This month, I'll finish by describing the HCS's editing software and demonstrating a simple schedule entry.

HOME RUN IS INTERRUPT-DRIVEN

The heart of the HCS is an interrupt-service routine. All other HCS functions are subroutines that are called from this main routine. I have outlined the software in great detail because many readers can understand and appreciate the HCS better from that perspective. Also, the control methodology can be used as a model for more personalized control designs should you not care to specifically build mine.

Figure 1 is the main interrupt handler. Each block in the flowchart represents a program action that in most cases is self-explanatory and requires few statements to implement. In more involved tasks, subordinate flowchart sections (figures 2 through 8) are referenced to explain those operations in greater detail. Together, they function as follows:

The timing-generator circuitry sends interrupts to the processor at approximately 601 hertz (Hz). When the processor detects the interrupt, it finishes the current instruction, saves its status, and gets the address of the interrupt-service routine. The processor executes the routine at that address until it encounters a return-from-interrupt instruction. When that occurs, the processor will recover its status and continue from where it left off prior to the interrupt.

When the interrupt-service routine is called, it decrements the interrupt counter. When this counter reaches 0, one second

(continued)

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is added to the current time. If the time changes to a new minute, the routine will check the status of the Command FIFO (first-in/first-out) buffer. If there are any commands (turning a module or output on or off), they are executed one at a time in the order they entered the FIFO buffer.

When the Command FIFO buffer is finished, the processor checks the status of the Time FIFO buffer. If it is empty, the table of events is scanned to find events that are activated by one of the input lines. When one such event is found, the appropriate input line is checked to see if it has changed status within the last second. If it has, the appropriate on or off command is placed in the Command FIFO buffer for execution. The scan continues until all input-activated events are checked.

If the Time FIFO buffer is not empty, the first time in the FIFO buffer is saved, and the table of events is scanned to find events that are scheduled to occur at that time. If the time matches, the appropriate on or off command is placed in the Command FIFO buffer for execution, and the event scan continues until all events have been checked.

(continued)

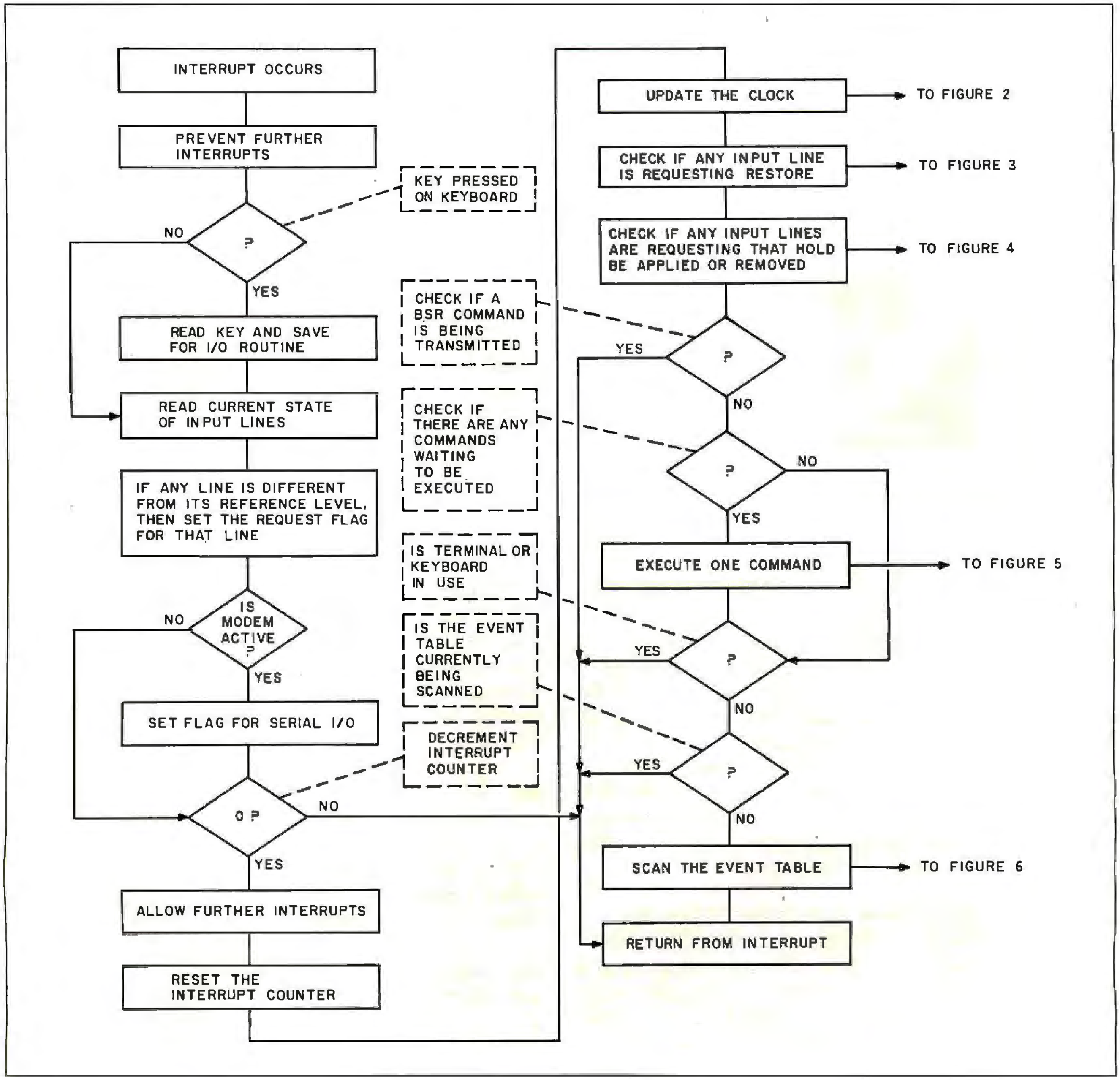

Figure 1: *Master Interrupt Handler flowchart.*

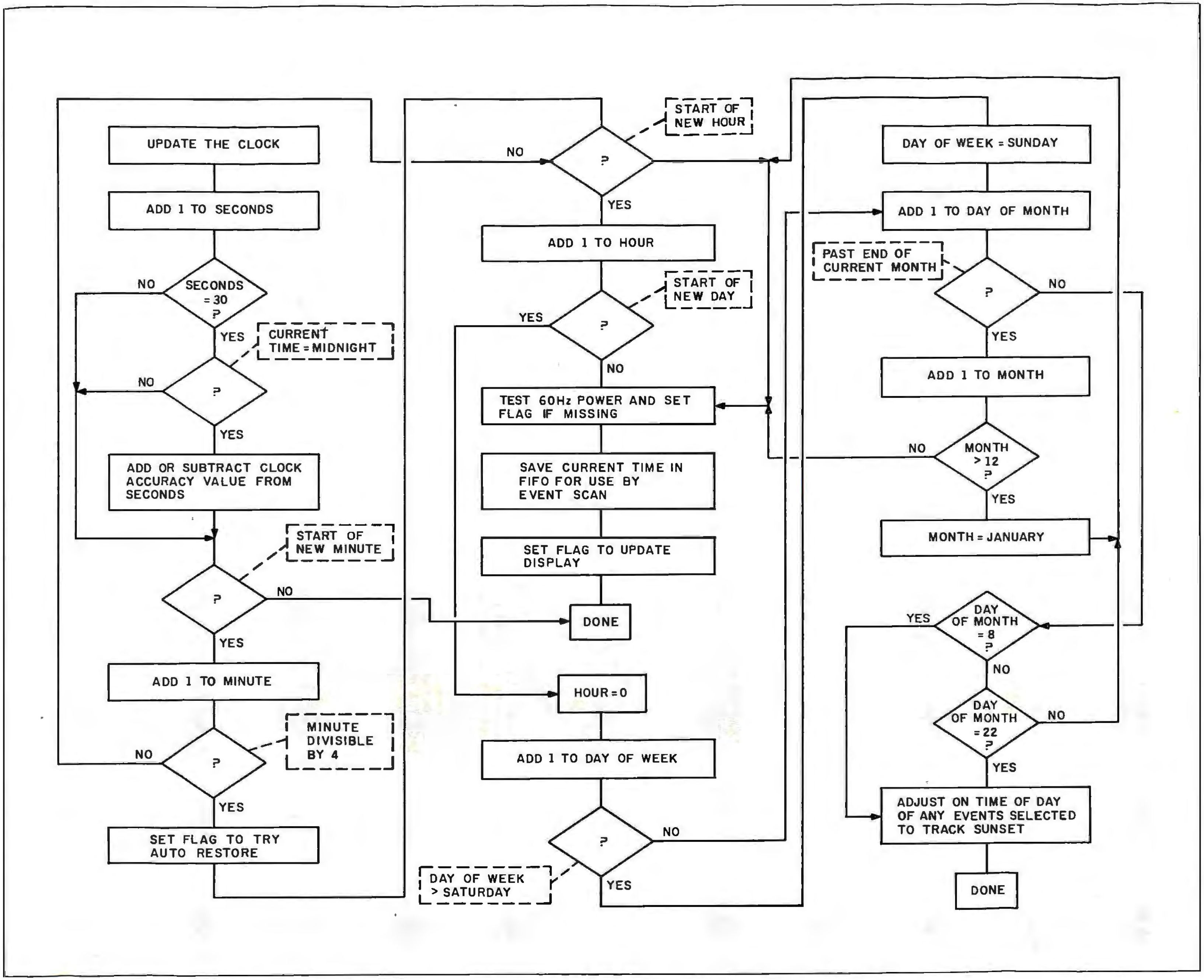

Figure 2: *Clock Update flowchart.*

If the time is the start of a new minute, the current time is put into the Time FIFO buffer for use in the event scan. If the terminal is not currently being used for some other display, the main display is updated, and the program starts checking the FIFO buffers.

When certain commands such as DIM, or functions such as Restore or Manual Control, are executed, they use a large amount of processor time. This can cause a conflict if the interrupt-service routine attempts to execute other commands or scans the event table. To prevent this possible conflict, the time-consuming routines set a priority flag that prevents the interrupt-service routine from performing any operations with the FIFO buffers. As soon as the priority routines are finished and clear the flag, the interrupt-service routine can begin processing the FIFO buffers again.

Whenever a function requires input from the terminal, it would be possible to miss a character that was typed if an interrupt occurred and a FIFO buffer required processing. To prevent this, routines requiring input set a flag that gives input priority to the terminal. The interrupt-service routine is allowed to put the current time into the Time FIFO buffer every minute, but it is prevented from taking times out and scanning the event table. When the flag is cleared, the interrupt-service routine begins scanning the event table with the times that were stored in the FIFO buffer. This means that if an event was scheduled to occur while you were typing, it would not really occur until after you had completed whatever you were entering.

If for some reason the HCS is left waiting for terminal input or in the editing mode and no characters are input

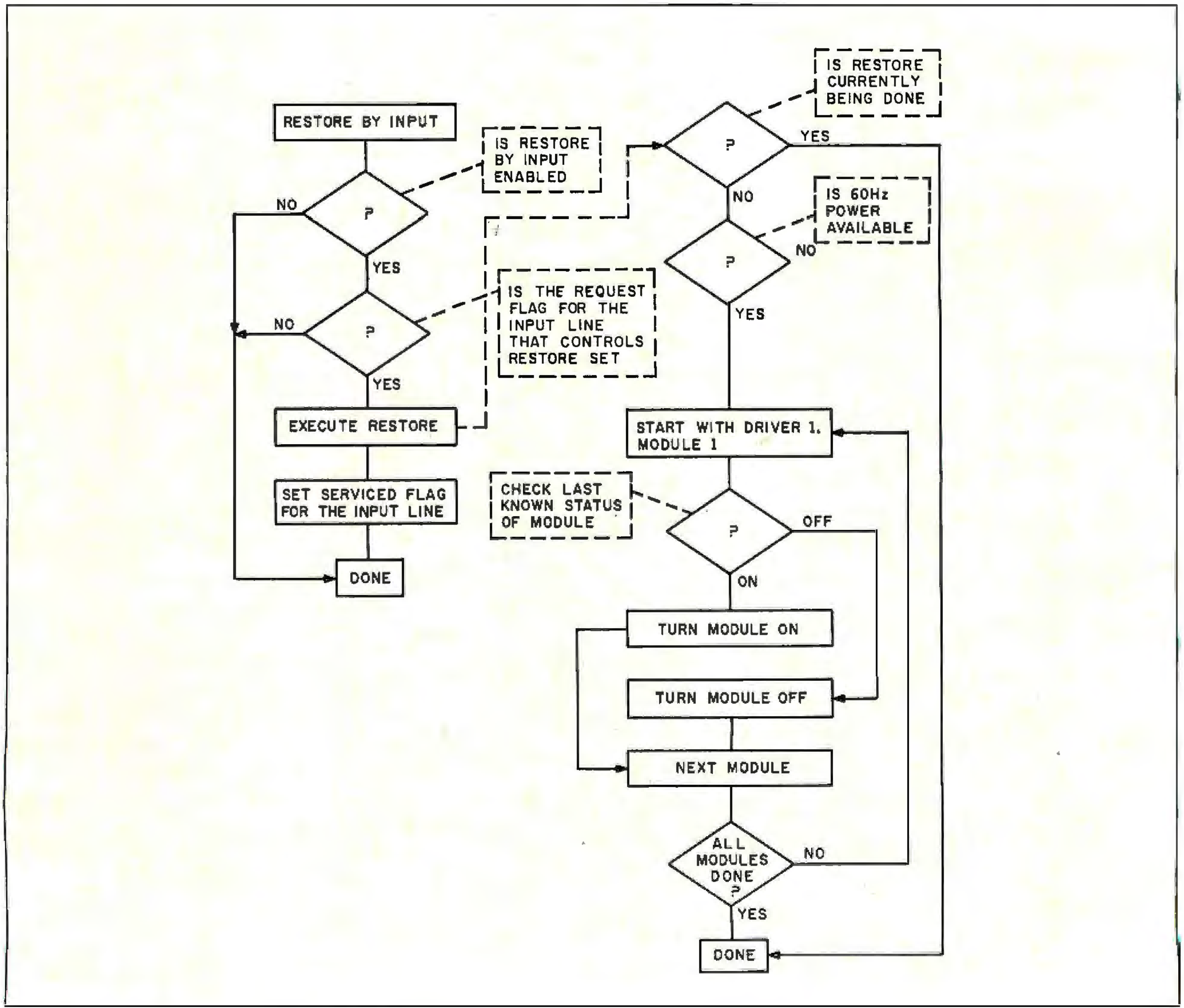

Figure 3: *Restore Request Check flowchart.*

for 5 minutes, it will return to the status display and begin processing the FIFO buffers.

NOMENCLATURE

Before I can adequately discuss all the menu options and control features of the HCS, the nomenclature must be described in more detail.

A module can be a message, a BSR module, or some electrical equipment connected to a direct output line. Each module is identified by a module number from 1 to 16 (8 in the case of the direct outputs). For messages, the module number identifies 1 of 16 possible messages (each can be any length). For BSR modules, the module number identifies the number you set on the BSR module's unit-code switch. For direct outputs, the module number refers specifically to the 1-of-8 output lines to which directly controlled equipment can be connected.

An event is a set of actions that you want performed on a module. Each event has four parts: the driver, the module, what turns the module on, and what turns the module off. "On" and "off" actions result from coincidence with a prespecified time and date, a logic-level transition on 1 of 16 input lines, or a predefined time duration.

A driver defines what an event does when it is executed. Seven drivers are used in the HCS (an eighth driver is the Superkey, which will be explained later), and their functions are as follows:

The Message driver (#7) displays messages on the terminal.

The BSR On/Off driver (#1, #4, and #5) turns a BSR module on or off.

(continued)

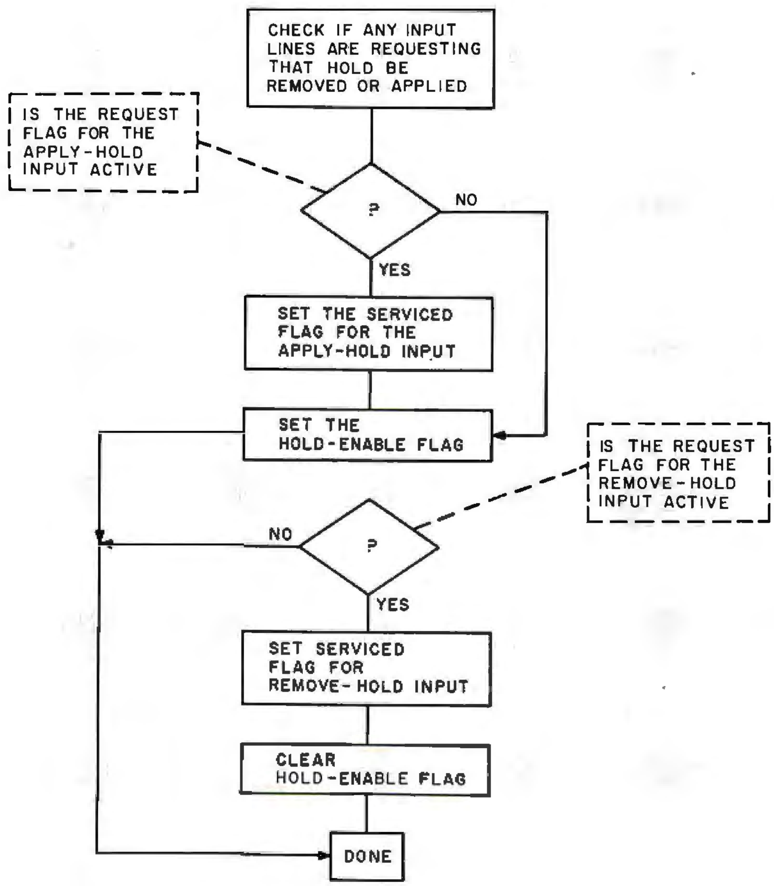

Figure 4: *Hold Request Check flowchart.*

The BSR Dimmer driver (#2) lets you remotely control the brightness of a lamp connected to a BSR lamp module. The brightness of the lamp is defined by a level from 1 to 16. Level 16 is fully on.

The BSR Cycler driver (#3) will turn a BSR module on for a selected time interval and then off for the same interval. This cycle repeats until the event is scheduled to stop. The interval is specified in minutes and can have a value from 1 to 180 minutes.

The Direct Output driver (#6) provides an open-collector TTL-compatible control signal on each of eight output lines. An 'ON' signal is a logical high, greater than 2.4 volts (V); an 'OFF' signal is a logical low, less than 0.4 V.

An input is an electrical signal that is less than 0.2 V (logic 0) or greater than 3.0 V (logic 1). The HCS can accommodate −9-V to +9-V input levels. When the HCS is first powered up or the manual Reset button is pushed, the current state of each line, either high or low, is saved and is considered to be the reference or nonactive state of that line. The reference state can be changed at any time by a command. If an input line changes from its reference state, either a transition from low to high or high to low, an input is said to have occurred, and the HCS will react accordingly.

Dimmer, Cycler, and BSR On/Off drivers are further defined by a house code. The house code determines which BSR modules respond to a particular driver. On power-up, the HCS defaults to house code A. It can be alternately redefined as any one of the 16 possible house codes through a menu-selected editing command. The first BSR driver and the Cycler and Dimmer drivers use the A house code, while BSR drivers #4 and #5 each use the next sequential letters. This allows control of 48 BSR modules independently.

The Status Display

When the HCS is functioning, the current on/off status of each module is presented with the time and date in a status display. Typically, it is a 24-line display that appears as shown in listing 1 and photo 1.

The number in the left column is the driver number used in input routines. The next column is the driver type and the house code for those that designate BSR drivers.

The status of each module is represented by a symbol. A dash (–) means that no events are scheduled for that driver/module combination. (A dash appears only on a printout or a terminal. A raised dot is used on the integral video display.) A zero (0) means that events are scheduled for that driver/module and that the last command executed was an off command (currently inactive). A one (1) means that events are scheduled for that driver/module and that the last command executed was an on command (currently active).

(continued)

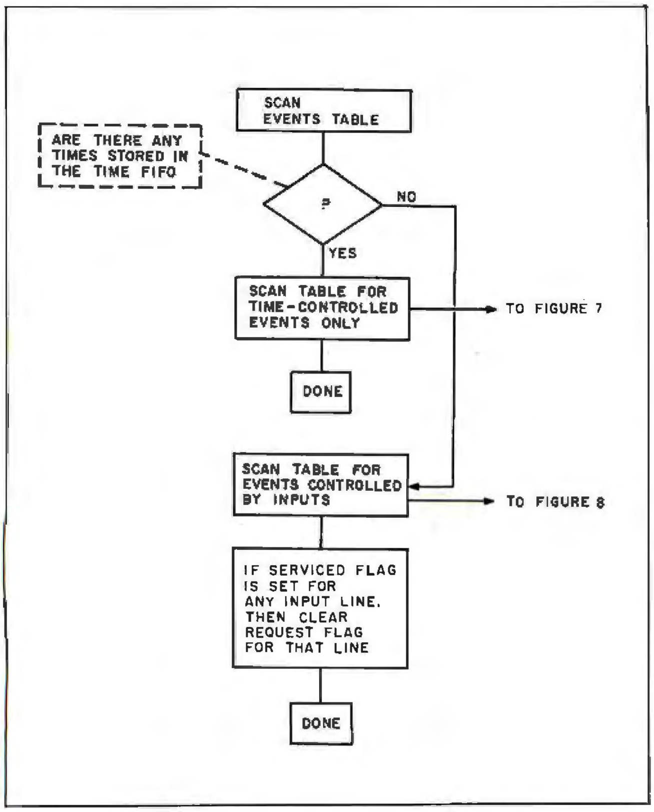

Figure 5: *Execute Command flowchart.*

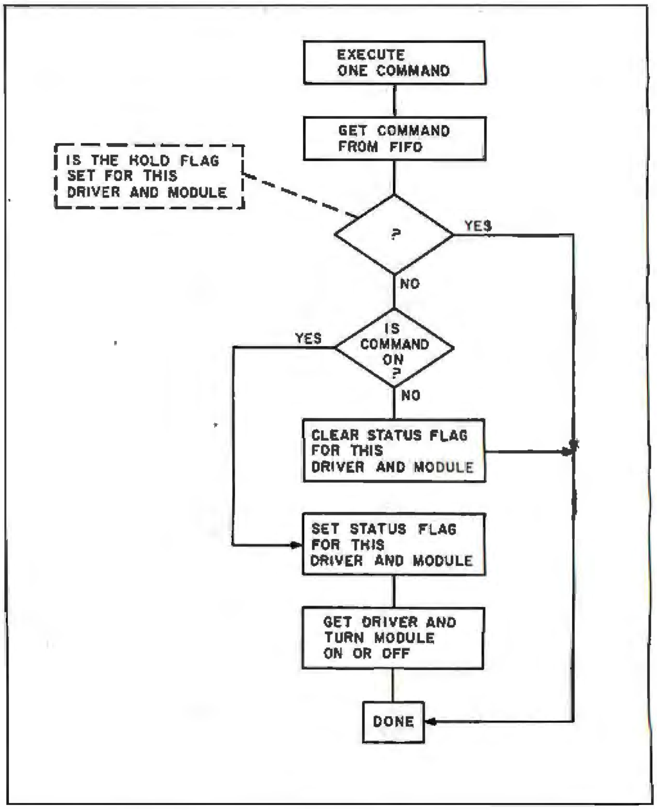

Figure 6: *Scan Events Table flowchart.*

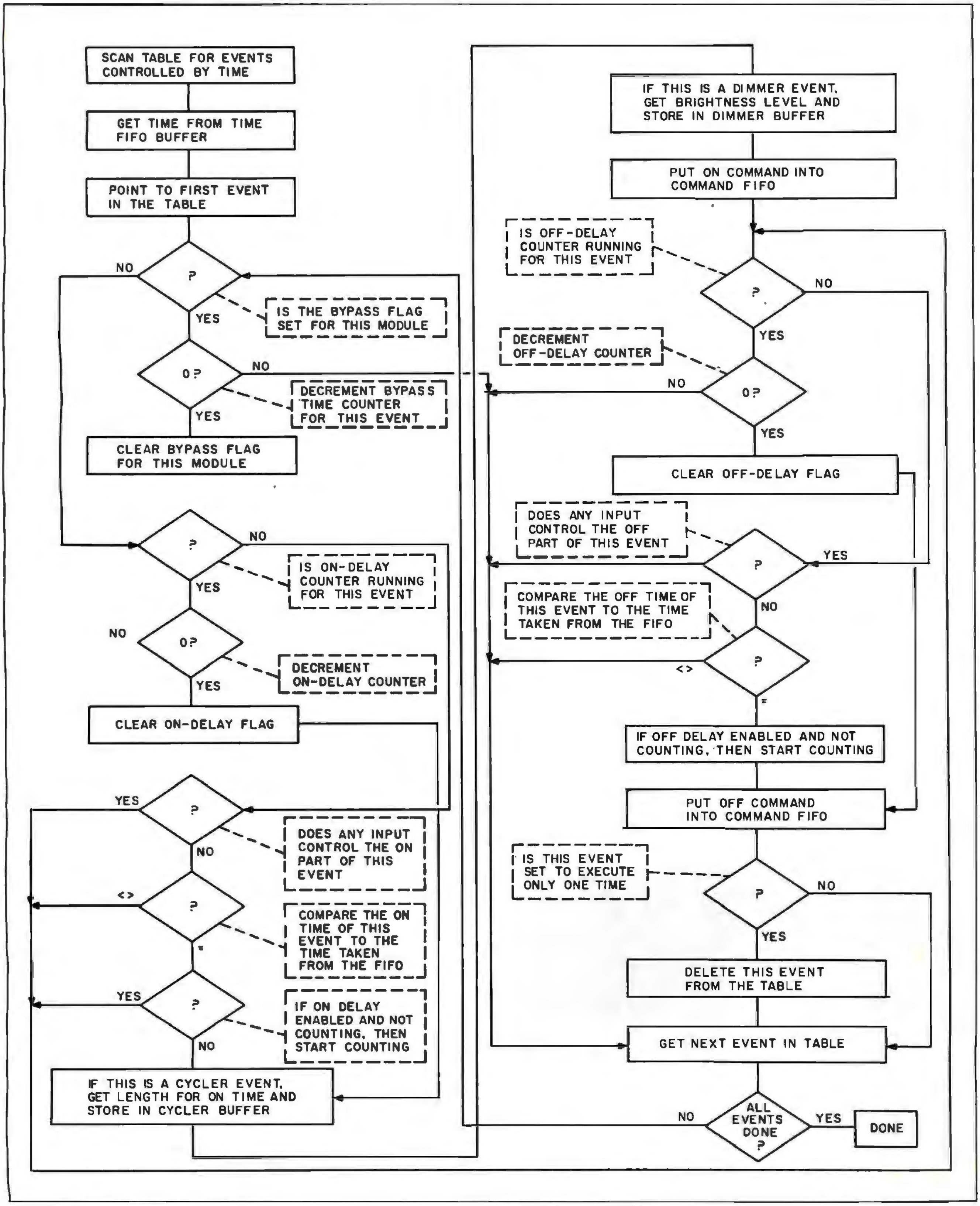

Figure 7: *Scan for Time Events flowchart.*

The normal display will show the current time, any messages, and the status of all 120 modules. To see a menu of the available commands, enter a space character. The HCS will display an editing menu, as shown in listing 2.

To use one of the functions displayed, answer the prompt with the appropriate letter followed by a return. Each of the editing functions will be discussed further as we attempt to actually run the HCS.

FIRING IT UP

Before starting to use your HCS for the first time, a few items must be considered. If you are using an external terminal or computer for display, use table 1 to select the data-transmission rate that your terminal or computer's serial interface uses.

Set the selected switch ON, making sure that only one switch is on at any time. If you intend to use only the internal video display and no serial peripherals, port configuration jumper J1 should be installed. If a modem or printer is to be connected, however, J1 should be left out. If you intend to use the internal video output with a modem, set the data-transmission rate to that of the modem.

If you intend using a modem or just want additional security, installing configuration jumper J2 enables the password identification. Whenever the modem answers or a command entry is made through the terminal or keyboard, the HCS will ask for your password (entered on power-up). If entered correctly, it will allow you to proceed; otherwise, it will revert to the status display and inhibit command entry. Once the correct password is entered, further password identification is not required as long as continuous communication is maintained with the operator. A lapse in command entry longer than 3 minutes will cause the HCS to ask for the password again.

Two additional jumpers must be positioned according to the amount and location of the RAM (random-access read/write memory) in the system. This area was covered in detail in part 2, and I refer you to that section for explanation.

After all the switches and jumpers have been set (I chose

(continued)

Listing 1: *Status display.*

```
SUN FEB  3  3:37 PM


                      1111111
                1234567890123456
1 BSR ON/OFF  A 00100---1-0-----------1
2 BSR DIMMER  A --------------0--------------
3 BSR CYCLER  A -------0----------------------
4 BSR ON/OFF  B ------------------------------
5 BSR ON/OFF  C ------------------------------
6 DIRECT OUT    01--------------
7 MESSAGES      000---------------------------
8 SUPERKEY      0-----------------------------
```

Listing 2: *Editing menu.*

```
A REPORT,CREATE,OR DELETE EVENT
B SET HOUSE CODE     C MANUAL ON/OFF
D MANUAL RESTORE     E AUTO-RESTORE
F RESTORE BY INPUT   G SET DATE AND TIME
H CLOCK ACCURACY     I TIME FORMAT
J TRACK SUNSET       K DAYLIGHT SAVINGS
L LIST EVENTS        M SET LIST SPEED
N **TOTAL RESET**    O LINES PER SCREEN
P INPUT STATUS       Q HOLD BY INPUT
R DEFINE SUPERKEY    S BYPASS MODULE
T DELAY EVENT        U SET BEEPER TIME
V SET EVENT TO EXECUTE ONLY ONCE

ENTER LETTER OF CHOICE (A–V)?
```

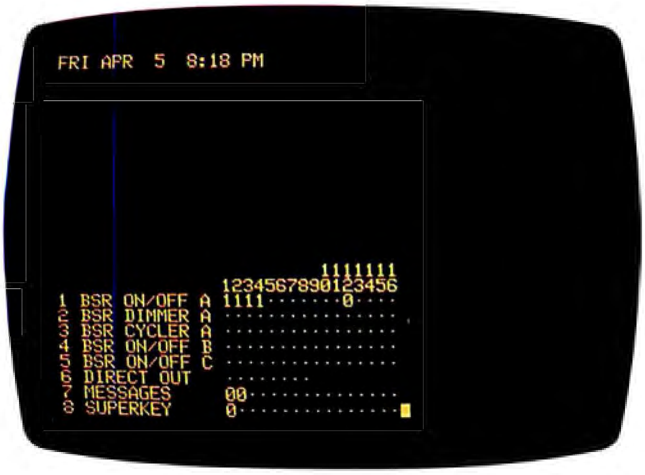

Photo 1: *Status display.*

Table 1: HCS *data-transmission-rate settings.*

Switch	Data-Transmission Rate
1	4800
2	2400
3	1200
4	600
5	300
6	150
7	75
8	not used

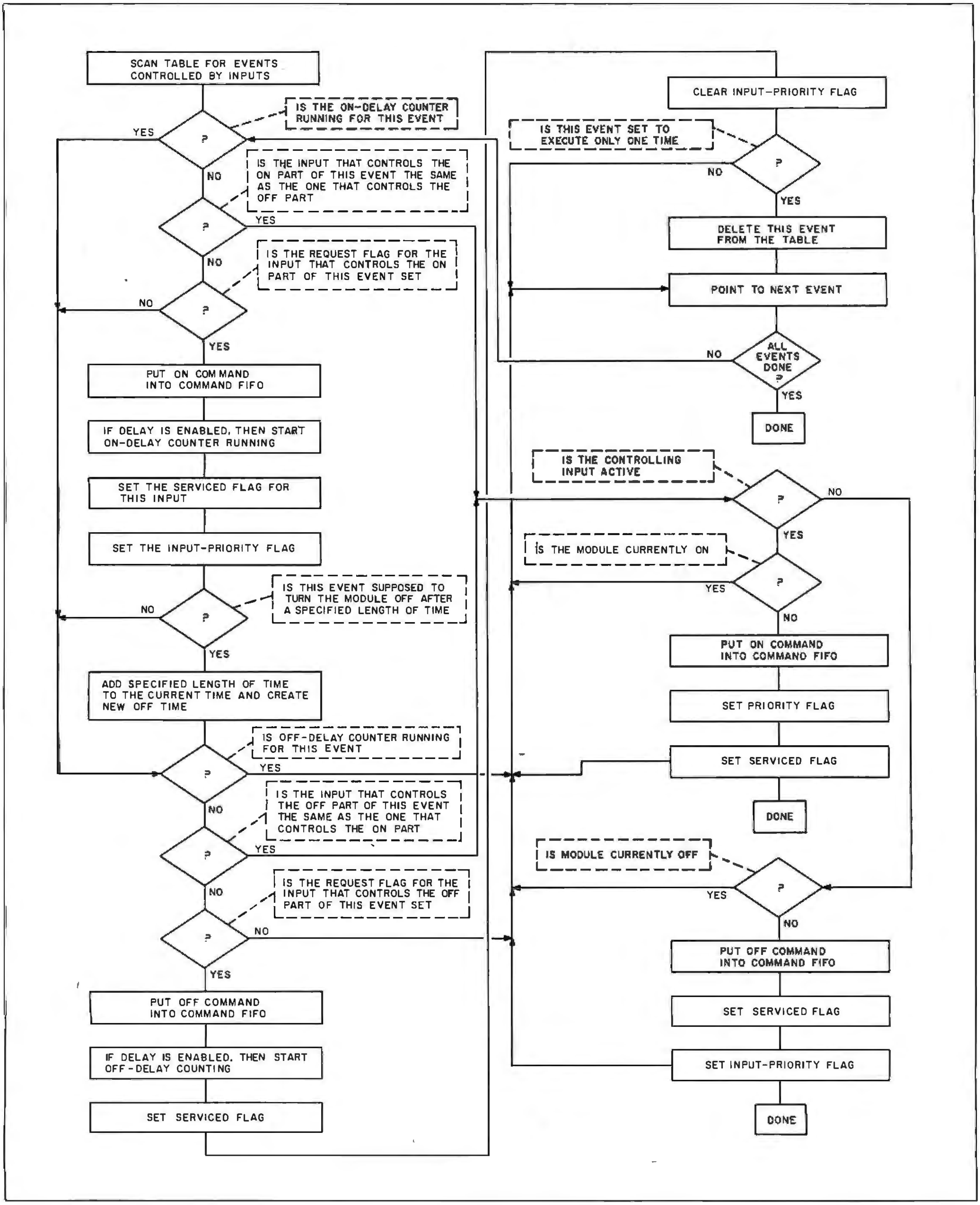

Figure 8: *Scan for Input Events flowchart.*

to include the password), the HCS is plugged in and the following appears:

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HOME RUN CONTROL SYSTEM
VER. X.XX
ALL RIGHTS RESERVED

ENTER NEW PASSWORD:

Since this is a cold start, you must enter the date and your five-letter password:

ENTER NEW PASSWORD: *STEVE*

I chose my name as the password in this example, but any five printable ASCII (American Standard Code for Information Interchange) characters (such as @#%&N) can be used. If you have enabled the password option, the HCS presumes it might have an auto-answer modem connected. The HCS will automatically send the necessary commands to a Hayes-compatible auto-answer modem to set the proper number of rings. I chose eight rings.

HOW MANY RINGS BEFORE ANSWERING
0 = DONT ANSWER (0-255)? *8*

In general, whenever you must choose one of several answers to a question, each item will have a number to the left of the item. To choose a particular item, enter the number when the prompt appears. In addition, the prompts themselves have the allowable entries in parentheses. If you enter a value outside of this range, the prompt will repeat until you enter a correct value. You can return to the main display at any time by typing only a carriage return in response to a prompt. The display prompts continue by asking the date and time as follows:

1 JAN 2 FEB 3 MAR 4 APR
5 MAY 6 JUN 7 JUL 8 AUG
9 SEP 10 OCT 11 NOV 12 DEC
ENTER MONTH (1-12)? *2*

ENTER DAY OF MONTH (1-31)? *3*

1 SUN 2 MON 3 TUE 4 WED
5 THU 6 FRI 7 SAT
ENTER DAY OF WEEK (1-7)? *1*

The final cold-start prompt will be

ENTER TIME AS HH:MM:A
OR HH:MM:P

? *4:56:P*

After this, HCS is ready to have events programmed, and a no-events-scheduled status display appears.

COMMAND AND EDITING FUNCTIONS

It's time to get back to an explanation of the editing-menu options. By selecting the different functions, you can create, delete, bypass, hold, or restore an event. The majority of these functions are different from typical home-control systems and are the essence of the HCS.

ENTERING EVENTS

When you want to create a new event, an event-trigger menu will be displayed, showing you the combinations of input and time used to start and stop an event:

1 ON AT SPECIFIED TIME
OFF AT SPECIFIED TIME

2 ON AT SPECIFIED TIME
OFF WHEN SPECIFIED INPUT OCCURS

3 ON WHEN SPECIFIED INPUT OCCURS
OFF AT SPECIFIED TIME

4 ON WHEN SPECIFIED INPUT OCCURS
OFF WHEN SPECIFIED INPUT OCCURS

5 ON WHEN SPECIFIED INPUT OCCURS
OFF AFTER PERIOD OF TIME

ENTER NUMBER OF ON/OFF
COMBINATION (1-5)?

If you select one of these combinations, one or a series of events can be created that use those same on and off parameters without redesignating this choice each time (to select another trigger combination, you exit to the status display and then return to this menu and make another choice). Number 1 will create events that use a time for both starting and stopping the event. Number 2 creates events that start at the specified time but will not stop until a specified input changes the logic state. Number 3 will create events that start when the specified input occurs and will stop at a specified time. Number 4 creates events that start when a specified input occurs and stop when another input occurs. If the same input-bit number is chosen for both conditions, it will constitute an "on while" state with the event activated only while the input bit is active. Number 5 creates a special type of event that starts when a specified input occurs and then waits a predetermined period of time (up to 24 hours) before stopping the event.

After you have selected the on/off combination, the status display will appear, and you will be asked to select the number of the driver and module you want the event to use. After entering these, if you did not select the Message driver and the selected module has not been used before, you will be asked to give it a name, or label:

216 CHARACTERS AVAILABLE
ENTER NAME OF MODULE

ONE RETURN STARTS NEW LINE
AND TWO RETURNS ENDS
? *Front Porch Light*

The first line indicates the number of characters set aside for use as labels. The available space depends on the quantity of RAM in the system. If the module already exists (i.e., you have already programmed the porch light to come on by some other combination of parameters), the label will be displayed, and you will be prompted to add to or delete these events.

Next, you will be asked to enter the parameters for the on and then the off part of the event. There will be prompts for either the time or input, depending on which combination you chose.

The prompts for a time look like this:

```
ENTER ON TIME

1 SUN    2 MON    3 TUE    4 WED
5 THU    6 FRI    7 SAT
8 REPEAT   9 DAY OF MONTH

ENTER DAY OF WEEK, REPEAT CODE,
OR DAY OF MONTH CODE (1-9)?
```

If you enter a number from 1 to 7, the event will use the day of the week that you select. If you enter a 9, you will be asked for the day of the month:

```
ENTER DAY OF MONTH (1-31)?
```

If you enter 8, you will be prompted for how many days you want the event repeated:

```
HOW MANY CONSECUTIVE DAYS DO YOU
WANT THIS EVENT REPEATED (2-7)?
```

For example, if you enter 5 and an event that starts on Monday, the event will occur every day from Monday through Friday. Repeating an event for seven days makes it a daily program. (For all modules, a combination of events can be designated. We could, for example, have the front porch light come on Monday through Friday from 5 to 11 p.m., Saturday and Sunday from 8 p.m. to 2 a.m., for 10 minutes every time the front door opens [contact-closure input], and on one night for as long as necessary until you get home.)

After the day is entered, you will be asked to enter the time:

```
ENTER TIME AS HH:MM:A
           OR HH:MM:P

?
```

The time of day is entered on a single line, the same way as setting the clock.

If input is selected as part of the combination, you will be asked to enter the number of the input line that you want to control the event:

```
ENTER INPUT # FOR ON (1-16)?
            or
ENTER INPUT # FOR OFF (1-16)?
```

If you select the Message driver and a message already exists for that module, you will be asked if you want to delete the old message. If you enter Y or no message existed, you can enter a message in the same way that you enter a label. Messages can be any length but are limited by available memory space. (Can't remember when to put the trash out? Have the HCS display PUT THE TRASH OUT every Friday morning at 8 a.m.)

If you select the BSR Dimmer, you will be asked to enter the brightness level (1 to 16); if you select the BSR Cycler, you will be asked for the time interval you want to use. Along with the BSR driver, these routines will repeat the prompts to create a new event using the same driver and module unless you abort the routine.

Manual Control

Manual Control lets you turn modules on and off without having to schedule an event. The routine will display the current driver/module status table and ask for the driver number. The routine then displays which keys perform which functions.

```
KEY ASSIGNMENTS:

1-16 - MODULE NUMBER
   Y     -     MODULE ON
   N     -     MODULE OFF
   D     -     DIM LIGHT
   R     -     NEW DRIVER

>
```

To turn a module on or off, you must type the module number and the appropriate letter, such as 1Y to turn module number 1 on or 1N to turn it off. You can enter more commands on the same line, such as 1Y2Y3N, which would turn modules 1 and 2 on and module 3 off. If you want to manually dim a light, you must first turn it fully on and then type D until the desired brightness is reached. When you are finished with Manual Control, type a return to exit to the status display.

The Restore Actual Status Function

The Restore function is one of the more unique functions of the HCS. BSR control modules are notorious for arbitrarily turning on or off as a result of power-line transients. While the HCS has direct outputs for the most critical control signals, it is disconcerting to find that BSR-controlled appliances and lamps are not in the desired state after a few hours. The HCS has the ability to restore the current state of all modules on command, on input, or at regular intervals.

Restore lets you make sure that every module in use is set to the same status, on or off, that is currently in the status table. Since BSR modules can be manually controlled without the HCS (i.e., you can directly turn on the hall light by pressing the BSR wall-module button), it might be necessary to return the house or office to a known condition.

(continued)

If a power failure occurs and the HCS is equipped with battery backup, a restore operation will be performed automatically after the power returns (it allows a few extra minutes for the line to settle first). Or, at any time, you can select the Manual Restore function to restore all outputs to that status listed in the status display.

The Auto-Restore function causes the HCS to perform a restore operation every 4 minutes automatically. This is useful, for example, if the HCS is being used to control modules that are unattended for long periods of time and will not be manually overridden.

A restore operation can also be triggered by an input. On power-up, restore by input is preset to bit 14 and inactive. When selected through the editing menu, the sequence is as follows:

RESTORE BY INPUT DISABLED

INPUT NUMBER FOR RESTORE IS 14

ENABLE RESTORE BY INPUT (Y-N)? *Y*

ENTER INPUT NUMBER THAT YOU
WANT TO CAUSE RESTORE, OR
RETURN TO USE THE CURRENT
INPUT NUMBER (1-16)?

Hold by Input

An equally unique HCS function is the Hold command. Hold is used to stop modules from turning on or off. For example, in a security system, the alarm modules could be put on hold when the building is open. Hold is activated and deactivated by input lines that you select. The lines default to 15 and 16 on power-up. The command displays the following:

HOLD STARTED BY INPUT #15
HOLD STOPPED BY INPUT #16
HOLD INPUTS CANNOT CHANGE HOLD STATUS

MODULE(S) ARE NOT ON HOLD

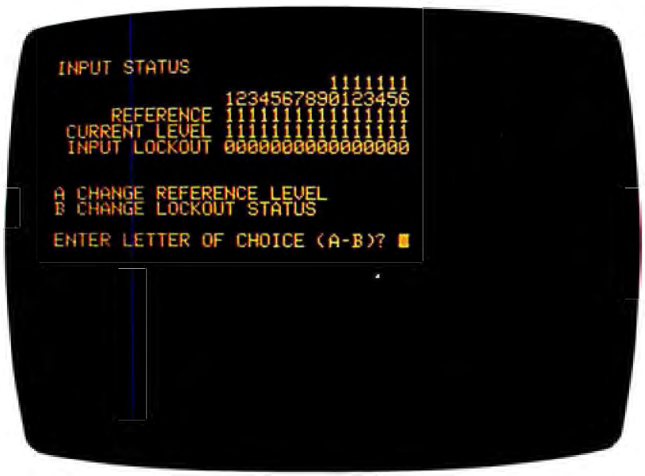

Photo 2: *Input status display.*

0 REDISPLAY STATUS
1 ALLOW INPUTS TO CHANGE HOLD STATUS
2 STOP INPUTS FROM CHANGING HOLD STATUS
3 ASSIGN HOLD-INPUT NUMBERS
4 SELECT MODULES TO PUT ON HOLD

ENTER OPTION NUMBER (0-4)?

When selecting modules to put on hold, the status display will show the letter "H," indicating which modules are set for hold. The "H" will toggle similar to the "S" in sunset when you enter a driver and module. When in the main display, modules on hold in the on state will be represented by an inverse "1," and a module in the off state will be represented by an inverse "0" on the video display. When Hold is enabled, the above display will state that inputs can change Hold status and whether they are or are not currently on hold.

In my application, I have the Hold input connected to the alarm system. When I am not home and the alarm is on, the HCS simulates occupancy. When the alarm is off and I am home, these functions are put on hold.

Delaying and Bypassing Events

Delay Event allows you to postpone the actual execution of an event for a time period up to 23 hours and 59 minutes. For example, if you have an event that is scheduled to turn a light on when you return home in the evening and you are going to be 2 hours late, instead of creating a new event for this one occurrence, simply delay the event for 2 hours. If the light is scheduled to turn on at 18:00 and turn off at 18:15, a delay of 2 hours would cause the light to turn on at 20:00 and turn off at 20:15 instead. After the delay has timed out, the event returns to its normal schedule.

The Bypass Module function allows you to instruct the HCS to ignore a driver/module combination for a time period up to 44 days, 23 hours, and 59 minutes. During the time Bypass Module is enabled, the scheduled events for that module will not occur. For example, if you have a large number of events for a driver/module, such as heating or cooling your home, and you are going to be away for several days, instead of deleting all the events before you leave and reentering them when you return, you can bypass that module for the amount of time you will be gone. The bypass time begins as soon as you enable it.

When selected, Bypass Module will display the current driver/module status and ask you for the driver and module to bypass. When you have entered these, it will ask for the length of the bypass in days, hours, and minutes. If you wish to remove a bypass early, entering 0 for the days, hours, and minutes will abort the bypass that is in progress and restore normal operation.

Input Status

The current status of the input lines can be displayed by typing the P option. It is displayed as shown in photo 2.

The row labeled REFERENCE is the nonactivated level for each input line. A reference level of 0 indicates a normally low/active high input signal. A reference level of 1 indicates a normally high/active low input. The row labeled CURRENT LEVEL is the current level of each input at the time the input status-display command is called.

INPUT LOCKOUT (indicated by a logic 1 in the designated display position) allows a user to selectively shut off inputs without using the Bypass Module or Hold functions. In the following display, inputs 1 through 6 are active low, and inputs 7 through 16 are active high. Inputs 6, 8, and 10 are locked out. The current input levels are as displayed:

```
INPUT STATUS
                              1111111
                     1234567890123456
      REFERENCE      0000001111111111
  CURRENT LEVEL      0110000110001111
  INPUT LOCKOUT      0000010101000000
```

SUPERKEYS

When I first started testing the HCS, it was necessary to continually preset the on/off conditions of many modules so that I could observe specific functions. To facilitate this, I designed the Superkey. Superkeys enable you to perform a large number of Manual Control operations with just two keystrokes. To create a Superkey, you specify which number you want to define (16 Superkeys are designated as #1–#16) and enter a list of modules you want to turn on or off. To execute a Superkey, you enter its number followed by an escape. A typical Superkey list might appear as follows:

```
8 SUPERKEY        1
  1 BSR ON/OFF A  1 OFF
  1 BSR ON/OFF A  2 OFF
  1 BSR ON/OFF A  3 ON
  1 BSR ON/OFF A  4 ON
  1 BSR ON/OFF A  5 OFF
  1 BSR ON/OFF A  8 OFF
```

If you press 1, then Escape, driver 1 modules 1, 2, 5, and 8 would turn off and modules 3 and 4 would turn on.

TRACKING SUNSET AND ONETIME EVENTS

One function that the HCS can perform is turning lights on at the same time relative to sunset each day. Sunset changes from day to day throughout the year. Ordinarily, fixed-time controllers would need to have their program manually changed every few weeks in order to keep up with the sunset. The HCS has a special menu selection that allows you to designate which modules will have their on times changed, according to the long-term variation in actual sunset. Each month, on the 8th and 22nd, the HCS recalculates the on times of sunset-adjust-designated modules. (The calculation is accurate only for North America at the present time.)

The 1-Time Event function allows you to create an event that will automatically delete itself after it executes the off portion of the event. When selected, it will display the current driver/module status table and ask you for the driver and module numbers. After you enter these, it will display all the events for that driver and module, each with an identifying number. To enable the 1-Time Event function for an event, enter the number of the event. If the particular event already has the 1-Time Event function enabled, the HCS will ask you if you want to cancel it.

A SIMPLE HCS APPLICATION

As I mentioned earlier, the Circuit Cellar and my home are somewhat unconventional. While many of you will no doubt find applications for the HCS as an environmental controller or security system, my initial use is for automatic lighting (I have a separate security system). Perhaps when you read this I'll have connected the air conditioning and vent fans, but right now I'm motivated by deadline and necessity. I am tired of walking in the dark, and it's hard to think about air conditioning when it's 7° and snowing outside. The only environmental control worth considering right now as I write this is keeping the doors closed and all the heat on.

When I go from the kitchen down to the storage area behind the Circuit Cellar, it is a long trek with six light switches along the way. In addition, there are a few other items I frequently switch on and off. If I assign a BSR module to each for remote control, the list could start as follows:

Circuit Cellar floor lamp	module #8
HCS CRT monitor	module #6
Upstairs hallway light	module #5
Staircase light	module #4
Circuit Cellar hallway/copier light	module #3
Storage-area lights	module #2
Garage light	module #1

In a standard off-the-shelf open-loop BSR controller, we'd be limited to timed activation of these lights or walking around with the BSR ultrasonic hand-held controller aimed at a command controller in each room. This is hardly convenient. My idea of automatic lighting is noncontact and not user-activated! I want a completely passive system. When I walk into a room, the lights come on. As long as I stay there, they remain on. When I leave, they turn off after a reasonable period of time.

The HCS can be easily programmed to control lights and appliances in this manner by monitoring certain signals through its direct input lines. In this instance, passive infrared motion detectors are used to scan the affected areas and indicate to the HCS when a person walks into a particular area. The motion detector senses a difference in heat level between the person and the surrounding area and simply opens a relay contact. Using a +5-V source and a pull-up resistor, the motion detector can be con-

(continued)

nected to the HCS as a simple TTL input.

To control all the lights in the areas I listed above, it was necessary to run a few wires around my house. Fortunately, I already have an elaborate commercially installed security system, and I was able to tap off many of the required signals directly from the alarm box. Unfortunately, security systems are perimeter-oriented and specific in purpose. I had to add more motion detectors to cover all the areas I wanted to control. I spent a few days stringing wires and drilling holes. There are now a dozen little infrared eyes watching my every move. Now, as I walk down the stairs, lights come on automatically, both on the staircase and the top and bottom landings.

Some of you may not want a computer-controlled house, but connecting these inputs and controlling the lighting provides a simple illustration of the HCS's capability and a process that I can describe. First, each motion detector is attached to a separate input bit. No motion is a logic 0 (gnd), and motion detected is a logic 1 (+5 V). The inputs are as follows:

Input #1	Garage-area motion detector
Input #2	Circuit Cellar storage-area motion detector
Input #3	Staircase motion detector
Input #4	Upstairs hallway motion detector
Input #5	Circuit Cellar office area

Next, we fire up the HCS and enter the statements that turn on the appropriate light and extinguish it after the prescribed duration. For brevity, I have chosen to edit out some of the more repetitive displays. In the following communication exchange (done with a live HCS via modem), HCS keyboard or terminal entries are in italics. The explanations I've added are presented in lowercase letters.

(continued)

Listing 3: *Programming events on the HCS to occur when a certain input occurs.*

```
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CIRCUIT CELLAR INC.

HOME RUN CONTROL SYSTEM
VER. 5.17

ALL RIGHTS RESERVED

ENTER NEW PASSWORD: STEVE          (password is asked for if jumper 2 has been installed)

HOW MANY RINGS BEFORE ANSWERING
0=DON'T ANSWER (0-255)? 5          (if your Hayes-compatible auto-answer modem is installed, the HCS will
                                   send it ATS0=5 to tell it to answer at 5 rings)
1 JAN   2 FEB   3 MAR   4 APR
5 MAY   6 JUN   7 JUL   8 AUG
9 SEP  10 OCT  11 NOV  12 DEC

ENTER MONTH (1-12)? 1

ENTER DAY OF MONTH (1-31)? 27

1 SUN   2 MON   3 TUE   4 WED
5 THU   6 FRI   7 SAT

ENTER DAY OF WEEK (1-7)? 1

ENTER TIME AS HH:MM:A
           OR HH:MM:P

? 2:48:P

(the status display appears here with nothing scheduled; next, A is entered to create an event)

ENTER LETTER OF CHOICE (A-V)? A

ENTER YOUR PASSWORD: *****         (the first time that you enter a command, the HCS requires a password
                                   verification; it will not be required again unless 3 minutes expire with no
* MEANS EVENTS ARE SCHEDULED       communication; an asterisk and not the password is actually displayed)

                   1111111
          1234567890123456
1 BSR ON/OFF  A ----------------
2 BSR DIMMER  A ----------------
3 BSR CYCLER  A ----------------
4 BSR ON/OFF  B ----------------
```

(continued)

```
5 BSR ON/OFF  C ----------------
6 DIRECT OUT    ----------
7 MESSAGES      ----------------
8 SUPERKEY      ----------------
```

(each time you enter the create or delete option, the HCS lists the status display with an asterisk to indicated modules that are in use—this is called the scheduled-events display)

```
ENTER DRIVER NUMBER (1-8)? 1

ENTER MODULE NUMBER (1-16)? 1

THIS DRIVER/MODULE NOT IN USE

CREATE EVENT,DELETE EVENT,OR
REPORT EVENTS AGAIN (C/D/R)? C
```

(the event-trigger listing appears again here)

```
ENTER ON/OFF COMBINATION (1-5)? 5
ENTER INPUT # FOR ON (1-16)? 1

ENTER PERIOD OF TIME TO WAIT
BEFORE TURNING OFF

NUMBER OF HOURS (0-23)? 0
NUMBER OF MINUTES (0-59)? 5
```

(here we have selected to turn on BSR #1 for 5 minutes each; input #1 goes high; the time duration extends if input #1 is retriggered before the 5 minutes has expired)

```
374 CHARACTERS AVAILABLE
ENTER NAME OF MODULE

ONE RETURN STARTS NEW LINE
AND TWO RETURNS ENDS
GARAGE LIGHT

GARAGE LIGHT
  1  INPUT#  1  PERIOD 00:05
```

(this is the form the HCS lists its programmed events)
(more events could be added)

```
ENTER INPUT # FOR ON (1-16)?
```

(entering just a return redisplays the status menu)

```
SUN JAN 27   2:53 PM


                    1111111
                    1234567890123456
1 BSR ON/OFF    A  0---------------
2 BSR DIMMER    A  ----------------
3 BSR CYCLER    A  ----------------
4 BSR ON/OFF    B  ----------------
5 BSR ON/OFF    C  ----------------
6 DIRECT OUT       ----------
7 MESSAGES         ----------------
8 SUPERKEY         ---------------A

* MEANS EVENTS ARE SCHEDULED
```

(the event we just scheduled is shown on the status display; it is presently inactive)

(we can go directly to the create function without displaying the editing menu; just enter A and return)

```
                    1111111
                    1234567890123456
1 BSR ON/OFF    A  *---------------
2 BSR DIMMER    A  ----------------
3 BSR CYCLER    A  ----------------
4 BSR ON/OFF    B  ----------------
5 BSR ON/OFF    C  ----------------
6 DIRECT OUT       ----------
7 MESSAGES         ----------------
8 SUPERKEY         ----------------
```

(scheduled-events display)

```
ENTER DRIVER NUMBER (1-8)? 1
ENTER MODULE NUMBER (1-16)? 2

THIS DRIVER/MODULE NOT IN USE
```

(continued)

```
CREATE EVENT,DELETE EVENT,OR
REPORT EVENTS AGAIN (C/D/R)? C

(the event-trigger listing is redisplayed here)

ENTER ON/OFF COMBINATION (1-5)? 5
ENTER INPUT # FOR ON (1-16)? 1

ENTER PERIOD OF TIME TO WAIT
BEFORE TURNING OFF

NUMBER OF HOURS (0-23)? 0
NUMBER OF MINUTES (0-59)? 5

358 CHARACTERS AVAILABLE

ENTER NAME OF MODULE

ONE RETURN STARTS NEW LINE
AND TWO RETURNS ENDS
STORAGE-AREA CEILING LIGHT

STORAGE-AREA CEILING LIGHT

  1    INPUT#  1  PERIOD 00:05

ENTER INPUT # FOR ON (1-16)? 2

ENTER PERIOD OF TIME TO WAIT
BEFORE TURNING OFF

NUMBER OF HOURS (0-23)? 0
NUMBER OF MINUTES (0-59)? 5          (this time we have scheduled the storage-area light to come on if either in-
                                      puts #1 or #2 are triggered)
STORAGE-AREA CEILING LIGHT

  1    INPUT#  1  PERIOD 00:05
  2    INPUT#  2  PERIOD 00:05

ENTER INPUT # FOR ON (1-16)?          (enter return)
```

The HCS begins with a cold start, as shown in listing 3.

Rather than bore you with continued display listings, I'll add a bit more without repeating it. In a similar manner (using option 5 from the event-trigger listing in all cases) as presented in listing 3, the following is scheduled:

```
CIRCUIT CELLAR HALL LIGHT
  1    INPUT# 3    PERIOD 00:03
  2    INPUT# 2    PERIOD 00:05

STAIRCASE LIGHT
  1    INPUT# 3    PERIOD 00:03
  2    INPUT# 4    PERIOD 00:03

UPSTAIRS HALL LIGHT
  1    INPUT# 3    PERIOD 00:03
  2    INPUT# 4    PERIOD 00:03

HCS CRT MONITOR
  1    INPUT# 2    PERIOD 00:15

CIRCUIT CELLAR FLOOR LAMP
  1    INPUT# 5    PERIOD 00:30
```

At this point, seven modules have been programmed with all events of the "on-duration" format. To give you some traditional control reference, I'd also like to demonstrate a time-on/time-off event as well. In my case, I'll turn the porch light on at 4:30 p.m. each day and off at 6 a.m. the next morning, as shown in listing 4.

IBM PC HCS Exec

While the menu-driven event programming is straightforward in the basic HCS and requires no external support hardware, the facilities afforded in a larger computer can greatly expand user-friendliness. An IBM PC HCS Exec upload/download program written by Robin Computing takes HCS programming from sequential menu entry to "paint by numbers." Shown in photo 3 (the display can be either black-and-white or color), HCS Exec uses cursor positioning, return, and escape as its primary entry codes. It can communicate with the HCS at up to 4800 bits per second and upload and download the complete HCS event program sequence.

In Exec, drivers and module numbers are referred to as devices, selected by name, as shown in photo 4. By positioning the cursor over the "upstairs hall light" and pressing Return, we display that device's particulars, as shown in photo 5. In Exec, any time a device selection is necessary, a window with the device list appears, and

(continued)

CIRCUIT CELLAR

Listing 4: *Programming events on the HCS to occur at a certain time.*

```
SUN JAN 27  3:06 PM


                            1111111
                   1234567890123456
1 BSR ON/OFF  A 000000-0---------     (our status display indicates
2 BSR DIMMER  A ----------------       that we have seven modules in
3 BSR CYCLER  A ----------------       use—none on)
4 BSR ON/OFF  B ----------------
5 BSR ON/OFF  C ----------------
6 DIRECT OUT     ---------
7 MESSAGES      ----------------
8 SUPERKEY       --------------A      (create an event by entering A)
* MEANS EVENTS ARE SCHEDULED

                            1111111
                   1234567890123456
1 BSR ON/OFF  A ******-*---------
2 BSR DIMMER  A ----------------
3 BSR CYCLER  A ----------------      (scheduled-events display again)
4 BSR ON/OFF  B ----------------
5 BSR ON/OFF  C ----------------
6 DIRECT OUT     ---------
7 MESSAGES      ----------------
8 SUPERKEY      ----------------
ENTER DRIVER NUMBER (1-8)? 1
ENTER MODULE NUMBER (1-16)? 12
THIS DRIVER/MODULE NOT IN USE
CREATE EVENT,DELETE EVENT,OR
REPORT EVENTS AGAIN (C/D/R)? C
(the event-trigger listing shows up here)
ENTER ON/OFF COMBINATION (1-5)? 1      (this time we select item 1)
ENTER ON TIME
1 SUN  2 MON  3 TUE  4 WED
5 THU  6 FRI  7 SAT
8 REPEAT  9 DAY OF MONTH
ENTER DAY OF WEEK, REPEAT CODE,
OR DAY OF MONTH CODE (1-9)? 8           (I want the event repeated
HOW MANY CONSECUTIVE DAYS DO YOU         seven days a week starting on
WANT THIS EVENT REPEATED (2-7)? 7        Sunday)
ENTER TIMES FOR THE FIRST DAY
1 SUN  2 MON  3 TUE  4 WED
5 THU  6 FRI  7 SAT
ENTER DAY OF WEEK (1-7)? 1
ENTER TIME AS HH:MM:A
           OR HH:MM:P
? 4:30:P                                (turn on at 4:30 p.m. Sunday)
ENTER OFF TIME
1 SUN  2 MON  3 TUE  4 WED
5 THU  6 FRI  7 SAT
ENTER DAY OF WEEK (1-7)? 2
```

(continued)

```
ENTER TIME AS HH:MM:A
          OR HH:MM:P

? 6:00:A
```

(turn off at 6:00 a.m. Monday)

```
236 CHARACTERS AVAILABLE

ENTER NAME OF MODULE

ONE RETURN STARTS NEW LINE
AND TWO RETURNS ENDS
FRONT PORCH LIGHT
```

(the HCS automatically generates the complete weekly schedule)

```
FRONT PORCH LIGHT
1 SUN  4:30 PM  MON  6:00 AM
2 MON  4:30 PM  TUE  6:00 AM
3 TUE  4:30 PM  WED  6:00 AM
4 WED  4:30 PM  THU  6:00 AM
5 THU  4:30 PM  FRI  6:00 AM
6 FRI  4:30 PM  SAT  6:00 AM
7 SAT  4:30 PM  SUN  6:00 AM

SUN JAN 27   3:09 PM
```

(turning on the porch light at 4:30 p.m. in January is fine but not in July; returning to the editing menu, we select J and sunset-adjust the porch light)

```
                                1111111
                       1234567890123456
1 BSR ON/OFF    A  000000-0---0----
2 BSR DIMMER    A  ----------------
3 BSR CYCLER    A  ----------------
4 BSR ON/OFF    B  ----------------
5 BSR ON/OFF    C  ----------------
6 DIRECT OUT        ----------
7 MESSAGES         ----------------
8 SUPERKEY         ----------------
```

(space brings up the edit menu, then the following)

```
ENTER LETTER OF CHOICE (A-V)? J

SUNSET ADJUSTMENT

                                1111111
                       1234567890123456
1 BSR ON/OFF    A  ******-*---*----
2 BSR DIMMER    A  ----------------
3 BSR CYCLER    A  ----------------
4 BSR ON/OFF    B  ----------------
5 BSR ON/OFF    C  ----------------
6 DIRECT OUT        ----------
7 MESSAGES         ----------------
8 SUPERKEY         ----------------

ENTER DRIVER NUMBER (1-8)? 1
ENTER MODULE NUMBER (1-16)? 12

SUNSET ADJUSTMENT

                                1111111
                       1234567890123456
1 BSR ON/OFF    A  ******-*---S----
2 BSR DIMMER    A  ----------------
```

```
3 BSR CYCLER A ---------------            (the porch-light event schedule
4 BSR ON/OFF B ----------------           will now be automatically
5 BSR ON/OFF C ----------------           adjusted every 8th and 22nd to
6 DIRECT OUT   ---------                  follow the change in sunset)
7 MESSAGES     ----------------
8 SUPERKEY     ----------------

ENTER DRIVER NUMBER (1-8)?                (just enter a return to get the status
                                          display again)

SUN JAN 27  3:10 PM

                        1111111
               1234567890123456
1 BSR ON/OFF  A 000000-0---0---
2 BSR DIMMER  A ---------------
3 BSR CYCLER  A ---------------
4 BSR ON/OFF  B ---------------         (input events take priority
5 BSR ON/OFF  C ---------------         over everything else; to keep
6 DIRECT OUT    ----------              the status from changing while
7 MESSAGES      ---------------         I was communicating via a live
8 SUPERKEY      ---------------P        terminal to an installed HCS, I
                                        locked out inputs 1-5; entering
INPUT STATUS                            P displays the input status)

                        1111111
               1234567890123456
    REFERENCE  0000011111111111         (for this illustration, I had
CURRENT LEVEL  0000111111111111         only five inputs connected;
INPUT LOCKOUT  1111100000000000         6-16 are open and read logic 1)

A CHANGE REFERENCE LEVEL
B CHANGE LOCKOUT STATUS

ENTER LETTER OF CHOICE (A-B)?

(at this point the lockouts are removed from input bits 1 through 5;
 the input status then appears as follows:)

INPUT STATUS

                        1111111
               1234567890123456
    REFERENCE  0000011111111111         (note that bit #5 is high)
CURRENT LEVEL  0000111111111111
INPUT LOCKOUT  0000000000000000

A CHANGE REFERENCE LEVEL
B CHANGE LOCKOUT STATUS

ENTER LETTER OF CHOICE (A-B)?

(return entered to see status again)

SUN JAN 27  3:16 PM

                        1111111
               1234567890123456
1 BSR ON/OFF  A 001110-1---0----
2 BSR DIMMER  A ---------------
3 BSR CYCLER  A ---------------
4 BSR ON/OFF  B ---------------         (while the input display showed
5 BSR ON/OFF  C ---------------         only me at the terminal in the Circuit
6 DIRECT OUT    ----------              Cellar when I called it—motion
7 MESSAGES      ---------------         sensors are short-pulse output
8 SUPERKEY      ---------------         devices—apparently the system
                                        caught me running upstairs to the
                                        bathroom; it turned the lights
                                        on, by the way)
```

Photo 3: HCS *Exec initial menu.*

Photo 4: *Device selection on Exec.*

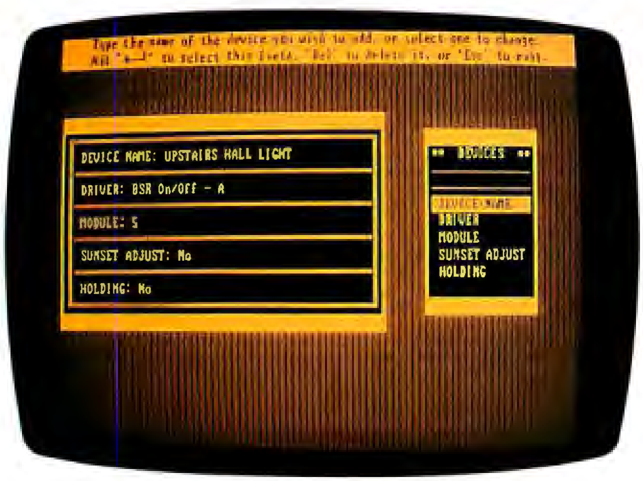

Photo 5: *Device particulars as shown on Exec.*

Photo 6: *Input selection on Exec.*

Photo 7: *Input particulars as shown on Exec.*

Photo 8: *Device status on Exec.*

the cursor is merely positioned over the device to select it.

In a similar manner, Exec defines and designates inputs by name, as photo 6 shows. Ten of the inputs are shown at a time (they scroll up and down), and positioning the cursor over an input gives the particulars for that input. In photo 7, the "Circuit Cellar Staircase" input designates a motion detector connected to input line #3, which is currently enabled and is activated with a logic 1 input level. When all inputs are defined, Exec can monitor inputs or devices in real time. The status display and input option (see photos 1 and 2) are polled once a second by Exec and used to update a real-time display on the PC. Devices that are currently active are highlighted (see photo 8).

Once the devices, and inputs if necessary, have been defined, events can be designated for each output device. In the case of the porch light (photo 9), seven daily events turn the light on at 7 p.m. and off at 6 a.m. For the upstairs hall light (photo 10), 3-minute time periods are triggered by either inputs from the "Circuit Cellar Staircase" motion detector or the "Upstairs Hallway" motion detector.

One thing that I hadn't thought of until late in the process is shown in photo 11. Under program control, this HCS option enables you to connect a parallel printer to produce a permanent record of time, date, and events triggered by an input change of state.

IN CONCLUSION

It's impossible to demonstrate all the features of the HCS in a few articles. My system has expanded considerably since the first few automatically controlled lights. Now I can call the Circuit Cellar from anywhere in the world, assess the situation, and modify the control accordingly. Of course, this same capability can be accomplished with your average personal computer, an elaborate I/O (input/output) interface, and many programmer-months of effort.

The HCS is a stand-alone single-board realization of all these fantasies. It is not an exercise left to the reader but a tried-and-proven design that allows control-happy computerists to come out of the closet at a reasonable expense.

For those of us who are beyond help, the maze just keeps growing. The 3- by 4-foot plywood area is full, a second HCS is performing dedicated control tasks, and I really am thinking about the air conditioning. Given all the installed motion detectors, the HCS can make real-time decisions and direct air conditioning only to inhabited areas. What's another 18-lead cable strung through the Circuit Cellar?

EXPERIMENTERS AND OEM USERS

As always, I try to support the computer experimenter by providing sources for many of the components. The Circuit Cellar HCS is suitable for OEM applications as well. It is available in various configurations that are all ultimately upgradable to the same potential.

If you plan on building the unit from scratch, good luck

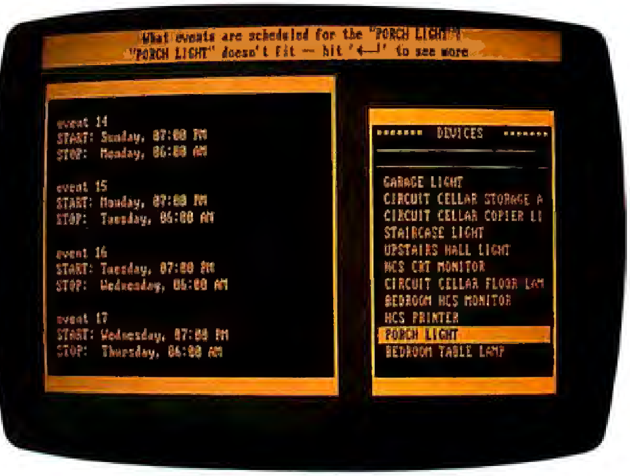

Photo 9: *Event triggers for a porch light.*

Photo 10: *Event triggers for a hall light.*

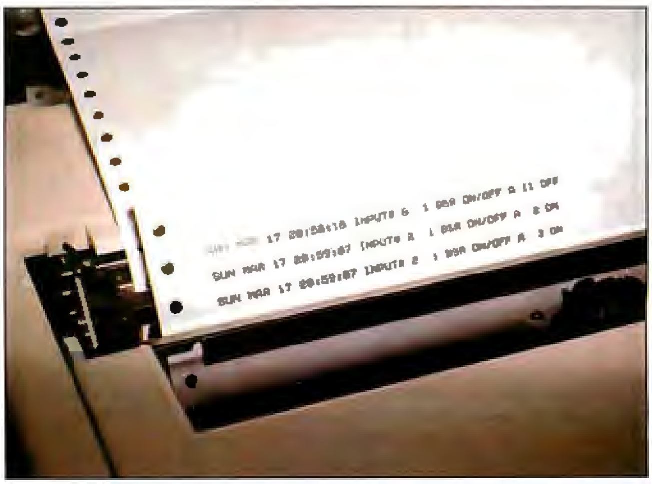

Photo 11: *Printer-interface capability.*

and take heart. Send me a picture of your board, and I'll send you a hexadecimal dump (16K bytes) of the control software (provided it is for noncommercial private use). If you're a bit more well-heeled, I'll supply the code on two 2764 EPROMs (erasable programmable read-only memories) and a manual for $32, postpaid in the U.S., $5 extra overseas. (No picture is required.)

Circuit Cellar Feedback

This month's feedback begins on page 461.

Next Month

I'll present a collection of alarm and environmental monitoring circuits. ■

Special thanks to Bill Summers and Leo Taylor for their software expertise.

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

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume* II covers December 1978 through June 1980. *Volume* III covers July 1980 through December 1981. *Volume* IV covers January 1982 through June 1983.

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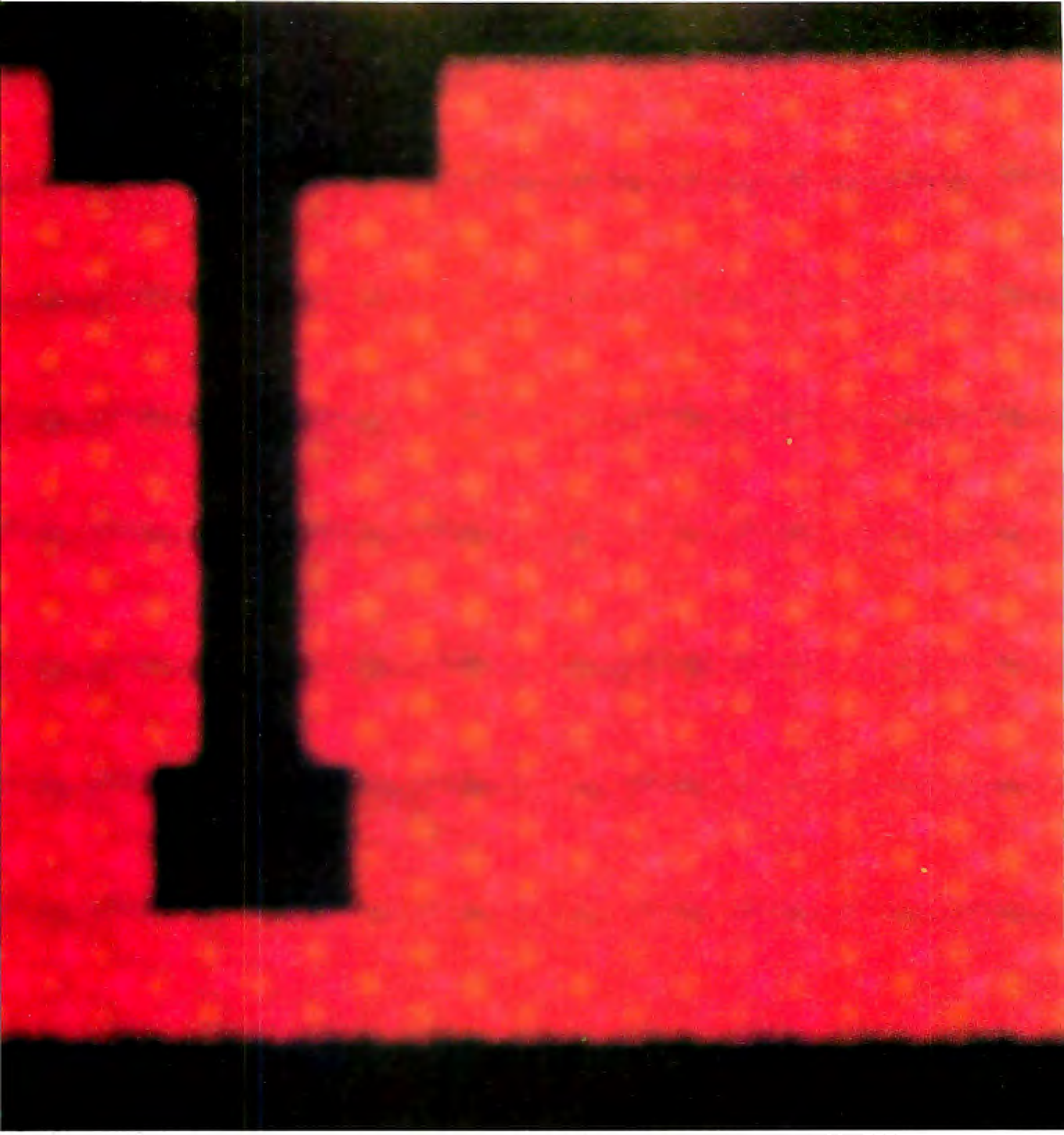

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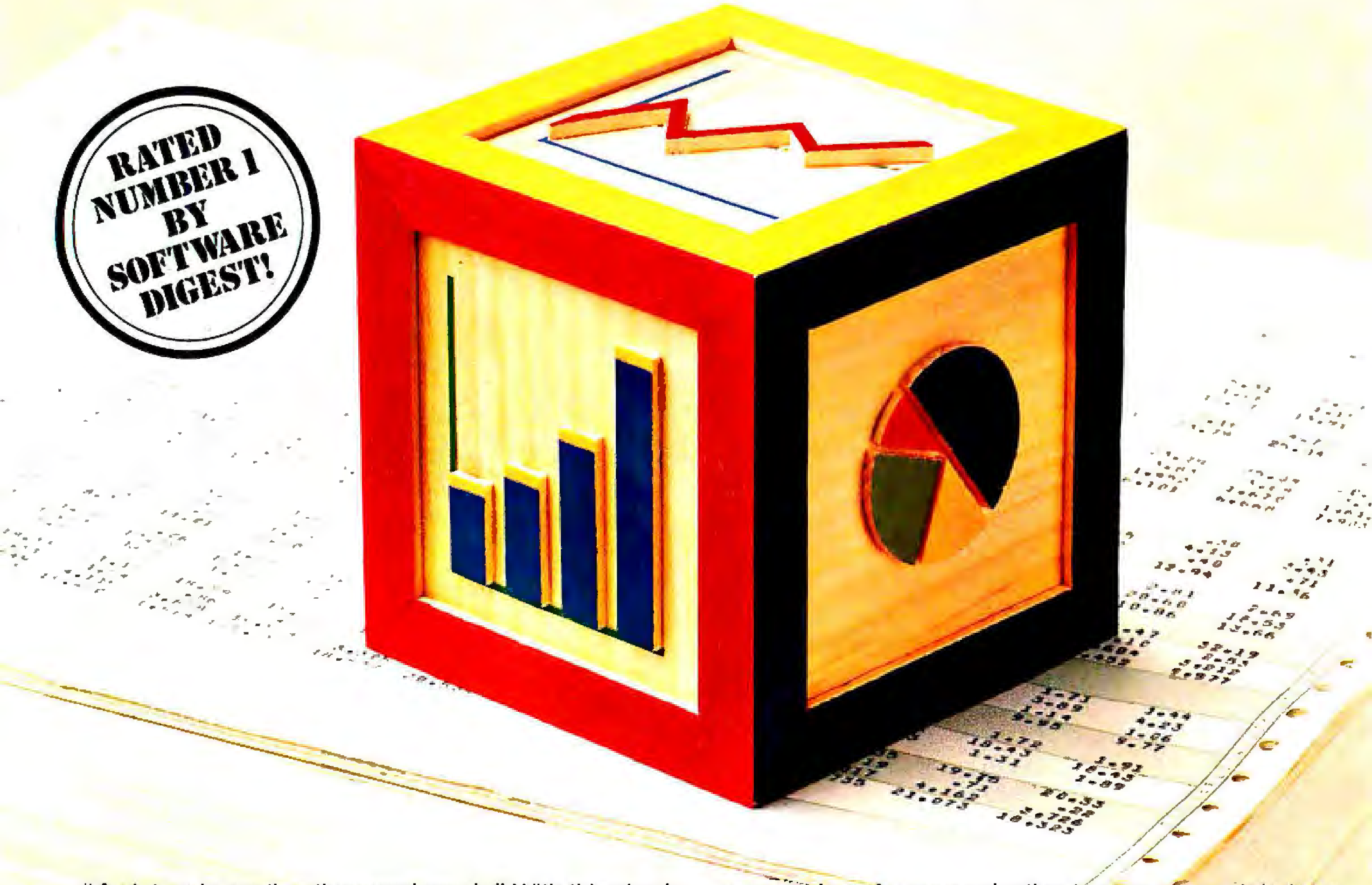

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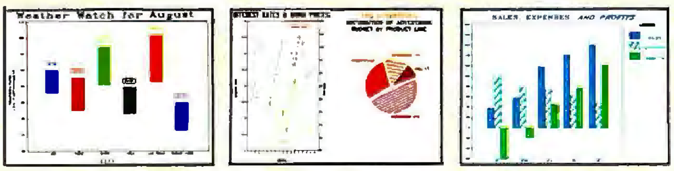

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BY SAMUEL D. FENSTER AND LINCOLN E. FORD, M.D.

SALT

A threaded interpretive language interfaced to BASIC for research laboratory applications

Research laboratories such as ours have become increasingly dependent on computers. This spiraling dependence has been fueled by the decreasing cost and increasing availability and power of microcomputers. A major impediment to the further use of computers is the lack of adequate software. To overcome this limitation, we developed a method of combining compiled and interpretive higher-level languages for general use in a diversity of laboratory applications.

In our previous work with minicomputers, control programs were written in a higher-level language, such as BASIC, with assembly-language subroutines for each specialized task. When two tasks were to be performed in immediate sequence, we either wrote a new routine combining the two earlier versions or made two separate calls to the routines from BASIC. Rewriting programs requires a great deal of programming time, but making repetitive calls from BASIC frequently took unacceptably long execution times. To eliminate both of these problems, we decided to develop a means of linking assembly-language routines together so that they could be used in a single CALL statement from BASIC. Before we had progressed very far, we found that we had reinvented the threaded interpretive language (TIL), this time in a form that was interfaced directly to BASIC.

THREADED INTERPRETIVE LANGUAGES

TILs consist of a set of "words." Primary words, called *primitives*, consist of machine-language subroutines. More complex words, *secondaries*, consist of a sequence of calls to primitives. Higher-level words may call primitives or previously defined secondaries in any order. They consist simply of a list of calls to starting addresses of the words. Program execution is rapid because all the primitives are run in machine language and the only extra time is that which is required to pass parameters to each routine and to proceed from one routine to the next.

A TIL has two distinct functions, *compiling* and *running*. Compiling consists of creating the lists of tasks to be performed in sequence and placing the necessary parameters in a place where the primitives can obtain them. Running consists of carrying out the tasks in sequence. The major difference between types of threaded interpretive languages is the way the program passes from one routine to the next by a process called threading (see reference 1). We use the technique called subroutine threading. When running, the program simply makes a subroutine call to each word in sequence. Every word, both primary and secondary, ends with a return (RET) instruction. Since the sequence of routines in our application is initially called from BASIC, the final RET statement in the list returns program control to BASIC.

It might be asked why we do not use one of the existing TILs. The principal reason is that we require a more interactive control language in the laboratory, where every possible turn of events cannot be anticipated when a program is written. Another reason is that we find looping and conditional branching restrictive and difficult to use in other TILs. Finally, other higher-level languages contain commands that are convenient for performing routine tasks but are not readily available in most TILs.

BASIC

BASIC was developed as a language for beginners. In fact, most people can learn to write programs in BASIC within a few hours. This is an advantage in a university laboratory populated partially by students, where inexperience is common and personnel turnover is high. It is not, however, the major reason for using BASIC as the principal language in the laboratory. Its major virtue in this setting is a characteristic that might usually be considered a drawback, namely, that it is

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You can write to the authors at the University of Chicago, Section of Cardiology, Department of Medicine, Hospital Box 249, 950 East 59th St., Chicago, IL 60637.

BASIC has become the standard language of many small computers, and thus is constantly being improved.

an interpretive language. This means that every command in a program is translated to machine language immediately before it is carried out. The need for separately interpreting each command slows program execution greatly, but it also makes the programs highly interactive. That is, a program can be stopped at any point and the operator will know precisely where he is because his original program is unaltered.

Once a BASIC program has been interrupted, the computer can be run in immediate mode. The operator can instruct the computer to carry out commands one at a time. In this manner, it is possible for the operator to determine the value of a variable, change a variable, or even change the path of program flow. The ability to interrupt a computer that is interfaced to laboratory apparatus is invaluable when the operation of the apparatus is not entirely predictable, as is often the case.

A final advantage of BASIC is that it has become the standard language of many small computers, including the IBM Personal Computer (PC). As a result, it is constantly being improved and has many useful features.

One disadvantage of some forms of BASIC is their limited memory capability. The version used on the IBM PC can address only 64K bytes. Although this is sufficient space for most programs, laboratory apparatus can frequently generate enough data to make this space seem cramped. Subsequent analysis can usually reduce the data to a more manageable size, but it is necessary to find some way to hold the data without severely limiting the program area. To this end we have designed SALT to store raw data in areas of "high" memory above the BASIC space. An entire block of data can be transferred between this space and disk. Portions of the data in a block can also be transferred between high memory and BASIC arrays. This ability to move large amounts of data between high memory and disk and to operate on smaller parts of it in BASIC arrays provides a type of virtual memory, greatly expanding the capability of BASIC.

The major disadvantage of BASIC is its slowness. While running programs in an interpretive language, the computer cannot respond fast enough for many laboratory applications. To overcome this slowness, machine-language subroutines control the computer when it is interacting with the laboratory apparatus. A difficulty with using simple subroutines occurs when two or more of them are to be run in sequence. Program control returns to BASIC after each subroutine call. This return costs valuable time, and more importantly, the time required may be somewhat unpredictable, especially when parameters must be passed from BASIC to the subroutines. For time-critical operations in which subroutines are to be run sequentially, it was previously necessary to write additional subroutines, combining earlier ones in the proper sequence. As the number of computer applications in the laboratory increased, the continued rewriting of subroutine sequences became costly. To overcome this difficulty, we have developed a method of calling subroutines from a master machine-language routine, with one CALL statement from BASIC.

SALT

SALT is a laboratory TIL. As with all TILs, SALT's two distinct functions are compiling and running. All compilation is performed by a single assembly-language routine called from BASIC. This routine, named LOADER, creates secondary machine-language words that are subsequently called from BASIC. A secondary word consists of a sequence of CALL instructions, each followed by the starting address of the routine being called and any necessary parameters. Thus, a call from BASIC to a secondary word initiates a second call to the first word in a sequence. The final instruction in a list is RET, bringing the program back to BASIC. It is not possible to call any of the primitive subroutines directly from BASIC. The LOADER routine must first translate the name of the routine to its starting address and create a secondary word consisting of a machine-language CALL instruction followed by all necessary parameters and RET at the end.

The secondary words in a program are recompiled each time the program is run. Thus, programs in SALT are actually created and stored from within BASIC programs. It is not possible with SALT, and probably not desirable in general, to create secondary words that retain their identity outside the individual program. To use SALT, a programmer must be familiar only with the general requirements of the assembly-language routines he wishes to run and with the requirements of the LOADER command. He need not know about any previously written programs or about the specifics of the assembly-language programs. [*Editor's note: See the end of the article for details on obtaining copies of the* SALT *software package.*]

At present, we have more than 100 separate assembly-language primitives. These are grouped into functional categories described in detail below.

HARDWARE

The software described here was written specifically for an IBM PC equipped with a Tecmar Lab Master board, 512K bytes of memory, and two floppy-disk drives. It was developed out of a need for an easy and efficient way to make use of the Lab Master. The general principles can, however, be applied to any similar computer system. Almost all laboratory applications can be described as

(continued)

a combination of the following functions: control of experiments, including timing and synchronization of external events, and setting external voltages; data acquisition, usually through the digital conversion of electrical analog signals; data storage; and data analysis. All of these functions can be implemented with the hardware and programs described here, except that the topics to be described under the heading of data analysis are limited to a few routines for simple arithmetic procedures and display that might be used as part of more sophisticated analyses.

The Lab Master board has four discrete functions required for laboratory application: an analog-to-digital (A/D) converter with 16 channels of input; two digital-to-analog (D/A) converters; a 24-channel digital input/output (I/O) device; and a chip with five programmable counters and an internal 1-MHz clock, whose basic frequency can be divided either by powers of 10 or powers of 16. Most of the software routines that we will describe are directed at implementing the four functions of the board. The remainder are used for performing simple arithmetic operations on blocks of numbers and for moving blocks of data between storage areas.

Details of Operation

SALT consists of a single compiling routine, LOADER, and a large number of small subroutines that perform very specific operations during program execution. The small subroutines are no different from any other type of assembly-language routine except that many are designed to be used in sets. For example, one subroutine may set up a counter for timing operation and another may be required to start the actual timing. The aspect of SALT that makes it unique is the LOADER routine that establishes the secondary words that are called from BASIC.

Loader

The LOADER routine that compiles the secondary words converts all other subroutine names to addresses, eliminating the time required to look up addresses during execution. It then uses the addresses in a sequence where each one is the operand of a CALL, which is followed by any necessary parameters. A RET is placed at the end of the sequence, and the starting address of the entire sequence in memory is placed in a table. The use of memory by the LOADER routines, as well as the memory allocation for SALT and the A/D data operation, is shown in figure 1. As illustrated, separate memory areas are reserved for secondary routines and for their addresses when SALT is loaded into memory. The LOADER routine fills these areas as it compiles secondary words. In the present version of SALT, those reserved areas are relatively small because there is no need in our application to have them any larger. In principle, the only limitation to the size of these areas is the amount of available memory.

The parameters passed to the routine can be of three types: fixed integer values placed after the routine call; positions of binary bits to be set in a byte that is then placed after the routine call; and BASIC integer variables whose addresses are stored after the call. The following example illustrates the operation of LOADER.

In this example, a word called DR.2 (driver routine number 2) will first configure the 24 I/O lines into three 8-bit

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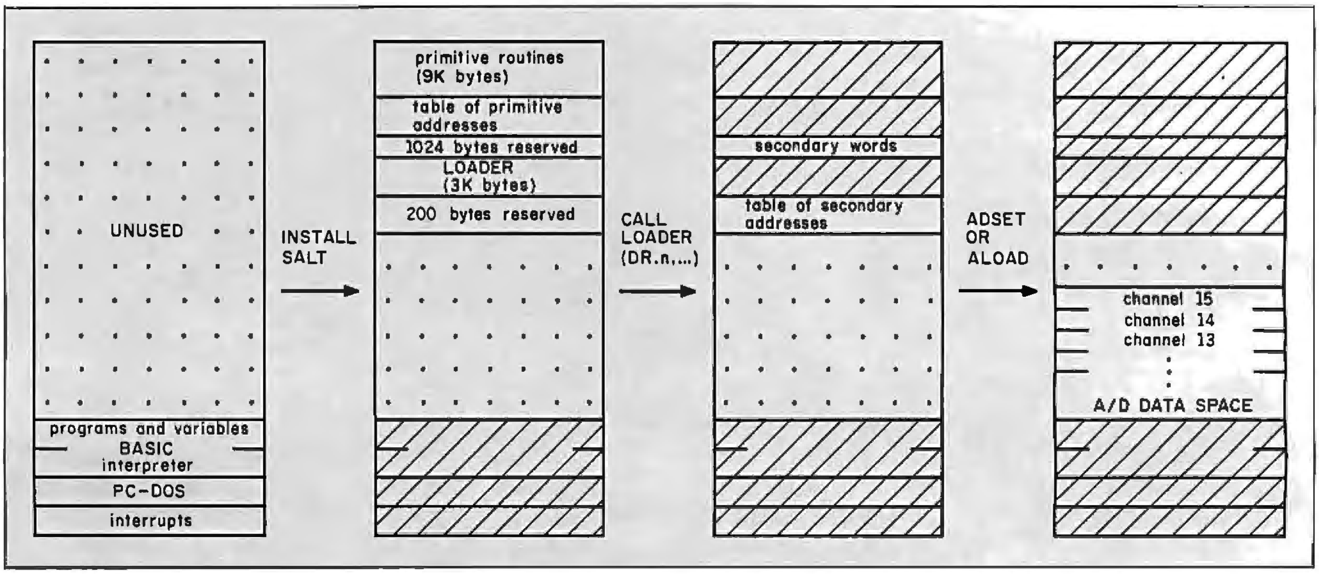

Figure 1: *Installing* SALT *with a* BASIC BLOAD *instruction puts the primitives and* LOADER *routines at the high end of memory and reserves space for the compiled secondary words and for a table of addresses of the secondary words. A* CALL *to* LOADER *creates a secondary word and places the starting address of the word in a table. The* ADSET *or* ADLOAD *routines allocate data space in memory immediately above* BASIC. *The data space is arranged into equal-size channels.*

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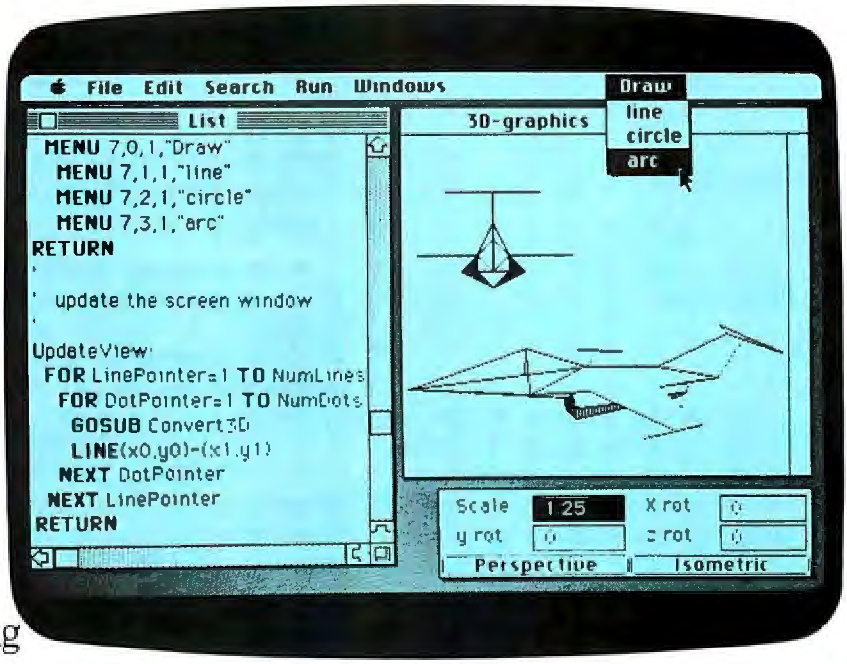

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ports such that the first (A) port is input and the remaining two (B and C) are output. Second, DR.2 initializes counter number 1 to count 20 milliseconds. Finally, DR.2 stops the counter at its initialized value to wait for the command START to begin counting. The BASIC command to perform this sequence is

CALL LOADER (DR.2,IOSET.1.0.0, TIME.1.20.3, STOP.1).

LOADER would then create a secondary word in memory consisting of the following sequence:

```
CALL 1003
        1
        0
        0
CALL 1097
        1
       20
        3
CALL 2034
        1
RET
```

The starting address of this sequence would be placed in the second position of the *driver table*, a position reserved specifically for the address of the secondary word called DR.2. The value 1003 is the starting address of the IOSET primitive that initializes the I/O ports, and the parameters 1.0.0. specify the desired configuration. The value 1097 is the starting address of TIME, the routine that sets a counter to count from the Tecmar clock. The parameter 1 specifies the first counter, and the parameter 20 gives the number of pulses to count. The parameter 3 specifies the millisecond rate. The STOP routine, which begins at address 2034, holds counter number 1 at its pre-set count until a START.1 command begins the count.

Once the initialization is complete, another secondary word can use parts of the Lab Master board for other purposes. For example, a word called DR.3 can be written to: wait for I/O line A2 to go high; read a voltage value on A/D channel 10; put the same voltage on D/A channel 1; wait 20 milliseconds using counter number 1, which was initialized by DR.2; and set I/O channels B2 and B7 high. The BASIC command to create this sequence would be

Table 1: *Functional categories of SALT's primitive subroutines.*

File and data management
Timing
Analog-to-digital conversion
Digital-to-analog conversion
Digital input/output
Arithmetic procedures
Miscellaneous routines

CALL LOADER
(DR.3, RHA.2, VAD.10, D.VOLT, VDAV.1, D.VOLT, START.1, WAIT.1, WHB.2.7)

The two secondary words DR.2 and DR.3 can be called from BASIC separately, or another secondary word can be written to call them in sequence with a single call. This latter option would be compiled with the command CALL LOADER (DR.4, CDR.2, CDR.3), which would use the addresses in positions 2 and 3 of the driver table to create the assembly-language sequence

```
CALL 812
CALL 871
RET
```

CALL DR.4 is the BASIC command that would execute the entire sequence of tasks before returning to BASIC.

The LOADER command has very specific requirements, some of which have been imposed for ease of the initial programming, some of which have been created for ease of subsequent programming, and some of which have been imposed by the idiosyncrasies of IBM BASIC. For example, all of the secondary words are called DR.*N* where *N* is an integer between 0 and 100, and the commands DEFINT D and LOADER = 3 must precede the first call to LOADER in the BASIC program. The starting address of the LOADER routine is 3. The necessity for using the DEFINT D statement has been imposed to eliminate the need for typing the "%" character following each DR definition and each BASIC integer variable parameter, such as D.VOLT. The term DR is always used to name the secondary words so that the LOADER program can find the beginning of the parameter list following the words CALL LOADER. A CALL statement from BASIC pushes the entire parameter list in the statement onto the stack. The LOADER routine examines the stack to find the first variable, which always begins with DR. Once this is found, the integer following DR. is used to identify the secondary word.

PRIMITIVE SUBROUTINES

The individual primitive can be grouped under the separate functional categories listed in table 1. They are described below in detail by category. The listings of the individual routines are not given here because they require too much space and because they are, for the most part, specific to the Lab Master board.

When these routines were developed, the highest priority was given to speed, because they were designed to be used in real-time applications. To achieve this speed, the routines were made as simple as possible. The number of Test and Conditional Jump instructions was kept to a minimum because they take a moderate amount of program execution time. The desired simplicity was achieved at the expense of some redundancy in the program. For example, there are nine separate routines to write nonvariable data to the three digital I/O ports. These nine routines differ from each other in only two characteristics, the I/O port to be written to, and the type of output, i.e., whether the specified channels are to be made high, made low, or to toggle (change from the previous value). Since there are three alternatives for each of the three channels, there are nine combinations. Each of the routines is short (about 18 bytes), so that the memory required for nine

(continued)

separate simple routines is not much greater than that for a single routine that would accept the I/O port and the type of output as parameters. A larger, single routine would, however, require much more execution time.

Execution times were measured for all the time-critical routines that might be used during an experiment. These were estimated in two ways. Some execution times were measured from failures to make A/D recordings on a regular schedule. A ramp voltage was put into one channel of the A/D converter, which was programmed to make conversions at regular intervals that had been established by the frequency of the internal clock. The intervals between clock cycles were decreased in increments of 1 microsecond (μs) until the A/D failed to make a conversion. To detect a failure, the recorded ramp voltage was output to the oscilloscope using the D/A routine. A missed sample was recognized as a double step between voltage levels in the displayed ramp, as shown by the arrows in figure 2. This method could also be used to measure execution times of routines by directing the computer to perform the routines between sampling periods. A second, more straightforward, method of measuring execution times was to use a primitive called COUNT that returns the value in the buffer of a specified counter without influencing the counter's operation. By setting the counter to count down from a large number at microsecond intervals, it was possible to estimate execution times with a resolution of 1 μs. The COUNT routine took 68 μs ± 1 μs each time it was called. The execution time of routines inserted between two calls to the COUNT routine was therefore calculated by subtracting 68 μs from the measured interval.

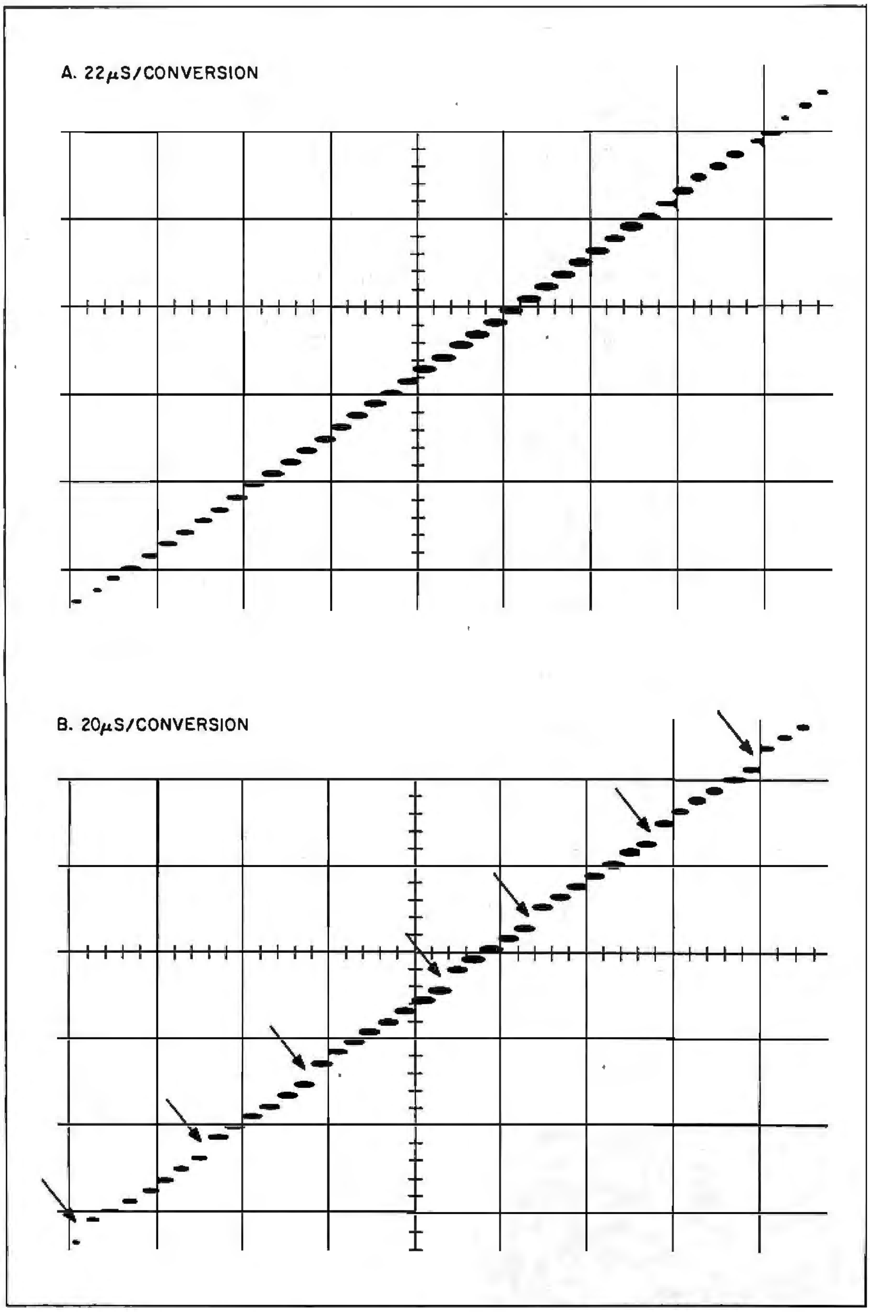

Figure 2: *A voltage ramp was recorded at two sampling intervals, differing by only 2 μs. The digitized data was displayed at the same rate for both. Failure to make a conversion, indicated by the arrows in B, resulted in a complete sample being missed after every 5–8 conversions. The voltage step after a missed sample is twice normal.*

It might be expected that the execution time for a given routine could be calculated from the number of clock cycles required for each instruction in the routine. In general, the routine took 30 to 50 percent longer than expected. A possible explanation for these longer times has been given in *PC TECH JOURNAL* (see reference 2). Further explanations are beyond the scope of this article. In addition, the execution times were somewhat variable. A possible cause of this variability in timing arises from memory-refresh cycles that occur at unpredictable intervals during program execution. This variability may cause a routine to take variable periods of time, so that variations in execution times will not occur regularly or predictably. Thus, it was necessary to

(continued)

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measure execution times repetitively and to estimate an average and a range of speeds.

FILE AND DATA MANAGEMENT

All data is handled as 2-byte integer samples. A few primitives operate on a single number. For example, one primitive sets a voltage value on one of the D/A channels and another records the voltage of a single A/D channel. Most data is handled as long arrays. Before such data can be recorded, a space must be reserved for it in high memory using the ADSET routine, as shown in figure 1. This primitive requires two parameters to establish the number of channels and the number of samples per channel. Once recorded, the data can be transferred to disk using the SAVEF primitive, which creates a disk file using a filename previously specified as a BASIC string variable. The first 2 bytes in the file are used to record the number of samples per channel. When a file is read from disk using the LOADF primitive, a buffer of the correct size is first created in high memory, and the data is read into it. To use the recorded data in a BASIC program, it is necessary to move the data from its buffer in high memory to a BASIC integer array (e.g., DATAARRAY). This is done with the FETCH primitive, which requires two parameters. The first is an integer that designates the channel number, the second (e.g., D.N2) is a BASIC variable that has been set by the BASIC VARPTR function to the starting address of the BASIC array. The BASIC instruction

```
D.N2 = VARPTR(DATAARRAY(0))
```

should immediately precede a CALL to a secondary containing the FETCH primitive because BASIC moves its arrays around unpredictably. The number of the first sample to be transferred from a channel is placed in the zero position of the BASIC array using a BASIC instruction. Samples are transferred sequentially until the defined array is filled or until the end of the channel is reached. In this manner, only a portion of a record is transferred at one time, so that only a small amount of BASIC array space need be used. Another instruction called STORE performs the inverse of FETCH. It transfers data from a BASIC array to a previously defined data space in high memory.

Two additional routines, SAVEF and LOADF, transfer arrays of data in high memory to and from disk. The arrangement of data into channels is the same as that produced by the ADSET routine (see figure 1).

There is a primitive called SWITCH that allows the operator to switch between two simultaneously existing buffers in high memory. Since each buffer can be as large as 64K bytes, a total of 128K bytes of high memory is available. The combination of ADSET, FETCH, STORE, SAVEF, LOADF, and SWITCH greatly expand the amount of space available to BASIC for handling data. Because data can be transferred between buffer and disk and then to and from BASIC, the routines provide BASIC with a form of virtual memory.

TIMING

Precise timing is essential in almost all laboratory applications. Such timing is made available by a 1-MHz clock in the timer-counter chip on the Lab Master board. The basic frequency can be divided either by powers of 10 or powers of 16. To keep the application simple, we have chosen to use only the decimal divisions. The divided frequencies are available in two forms. They can be divided further by numbers ranging from 1 to 16 and made available externally as an "F-out" square wave. We have not yet found this provision useful and instead have chosen to perform timing using one of the five counters in the chip. There were two reasons for this decision: The F-out pulse is not available internally to software, and more importantly, it cannot be synchronized to external events. The 1-MHz clock and its dividers operate continuously so that they cannot be synchronized at all. The counter can, however, be made to begin counting in synchronization with an externally applied signal. By counting a large number of high-frequency pulses, it is possible to synchronize the counters to within the limits of the basic frequency. Since the counters can count to two pulses, it is possible, in principle, to achieve 1-μs accuracy of synchronization. In practice, the accuracy is limited to 3 μs because about 3 out of every 15 μs (14 out of every 72 central-processor clock cycles) are used by the computer for memory refresh, and it is not possible to control when the 3-μs interruptions will occur.

The counters on the Lab Master board are complex and have 18 different modes of operation. Despite this complexity, the chip containing the five counters, the 1-MHz frequency generator, and the frequency divider is controlled using two 1-byte ports. While it would be possible to initialize the counters directly from BASIC by sending data to the two control bytes, the complexity of the timers makes it much easier to use separate subroutines to establish each of the modes of operation.

(continued)

The complexity of the counters arises from the combinations of available functions. Each counter can count either internal pulses or external pulses, each can count repetitively or give a single count, and each counter can be gated either internally or externally. Finally, each counter has two 16-bit registers from which it obtains its count.

In our application the counters are used for two main purposes. The first is the timing of D/A and A/D conversion. Since conversions are usually made at regular intervals, the counters are usually set to run continuously. In most cases, the duration of the pulses is not critical because the digital conversions are triggered on the changing edge of the counter pulses, so that only one of the two counter registers is used at one time to generate the correct frequency. In one application, the counter pulses are also applied to sample-and-hold circuits used to synchronize the conversion. In this case the pulses from the counter must be sufficiently long to hold all the external circuits in the hold mode until the analog values are converted. Both counter registers are used, one to establish the frequency and the other to set the pulse duration. In another application, the two counter registers are used to establish two separate frequencies. Switching between the two frequencies is accomplished with gating pulses applied externally. The use of these gates eliminates the need for reprogramming the counters and thereby hastens program execution.

The second application of the counters is to control external events by providing pulses of specified duration at specified times. The counter registers are used to establish pulse duration as well as the delay between some initiating event and the onset of the pulse. The counters can be very useful for this purpose because they operate independently of the computer's central processing unit once they have been started. This independent operation speeds program execution greatly.

A/D CONVERSION

The simplest A/D primitives convert a single analog voltage value on one A/D channel and place the digitized integer value in the BASIC variable space. All the other A/D primitives make sequential conversions at a frequency determined by a counter on the timer chip. The principal need for speed in laboratory applications is in the rapid accumulation of digitized data from electrical analog signals. There are four separate routines for this purpose and each has separate advantages with respect to simplicity, speed, and synchronization. All of the routines have been written in a way that makes it possible to interrupt

(continued)

The two main uses for digital-to-analog conversion in the laboratory are setting control voltage and displaying data.

recording to perform some task, such as changing the speed of recording or outputting a control pulse. This latter provision makes it possible to exert a great deal of control over the experiments while collecting data.

All of the sequential A/D routines require that a buffer for the digitized data be established in high memory above the BASIC program area. This is done with the ADSET primitive described above. If recording is stopped before the buffer is full, data will be placed in the next available space when recording resumes. It is also possible to establish two buffers in the present version of SALT. This provision permits data to be collected from a different number of channels at different times. It also makes it possible to transfer data from one buffer to another while performing mathematical manipulations, without destroying the original data.

The simplest sequential A/D primitive, AD1E, makes a single conversion from one channel on every clock pulse and the digitized data is sent sequentially to memory. This is the fastest form of operation because the assembly-language instruction that sends the data to memory increments automatically and there is no need to keep track of the memory location. The AD1E routine was used to collect the data in figure 2. The minimum safe time between conversions is 22 µs. Timing is accomplished by wiring the external output of a frequency generator to the external start input of the A/D converter. This mode of operation is used because it provides the most accurate timing; each conversion is initiated on a counter pulse without any program intervention.

The three other sequential A/D primitives collect data from multiple channels in sequential order. The Lab Master board has a provision that automatically increments the channel number, beginning with a channel that is specified by software and ending with a channel that is specified by switches on the board. We keep our switches set at the highest channel number to be able to use all 16 channels on the board. The simplest of these multichannel primitives, ADQE, sends data to memory as it is collected, so that the first sample of channel 1 is followed by a first sample of channel 2, and so on. At the end of the period of recording, a routine called SORT orders the data by channels so that the first sample of channel 1 is followed by the second sample of channel 1 and the last sample of channel 1 is followed by the first sample of channel 2, etc. Data acquisition with this routine is as fast as AD1E (22 µs per conversion) because the channel number is incremented automatically, without program intervention, and because the routines for memory storage are the same.

The remaining A/D primitives order the data as it is collected, sending data from each channel to its proper place in memory. Even though the auto-increment mode is used, the program must keep track of which channel is being converted because the data must be sent to the correct channel block within the buffer. Thus, the program must use two counter registers, one for the channel number and one for the sample number. The need for two counters, as well as the additional programming required to continuously redirect data to different parts of the memory slows program execution substantially. The minimum interval between conversions ranges from 40 µs for 16 channels to 48 µs for two channels. The main advantage of these routines over ADQE is that the data need not be reordered after recording, so that a second buffer is not needed. For many applications this routine is more satisfactory because it is simpler.

The multichannel A/D primitives described above collect data from the different channels at regular intervals so that the first sample of channel 2 is collected later than the first sample of channel 1, and the first sample of channel 3 is collected later than the first sample of channel 2, etc. This is not a major disadvantage because the values in any channel at any given time can be estimated by interpolation. The final A/D primitive, AD, is designed to make nearly simultaneous conversions from all channels. With this primitive, each round of conversions is initiated on a single clock pulse and all samples are converted as rapidly as the software will allow, thereby minimizing the intervals between samples taken from different channels. The interval between samples is not critical because the routine is designed to be used with external sample-and-hold circuits. This routine uses a "software start" to initiate each A/D conversion and instead of detecting an "A/D done" flag, it detects the presence of a pulse on the counter output to start the round of conversions. The same pulse is also output externally to trigger sample-and-hold circuits for each channel. Synchronization occurs because the sample-and-hold circuits are triggered to hold their values on the rising edge of the pulse.

D/A CONVERSION

The two main uses for D/A conversion in the laboratory are setting control voltage and displaying data. Control voltages are set using one of three routines, which differ according to the type of parameter they take.

Data is displayed on an oscilloscope, as in figure 2, using sequential D/A primitives. There are 2 D/A channels and there are 16 A/D channels, so it is necessary to specify which channels are to be displayed. In addition, it is necessary to specify the

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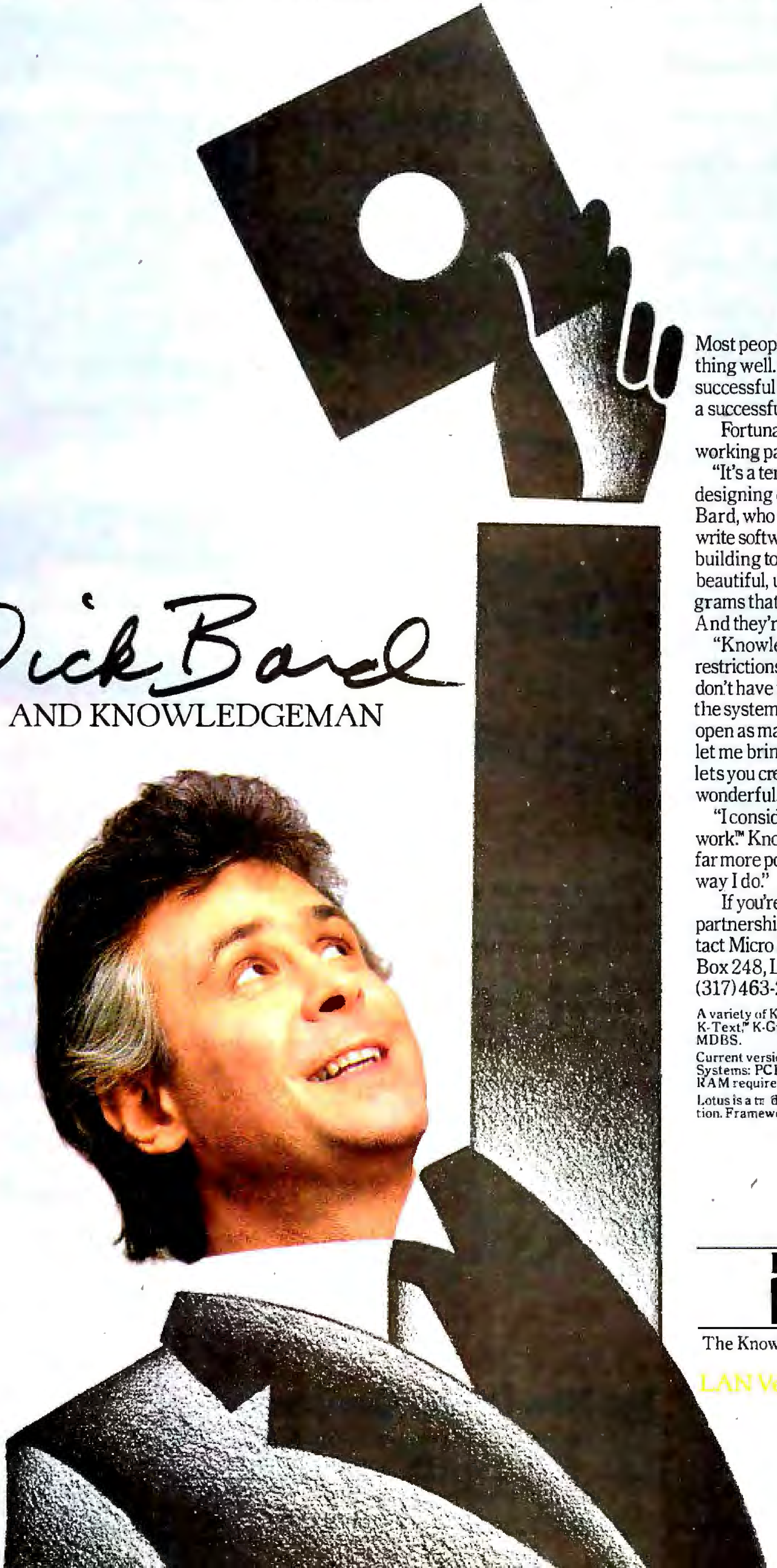

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SALT

rate of conversion. Since the output is displayed repetitively on an oscilloscope, it is important to make this routine as fast as possible. In addition, it is highly desirable to have the sample output rate be a round number of milliseconds. The D/A routines can operate without failure at 48 μs per conversion and so can be used conveniently at 50 μs per conversion. At this rate two channels of 1000 samples each require 50 milliseconds for display. The two-channel repetition rate is thus about 10 per second. The repetition rate is actually a little lower because the oscilloscope requires a few milliseconds to reset its beam to the beginning of each trace. A repetition rate of 12 to 18 Hz is not flicker-free, but is also not too uncomfortable to scrutinize.

Digital I/O Primitives

The I/O ports are used in our laboratory to transfer 5-volt TTL (transistor-transistor logic) pulses between the computer and other apparatus. This transfer of digital signals enables the computer to control the experiments, or in some cases, to be directed by external events. Frequently the digital pulses must be transferred during other time-critical operations, such as making rapid A/D recordings. For this reason, these routines were made as simple and therefore as short as possible. As explained above, this need for simplicity resulted in a large number of very similar primitives. The simple routines take about 31 μs. If the routine is to be run during A/D sampling, an additional 50 μs is required to stop and start the sequential A/D routines.

Arithmetic Primitives

A group of primitives perform simple arithmetic manipulations on entire channels of data located in high memory. The manipulations include addition, subtraction, multiplication, and division by constants as well as integration and differentiation. These routines can be very useful in making displays, finding maxima, and detecting trends.

(continued)

There are a few miscellaneous routines for operations that could also be run from BASIC, but which have been included in SALT so that program control would not have to return to BASIC each time they were to be run. These routines print messages on the monitor, sound the beeper, etc. They can be used, for example, to provide warning sounds and error messages in SALT.

FUTURE IMPROVEMENTS

This first version of SALT contains all the necessary routines for interfacing a computer to laboratory apparatus and for manipulating blocks of data, but it contains very little else. It is obvious that more primitive routines for data analysis would be useful, and that the language might be useful outside the lab. Rapid routines for displaying records with cursors on the displays, finding maxima and minima in records, etc., would greatly speed some types of analysis. High-speed mathematical routines, such as fast Fourier transforms, could also be extremely useful in some specialized applications. Nonlaboratory applications would include all forms of assembly-language routines to be run in batches under control of an interactive higher-level language, such as BASIC. The use of assembly-language routines for performing repetitious procedures and for handling large blocks of data can greatly hasten program execution time and expand the memory space available to BASIC, without sacrificing its interactive qualities. Fortunately, the structure of the language permits the simple addition of the necessary primitives. Once the routine is written, its name, starting address, and parameter format are simply added to the tables of primitives. Since the assembly-language routines are short, it will generally not be necessary to remove old routines to make room for new ones. The current version of SALT occupies about 12K bytes of instruction space, of which 9K bytes are used for primitives. As written, the program can fill up to 64K bytes of higher memory with assembly-language programs, so that the space occupied by the primitive routines can be expanded over fivefold before economy of space becomes a consideration. [*Editor's note: You can obtain a copy of* SALT *on disk and documentation of its operation by sending* $50 *to Sam Fenster,* 4949 S. *Woodlawn Ave., Chicago,* IL 60615.] ■

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2. Smith, Bob, and Tom Puckett. "Life in the Fast Lane: Techniques for Obtaining Timing Information with Microsecond Resolution on the PC." *PC TECH JOURNAL*, April 1984, page 63.

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By Phillip Robinson

The SUM: An AI Coprocessor

Turning a common AI operation into silicon

Logic programming is a staple of artificial-intelligence (AI) software and is often dominated by the pattern-matching process of unification (see the "Resolution and Unification" text box on page 173). In fact, when logic-programming languages such as Prolog and LOGLISP are used, as much as 50 to 60 percent of a computer's processing time is spent on unification. When a single algorithm is used that frequently, it is natural to consider implementing it as custom hardware. When that same algorithm lends itself to parallelism and concurrency because of its recursive, tree-search characteristics, it practically begs for VLSI (very large scale integration) implementation.

SUM History

Professor John Oldfield and a team of researchers at Syracuse University are developing the SUM (Syracuse Unification Machine), a coprocessor for computers geared toward AI programming. The project combines the resources of the Syracuse CIS (Computer and Information Science) department, ECE (Electrical and Computer Engineering) department, and the CASE Center (Computer Applications and Software Engineering Center, set up by New York State). Key SUM individuals are Dr. Oldfield himself (who contributed CAD [computer-aided design] and VLSI expertise), Professor Alan Robinson (who is the head of the logic-programming efforts at Syracuse), and Kevin Greene (who made the initial designs of the SUM). Because of a famous 1965 paper, Dr. Robinson is often credited with inventing unification. He is more modest, pointing to the work of Herbrand in the 1930s and the studies of Prawitz and Kenger concerning unification. Dr. Robinson contends that he was just the first to formalize the unification process and apply it to resolution.

In 1981, the Syracuse CIS logic-programming group learned that Caltech (California Institute of Technology) student Sheue-Ling Lien had designed a chip that embodied Dr. Robinson's original unification algorithm (see the "Unification on a Chip" text box, page 174). Dr. Robinson and his colleagues were somewhat taken aback that someone else had taken this step. Lien's report was a major inspiration for the development of the SUM, even though the chip it described was never actually made. Because ECE had been developing custom VLSI chip-design capability and had a strong logic-programming group, combining the pursuits "seemed a natural thing" according to Dr. Oldfield.

Coprocessor Strategy

As Dr. Oldfield explains, "Although we started talking about a unification chip, following along the lines of the Caltech one, it soon became fairly clear that at present levels of integration that was fairly ridiculous. You could make a chip, but it would be limited to solving such small problems that it wouldn't be worthwhile." The SUM group wanted to design a full-blown, practical processor. Besides, Lien's chip used Dr. Robinson's original 1965 algorithm. Much more efficient algorithms have been developed since.

When they realized that a single chip wasn't realistic, the members of the group looked at the possibility of a coprocessor, initially for the LMI

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(LISP Machine Inc.) Lambda computer. Dr. Oldfield continues, "Here's the LMI Lambda executing a LISP program. When it comes up to the point where it needs to do a unification, then that task is given over to the SUM," which would handle it more efficiently than the Lambda could. The SUM interface is tailored to the LMI Lambda's high-speed, parallel Nubus (developed by Texas Instruments) but could easily be adapted to other machines and buses.

RESOLUTION, UNIFICATION, AND TREES

Although the unification algorithm has a number of uses, it is often employed as part of a wider process called *resolution*. Resolution is a rule of inference for constructing deductive proofs from any number of accepted clauses. Practical problems may involve thousands or millions of clauses. One way to view resolution is as the exploration of a tree of possible proofs. Resolution uses unification to help reduce the number of clauses. Unification, in effect, works on its own tree, moving down branches and trying to bind—find acceptable values for—variables. If unification is successful on one branch, it switches to another branch farther down and binds some more variables.

Failure of resolution on a branch of the resolution tree is not a disaster; it just means another branch must be explored. Similarly, when unification fails on a branch of the unification tree, the process keeps all bindings except the most recent and explores another branch.

SUM ARCHITECTURE AND OPERATION

Figure 1 is a block diagram of the SUM that Kevin Greene developed. Unification tasks come into the SUM from the Lambda, are performed, and the results are passed back. The communication agent, which is the interface between the Lambda and the SUM, passes unification tasks to the work manager. Initially, the work manager's task pool will have only one task, but as processing continues other tasks will come back from the binding agents. Those tasks must be coordinated with the tasks coming from the communication agent. The work manager pushes the unification task out into the analysis agent, which executes the heart of the unification algorithm.

The analysis agent must decide what to do with the expressions it receives. What it does depends on the type of expression. If both expressions are simple constants, unification succeeds only if they are identical. If

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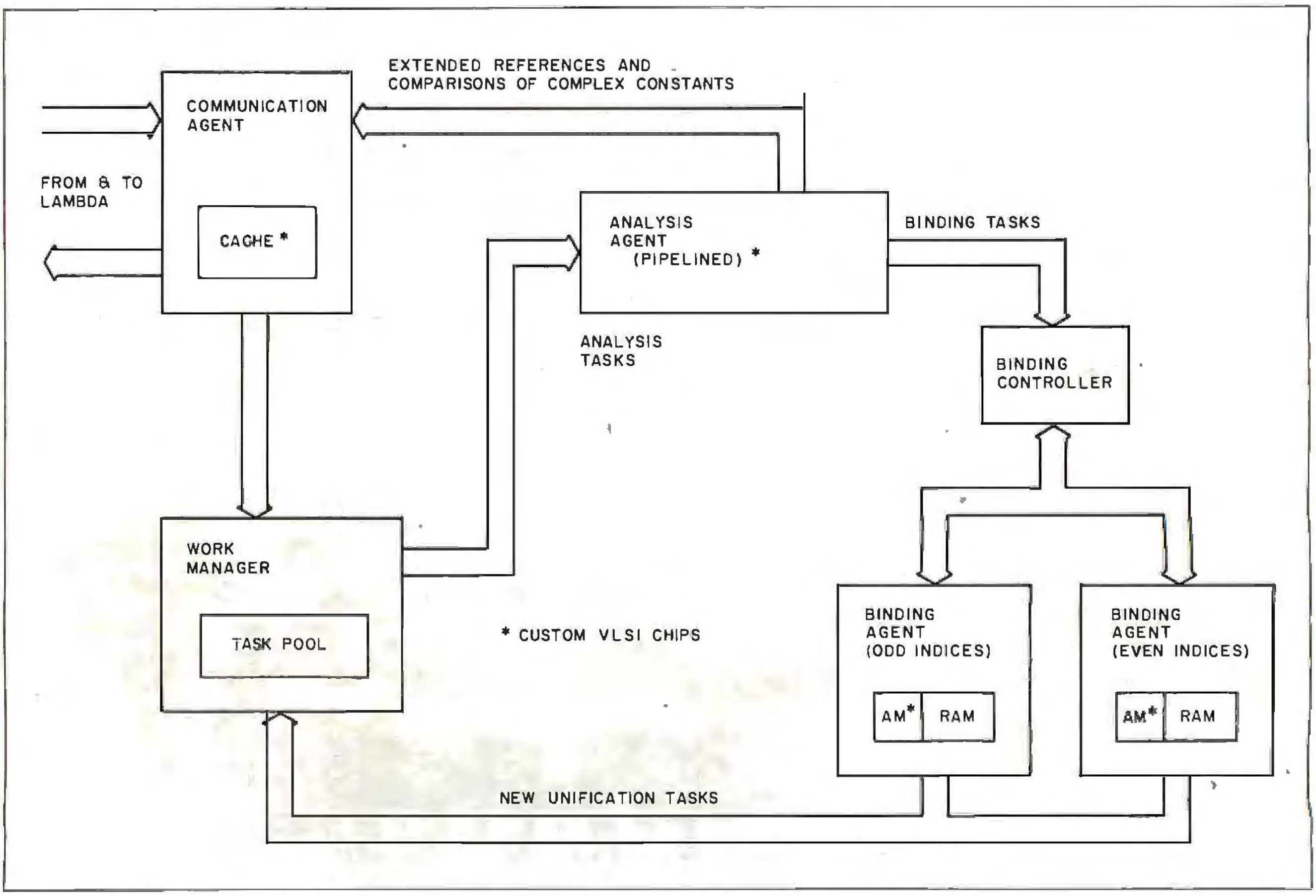

Figure 1: *A block diagram of the Syracuse Unification Machine.*

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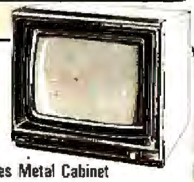
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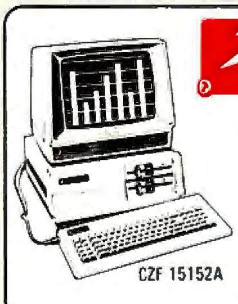
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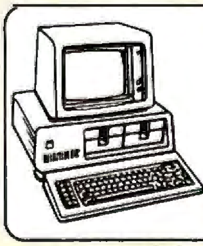
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the expressions are complex constants, such as floating-point numbers or strings, the analysis agent may be given pointers to the data structures rather than the data structures themselves. Since unification requires an equivalency check, the SUM must pass the pointers back to the Lambda. As Dr. Oldfield says, "SUM doesn't know anything about list structures. All it can handle are pointers to structures that continue to reside in the Lambda." In this case, the comparison is made by the Lambda, and the result is then returned to the SUM.

Finally, the analysis agent may encounter the job of having to unify a variable and an expression. It can try

(continued)

RESOLUTION AND UNIFICATION

Many problems in AI are most efficiently solved by logical operations. In fact, the language Prolog is specifically oriented to the use of propositional and predicate logic. In their simplest forms, the rules of logic deal with operators such as AND, OR, and NOT. However, complex problems in AI are nearly always solved by application of a more powerful logical technique, a deduction method known as *resolution*.

Propositions are statements of fact that may be true or false. These are propositions:

My hard disk just crashed.
My warranty expired yesterday.

We frequently represent propositions symbolically as single letters:

p q

Atoms are propositions that cannot be broken down into other propositions. Atoms are also called positive literals; atoms preceded by the NOT operator are called negative literals. The propositions described above are atoms, while the following are not:

My hard disk just crashed AND my warranty expired yesterday.
p OR q

A series of literals connected by OR operators forms a clause, and we can use resolution to work with clauses in this way:

If there is a clause	p OR q
and another clause	(NOT q) OR r
then	p OR r

follows by resolution. Resolution makes no statement about the truth of p, q, or r; it merely assures that we can perform that particular manipulation of the logical instructions.

Where does unification come in? To resolve two clauses, two literals must be found, one in each clause, such that one literal is the exact negation of the other. If the literals do not match, they can sometimes be made to do so by substitutions that follow certain rules. You can replace a variable with a constant (this is called *instantiation*), with another variable, or with an expression (as long as that expression does not contain the original variable). If you follow the rules and find a substitution that resolves the two clauses, then you have found a unifier and have performed unification.

In general, after you have converted the logical statements describing a situation into clauses, you can use unification to try to prove a theorem about the situation. Resolution will terminate either when clauses remain that are not resolvable or when resolution is attempted on a statement and its negation—a contradiction (this produces the empty clause, often called NIL).

For instance, if a robot were underwater and wanted to know if its batteries were endangered by the water, it would first combine all the rules it knew about water and batteries with the data from its sensors. That information would be put into clause form along with the negation of the theorem "My batteries will be damaged." The robot would then use unification substitutions to attempt resolution. The result will either be unresolvable clauses, in which case the theorem is false and the robot can go on to worry about something else, or an empty clause, in which case the theorem is true and the robot may be doomed.

to bind the variable to the expression, in which case the task is pushed out to the binding agent.

Parallelism and Recursion in Binding

The SUM team decided that the binding process could exploit parallelism because many bindings can be done concurrently. The original design uses two binding agents, but the work could be split up for four, eight, or more.

Before you make a binding, you have to find out whether the variable is already bound. For example, if A is already bound to 15, or to a character string, you don't make a new binding of A to 3. For efficiency, the SUM must be able to check bindings quickly in what is basically a table lookup. A subsidiary unification task is generated, goes back into the work manager's task pool, and then goes around the system again.

Unification Failure and Success

Unification can fail in only one of two places: the Lambda or the analysis agent. If unification fails, all activity in the SUM must cease. Then the SUM must inform the Lambda of the failure. However, the Lambda may find out by itself. For example, in the case of the complex constants that are passed back to the Lambda, the Lambda recognizes failure before the SUM does. In that case, the Lambda immediately directs the SUM to move on to the next task.

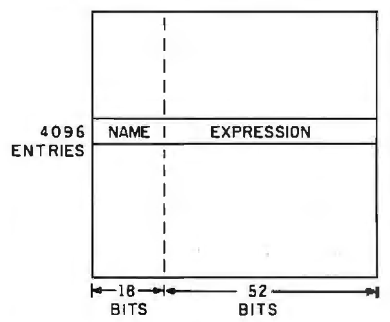

Figure 2: A *diagram of the binding agent.*

Unification has succeeded when there are no tasks waiting in the SUM—nothing in the analysis agent and no bindings in progress. In that case, any new bindings are extracted and passed back to the Lambda.

The bindings are made in a stack that grows from the bottom up. The shift-register-like organization of the stack pointer makes for fast and flexible manipulations. For example, when unification succeeds and bindings have to be extracted for return to the Lambda, you can unwind the stack without losing its contents. This is important if you are performing more than one unification using the same set of bindings. Also, in cases such as failure of unification, the Lambda can instruct the SUM to relocate its stack pointer and adjust to an earlier context.

Binding Agent—Custom CAMs

The asterisks in figure 1 indicate the parts the SUM team feels have the most promise for VLSI implementation. While the cache and various controllers have had some development, "The binding agent is the part that we've done the most work on and where there seems to be a tremendous amount of payoff for custom VLSI," according to Dr. Oldfield.

Figure 2 is a simple block diagram of the binding agent. It has 4096 entries, each with a name composed of a 12-bit index and a 6-bit identifier. Associated with each name is a 40-bit expression and another 12-bit index. In other words, the binding agent requires a lot of RAM. Rather than inte-

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Unification on a Chip

While many people have talked about putting unification on a chip, a computer science graduate student's attempt was the charge that galvanized the Syracuse team to seriously address the challenge. As a master's project in 1981 for Professor Jim Kajiya, Caltech student Sheue-Ling Lien—now Dr. Sheue-Ling Chang of Sun Microsystems—designed a chip that implemented Robinson's original 1965 unification algorithm. She called it the UNIF-chip.

Dr. Chang had been very interested in Prolog and realized that unification presented a bottleneck to efficient Prolog execution. She decided that a unification-chip coprocessor, combined with Caltech's strong interest in VLSI, was just what the doctor ordered. DARPA (Defense Advanced Research Projects Agency) sponsored the research. Dr. Chang designed the chip with the idea that many of them might be linked together to concurrently solve unification problems on different branches of a Prolog tree structure.

About 18 months after the first design was complete, Chang and Kajiya discussed the possibility of taking some of the stack memory off the chip to make it small enough for actual production. They decided against it because Chang had become ensconced in her solid-modeling graphics Ph.D. work and didn't have time to completely redesign a chip. The paper disappeared into the Caltech library.

Professor Kajiya says no one else at Caltech took up the challenge of silicon unification because they were waiting for better design tools. In his opinion, those tools haven't arrived yet. Still, when they do get here, he feels that putting complex tasks such as unification into silicon is "definitely the way to go." He points out that, while the past 20 years has seen much effort in improving algorithms, there is now evidence that sheer processing speed and power can accomplish more than was previously thought. Kajiya points to the championship chess-playing programs, such as Belle (which has its own custom hardware) and Cray Blitz (for the Cray supercomputer), which exploit tremendous hardware power. Kajiya says that the success of these chess machines may "teach us that the eighties is the decade of brute force."

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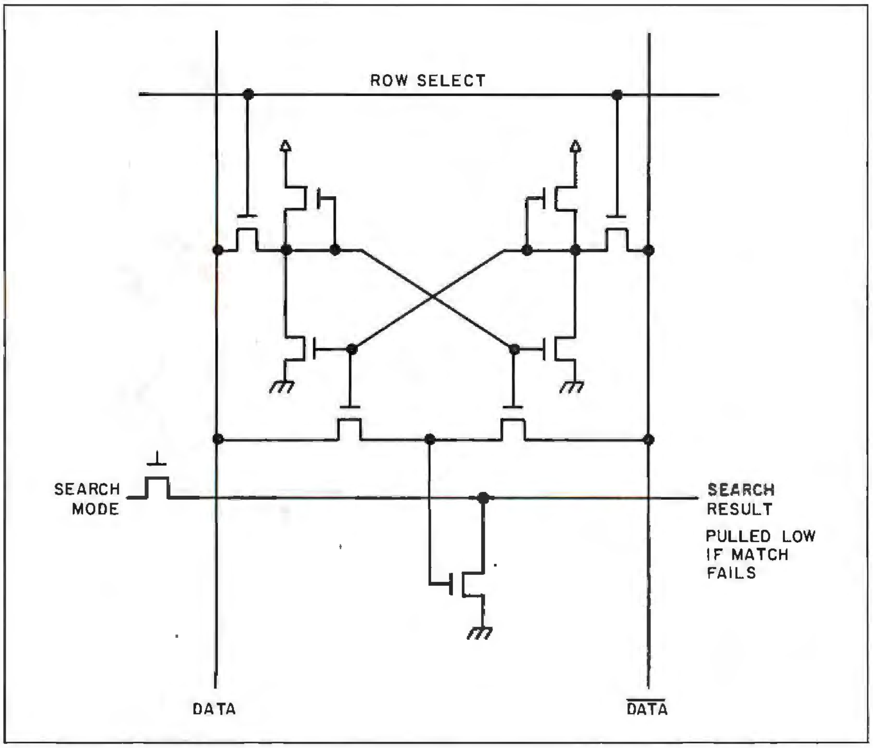

Figure 3: *A 9-transistor associative-memory cell. By adding another 3 transistors to a basic 6-transistor static* RAM *cell, you get a well-known but rarely used cell that is the basis of the custom* CAM*. This cell has a very attractive search feature: Every word in the memory can simultaneously be searched by a single read access that takes about* 100 *nanoseconds.*

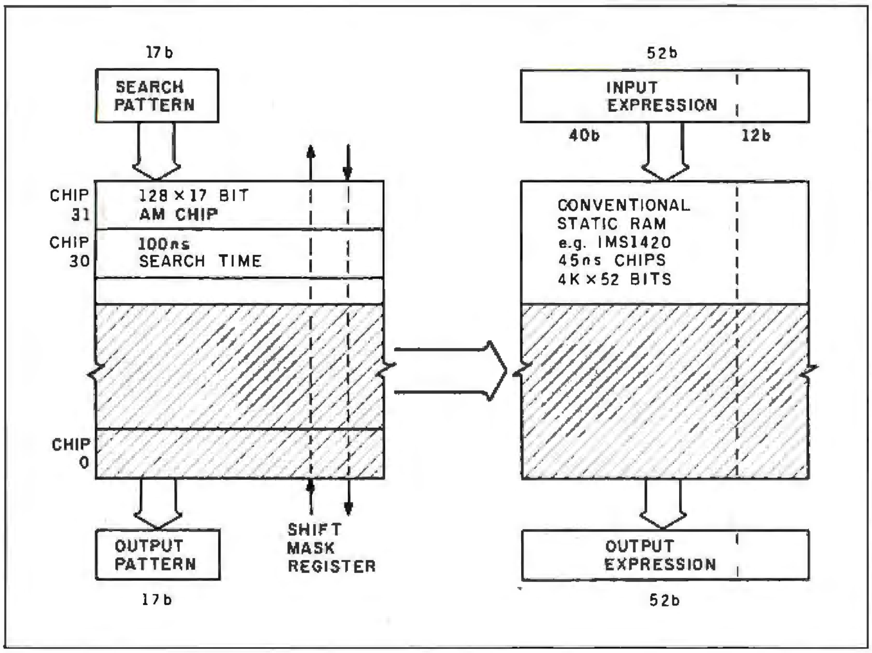

Figure 4: *Two parts of the binding agent: an associative-memory stack (left) and a conventional* RAM *(right).*

grating it all on custom silicon, Dr. Oldfield decided to use conventional memory chips wherever possible.

A student's VLSI project on associative memories gave Dr. Oldfield the clue to the fast table-lookup architecture he needed. An ideal CAM (content-addressable memory) or AM (associative memory) would allow you to simultaneously search all entries for a name, an expression, or both. As Dr. Oldfield states, "It's very, very much faster than you can do by software techniques" (see figure 3). Such a memory could even have wild-card fields. Dr. Oldfield split the binding agent into the two parts shown in figure 4: an AM stack (on the left) and a conventional RAM (random-access read/write memory) (on the right).

To maximize the SUM's performance, the designers squeezed as many variable names as they could onto the CAM chip. The result was 128 entries of 128 rows by 17 bits. Each bit is implemented by a 9-transistor AM cell. (If you recall that each name entry is composed of 12 + 6 = 18 bits, you are probably wondering what happened to 1 bit. The explanation is that it has been split off and indicates which of the two binding agents to use.) The system of 4096 entries requires 32 of the custom CAM chips.

CAD Problems

With a theoretical design for the binding agent's CAM completed, the SUM team decided to make the largest prototype chip possible with its CAD facilities. But, as Dr. Oldfield admits, "At the time our CAD facilities were very rudimentary." Most of the powerful tools (mainly computer-aided design and test programs) are written in C for a UNIX machine but were too big to run on Syracuse's DEC PDP-11. "It's a funny way to describe it," says Dr. Oldfield, "but you really have to have a VAX to do anything in this business. So we had to do all of our software locally."

In fact, all of the students had to lay chips out in CIF (Caltech Intermediate Form). CIF is a low-level, machine-

(continued)

readable, layer-description language that, as Dr. Oldfield describes, is "painfully" written out by hand. Fortunately, Syracuse now has a set of tools from the University of Washington running on a borrowed VAX and is installing its own VAX.

The experimental prototype has all the features of the full-scale CAM chip. However, instead of having 128 rows of 17 bits, it has only 8 rows of 3 bits. According to Dr. Oldfield, it was "a very ingenious student named Ser-Hou Kuang" who designed the 8 by 3 prototype memory. Kuang worked out a stretched version of the 9-transistor cell that was as long and thin as possible, yet still met MOSIS design rules. (MOSIS—Metal-Oxide Silicon Implementation System—is a nonprofit intermediary organization affiliated with the University of Southern California and DARPA that accepts prototype chip designs from universities, government agencies, and others, and arranges to have those designs fabricated by Silicon Valley manufacturers.) Referring again to his group's poor CAD facilities, Dr. Oldfield said, "In fact, I would claim this is sort of a record. This must be about the most complicated chip anybody's every designed with such poor aids."

The University of Rochester, which had better CAD facilities, helped by running a design rule check on the chip. The design was then submitted to MOSIS and the sample chip shown

The prototype has all the features of the full-scale CAM chip.

in photo 1 was fabricated. Figure 5 is a floor plan for the prototype.

All of the chips functioned except for one problem: The address encoder didn't work. As Dr. Oldfield remembered, "You could write to the memory, you could search on it, you could find the pattern you were looking for, and you could read stuff out of the memory. Everything worked functionally except it never set the address lines properly."

Finally, after using a mask-extraction program called MEXTRA, the SUM team found a faulty part of the circuit. A depletion transistor was always on because it was connected by a length of diffusion to ground and had no gate. Apart from that trivial design mistake, the prototype chips performed excellently and proved the SUM concepts.

In December 1984, the full-size prototype design was finished and waiting for final design check. Assuming it works, the SUM team is thinking about the next phase, producing quantities of the chip. Dr. Oldfield points out that university work often "leads to just one chip" and that it is "interesting to find a case where you can usefully use a significant number in an operation."

Possibilities for the Future

A negative aspect of the SUM concerns its overall impact on AI. Even if unification takes up a full 60 percent of a LISP machine's time, an infinitely fast SUM could speed up the overall process only by a factor of slightly better than 2. Coprocessors in other circumstances sometimes speed processing on the order of hundreds of times. As Dr. Oldfield freely admits, this is "not the same story at all."

Looking down the road, Dr. Oldfield

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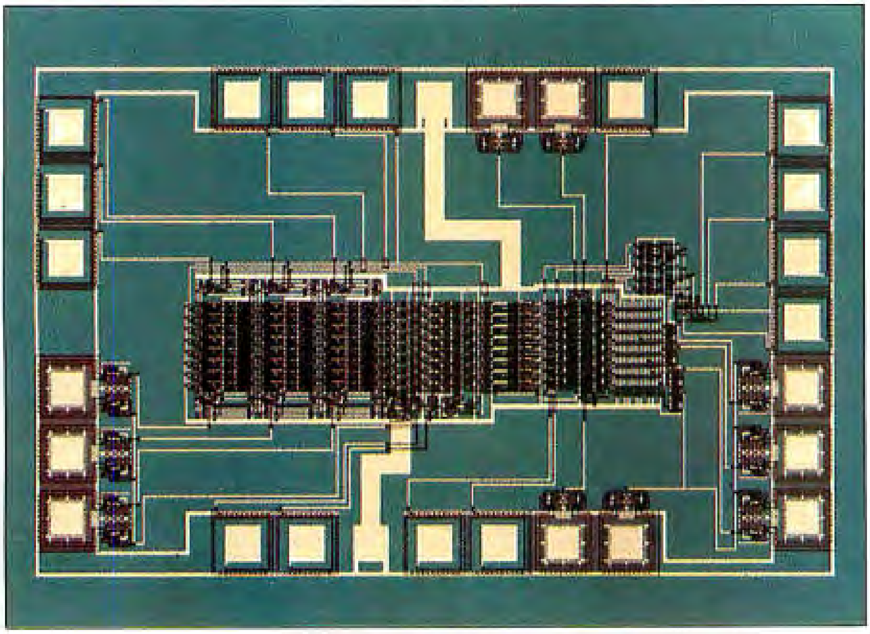

Photo 1: *Prototype content-addressable memory chip used in the SUM's binding agent.*

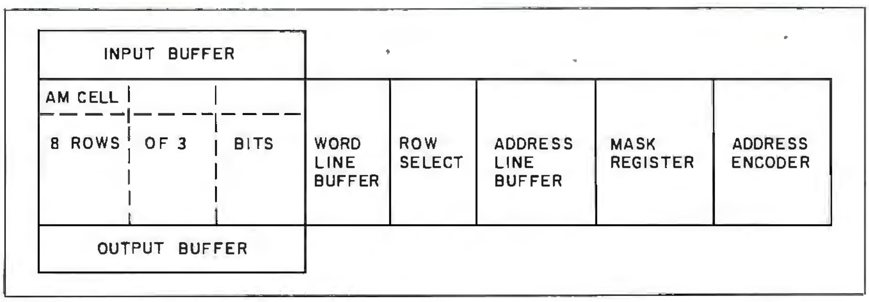

Figure 5: *The 8 by 3 prototype associative memory.*

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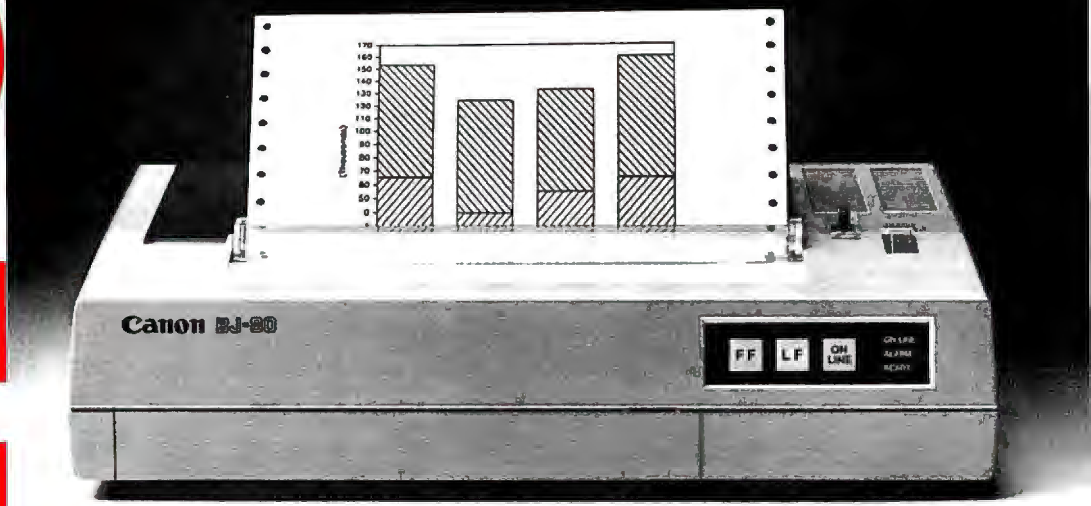

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sees the SUM shrinking. He says that while "this overall machine's not a chip, at the beginning we sort of hoped to have a chip." As it turns out, each binding agent comprises at least 32 chips. But the chips are made using a fairly conservative 4-micron NMOS (N-channel metal-oxide semiconductor) process. MOSIS already is offering a 1.25-micron process that could substantially increase chip density. And although it will be some years, Dr. Oldfield explains that "It's not unrealistic to think of the effect of higher packing density leading to SUM as a custom VLSI component." ■

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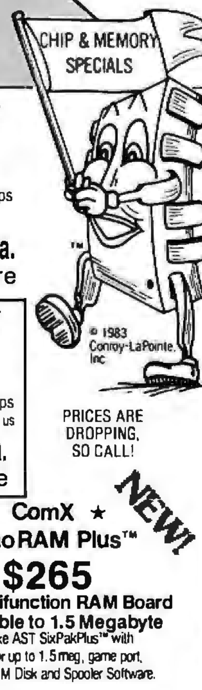

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BY DAVID USHIJIMA

INSIDE APPLETALK

A closer look at Apple's new link

In January Apple Computer Inc. unveiled its long-awaited AppleTalk local-area network (LAN), designed to let Apple and non-Apple products communicate and share information and resources. (See "The Macintosh Office" by John Markoff and Phillip Robinson, February BYTE, page 120, for more information.)

Physically, AppleTalk consists of a simple shielded twisted-pair cable called a trunk cable. You attach devices such as computers and peripherals to the trunk cable using connection boxes (see figure 1). Each connection box contains two miniature 3-pin connectors and a short length of cable terminating in a DB-9 connector. With the connector modules joining the segments of the trunk cable, you can connect up to 32 devices to a single AppleTalk network over a total distance of up to 300 meters. In addition, you can interconnect a number of such networks using a special device called a bridge.

Electrically, AppleTalk is an RS-422A balanced transmission line with a raw data-transfer rate of 230.4K bits per second. The data is sent over the bus in a synchronous format using a bit-oriented protocol based on the synchronous data-link control (SDLC) protocol. Currently, only the Macintosh has the hardware necessary to support this standard.

Serial port B on the back of the Macintosh (the printer port) can be attached to AppleTalk. The circuitry required to implement the AppleTalk protocols is entirely contained on the Macintosh's digital board. The heart of the serial interface is the Zilog 8530 serial communications controller (SCC). This chip takes care of all the details necessary to send and receive data in the format required by AppleTalk. The RS-422A drivers and receivers (26LS30 and 26LS32) provide the balanced line interface to the bus.

To allow IBM Personal Computers (PCs) to share resources and data with Macintosh office products, Apple is marketing an interface card for the IBM PC that will let it communicate via AppleTalk. While Apple has not announced an AppleTalk card for the

(continued)

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ILLUSTRATED BY ANDREW SHACHAT

Apple II, it would be easy for the company to add one.

CONFIGURING THE BUS

AppleTalk was designed specifically as a network for personal computers. As a result, it is extremely flexible and can be used in three ways: as a peripheral bus, as a small LAN, or as a path to a large, complex network.

As a peripheral bus, AppleTalk allows the implementation of so-called virtual slots. While you cannot expand the Macintosh by plugging in boards (as with the Apple IIe or the IBM PC), you can add devices via AppleTalk. Since the bus is fast enough to accommodate the connection of devices such as hard disks, it provides the functional equivalent of slots—thus the term "virtual slots."

Although the speed with which the Macintosh can access a device via AppleTalk is slower than that which could be obtained if you were to plug a controller card directly into a slot, the overall performance is still respectable (approximately 29K bytes per second).

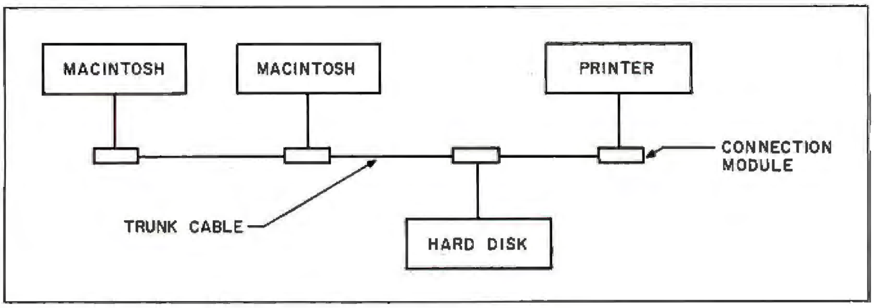

Figure 1: *The typical AppleTalk configuration.*

The LAN configuration of AppleTalk is probably the most common for most small- to medium-size businesses. In this configuration AppleTalk is used to connect small clusters of computers so that they can exchange information and share hard disks and high-speed printers (such as Apple's new LaserWriter).

Devices that let computers share a resource are called servers. A file server lets users share files on a hard disk and a print server lets them share a high-speed printer. The LaserWriter and the as-yet unreleased file server are examples of servers. An LAN configuration is shown in figure 2. In this case, a node is any device connected to the bus. Thus, a node could be a Macintosh or an IBM PC with the proper AppleTalk interface card.

One variation of the LAN configuration would allow a local AppleTalk network to serve as a path to a larger, more complex network such as GTE's Telenet. This would allow you to communicate with computers that are located beyond the confines of the local area.

The most complex configuration of AppleTalk is that of a full-blown network such as the one shown in figure 3. While AppleTalk was designed to accommodate a large number of computers configured in complex arrangements, most users will never have to deal with this level of complexity. Universities and large businesses that need to incorporate a large number of personal computers into a unified network will be concerned with this configuration.

THE APPLETALK ARCHITECTURE

In the real world, the development of a network can be likened to the development of a telephone system. For communication to take place, you must have a connecting link, the telephone cable. Before you can lay the cable, you must have a set of plans that everyone agrees to follow. In the case of AppleTalk, the plans for the system consist of a set of rules or protocols that a device such as the Macintosh or Lisa must follow in order to talk to other members of the network.

The AppleTalk architecture consists of a set of well-thought-out rules that allow a wide range of devices to be connected together. Apple has designed the architecture to be an open system, that is, one in which outside or third-party developers are encouraged to add to or modify the system according to their needs. Essentially, Apple is providing third-party developers with a set of tools that will allow them to connect their devices to the network and with a set of sug-

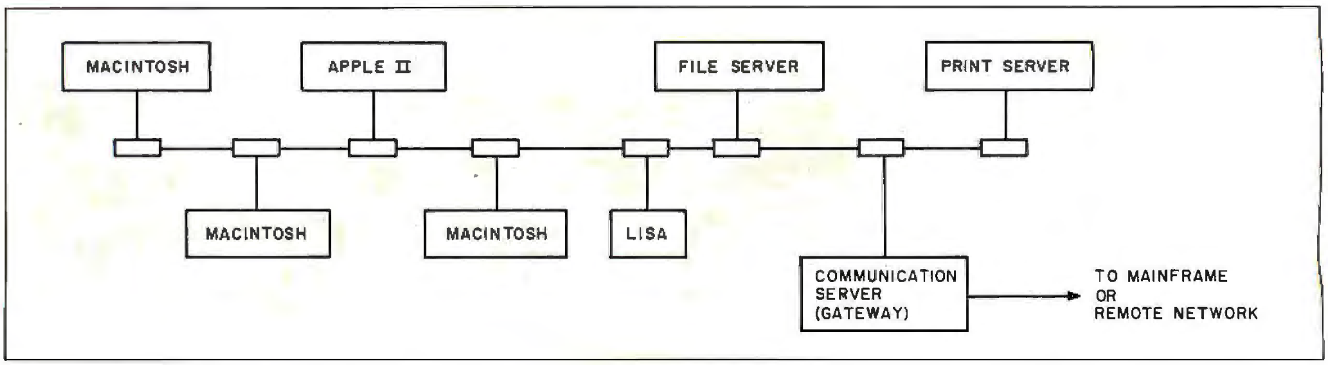

Figure 2: *AppleTalk configured as a local network.*

gested rules that will let them implement various functions. Beyond the basic rules, developers are free to select and design their own protocols to add to what Apple supplies.

THE ISO OPEN SYSTEMS MODEL

To understand the workings of AppleTalk let's take a look at the ISO (International Standards Organization) Open Systems Model. The ISO was established to guide network developers and promote compatibility between networks. Since different networks are designed with different goals in mind, one network may implement a number of features that are not necessary on another network. However, it is desirable to have compatible networks. To promote compatibility, the ISO Open Systems Model defines what it calls "levels" or "layers" of a network. Each layer consists of a particular set of rules. The layers at the bottom of the network specify the most elementary or basic rules or protocols. Each successive layer, proceeding from bottom to top, adds a function or feature that depends on the mechanism defined in the layer below it.

Because the Open Systems Model is based on logical rather than physical divisions, it can be somewhat confusing when you are trying to interpret how a physical system is actually put together. To get a feel for how a model like this represents a process that occurs in the real world, consider the analogy of a telephone conference.

Suppose you set up a conference call between members of different countries. For this to be possible, the basic telephone equipment must be compatible. Furthermore, everyone must agree to speak the same language. The participants must agree on a set of rules (formal or informal) detailing, for example, who may speak when, for how long, etc. Without this groundwork, the conference call could result in a mélange of voices. In this example you can see several levels of protocol that must be in effect for communication to take place.

The ISO Open Systems Model consists of seven layers: physical, data link, network, transport, session, presentation, and application (see figure 4). While the model allows you to understand the workings of the system, it doesn't necessarily reflect the system's physical structure. Let's take

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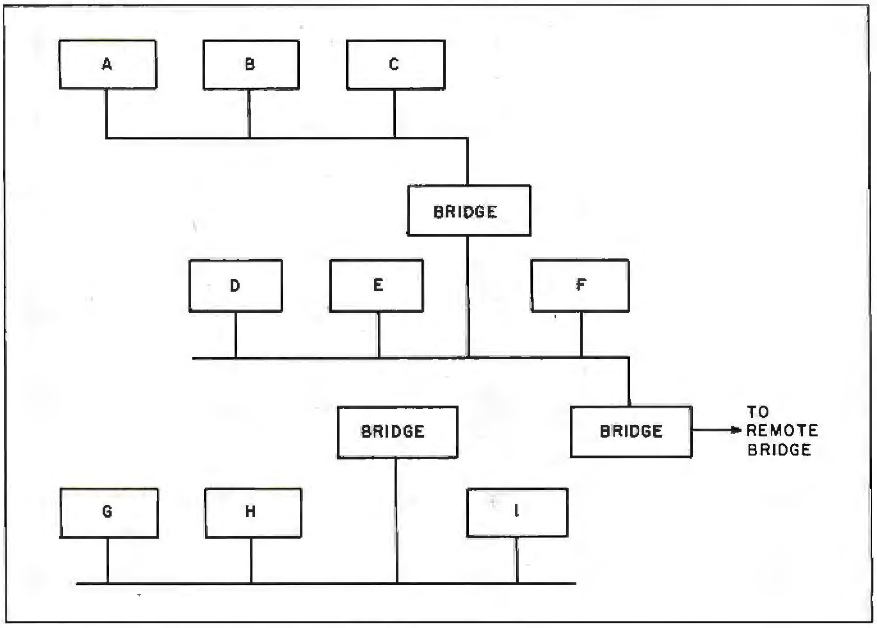

Figure 3: *An AppleTalk internet.*

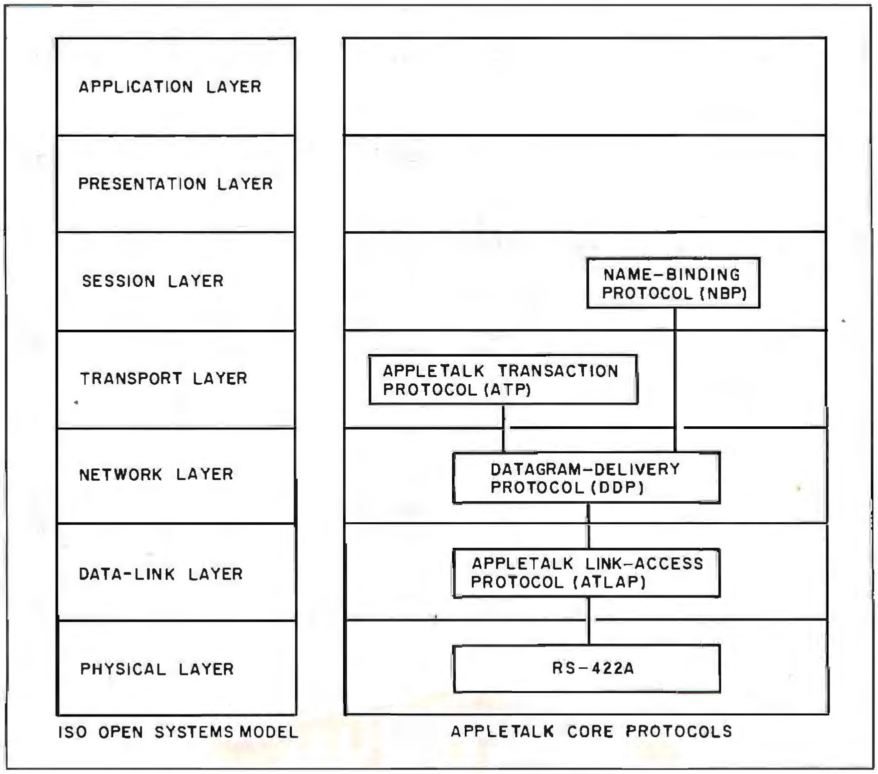

Figure 4: *The ISO Open Systems Model and the AppleTalk core protocols.*

a look at what each of the levels represents.

The lowest level is the physical link. This is simply a set of rules specifying the electrical and physical connection between devices. The physical link specifies the cable connections and the electrical rules necessary to transfer data between devices. Typically, the physical link corresponds to established interface standards such as RS-232C, RS-422A, or RS-423A.

The next layer up is the data-link or link-access layer. This layer specifies how a device gains access to the medium specified in the physical layer. With a number of devices vying for access, this becomes an important issue. The data-link layer is also responsible for framing—that is, enclosing the data in the electrical equivalent of the envelope you use to mail your letters. Finally, this layer is responsible for addressing the envelope to the destination device on the link.

The network layer is responsible for setting up a logical connection between a source and a destination on the network. In a complex network, a source and a destination may not be directly connected by a single path. Rather, the path may consist of many subpaths. Thus, the network layer is responsible for routing the data over this path through the network system.

The transport layer is responsible for guaranteeing that a message is correctly received. This is often implemented by having the receiving party return an acknowledgment upon receipt of a message from the sending party.

While the first four layers are fairly well defined, the top three layers may vary depending on the network. Generally, though, the session layer will allow two devices on the network to coordinate their actions (for example, one device accessing the files of another device). Messages at this level may consist of commands that allow one device to control another over the network.

The presentation layer is responsible for formatting data in such a way

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that information sent from one device can be properly used by the receiving device. For example, the presentation layer would translate a document into a form that could be understood and printed by the LaserWriter.

Finally, the application layer ensures that data from an application running on one device is directly usable by an application running on another device.

A Closer Look at AppleTalk

Figure 4 shows the relationship of the primary AppleTalk protocols to the ISO Open Systems Model. The five levels of AppleTalk represent what Apple calls the core protocols. These are the protocols that Apple will be providing for use by third-party developers with computers such as the Macintosh and the Lisa. Since AppleTalk was designed as an open system, developers are free to add to the basic set of protocols. Similarly, a developer may choose to use only the bottom layers provided by Apple and institute its own higher-level protocols. For example, by using the services provided by Apple at the three lowest layers of the ISO model, a developer will still have the ability to send messages, or "datagrams" in AppleTalk terminology.

Let's take a closer look at the major protocols or services that Apple will provide.

The Physical Link

The lowest level or physical layer of AppleTalk is the shielded twisted-pair cable and the connection box. Through the use of the connection box, each node is coupled to the trunk cable with a transformer. Thus, a missing node or one that is unable to receive or transmit will not affect the performance of the bus. Also, transformer coupling provides ground isolation as well as protection from static discharge. The physical link of AppleTalk is also defined to be RS-422A-compatible.

So far we have a cable and a set of pin definitions for the interface. To this we now add a method of bit encoding

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known as FM (frequency modulation) 0 (see figure 5). With this method, there is at least one transition at the beginning and end of each bit. A cell representing a 0 will contain an additional transition in the middle of the bit cell. This technique allows the clock to be recovered using a phase-locked loop at the receiving end.

The physical layer of AppleTalk defines a synchronous RS-422A bus upon which each succeeding layer can build. Notice that the physical layer only provides for a series of 1s and 0s to be sent over the bus. The rules governing how a node gains access to the bus and how the 1s and 0s are to be interpreted are left to higher levels of the architecture.

THE DATA LINK

In the AppleTalk architecture, the data-link layer uses the AppleTalk link-access protocol (ATLAP). There are three functions implemented in the ATLAP: framing, bus-access control, and node addressing.

To send a message, a device must have some way of putting the message into the equivalent of an envelope. In the terminology of a network, an envelope is called a frame. ATLAP specifies a frame that is based on a bit-oriented message; that is, messages are sent as pure sequences of bits, not as individual characters. The ATLAP frame is shown in figure 6.

The ATLAP frame consists of three parts: the header, the data, and the check field. At the beginning of each header are two flag bytes (hexadecimal 7E), followed by a single byte destination and source address specifying the node number of the source and destination. This is followed by a type field used to specify the type of frame. ATLAP frames may be one of two types: control or data.

ATLAP uses control frames for its internal functions such as assigning addresses to nodes and controlling access to the network. A control frame is indicated by a type field value from 128 to 255 (hexadecimal 80 to FF) in the ATLAP type field. Values from 1 to 127 (hexadecimal 01 to 7F) indicate a data frame.

In a data frame, up to 600 bytes of user data (provided by the higher-level protocols) can follow the ATLAP header information. ATLAP control frames do not contain a data field. Finally, following the data field is a 16-bit frame-check character used to ensure the validity of the data in the frame.

The second function of the ATLAP layer, controlling who gets access to the bus and when, is of fundamental importance because up to 32 different devices may be trying to talk on a single AppleTalk network at the same time. Suppose you have the configuration shown in figure 2. In this case you have many devices or nodes vying for access to the bus. In the real world, that's like having several peo-

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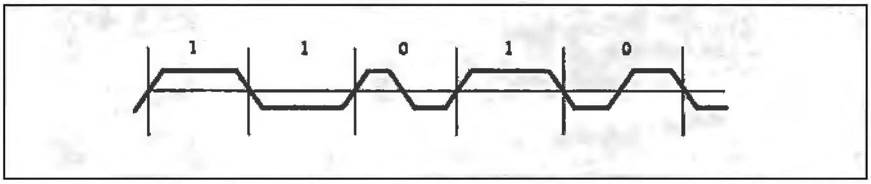

Figure 5: *An example of* FM 0 *modulation.*

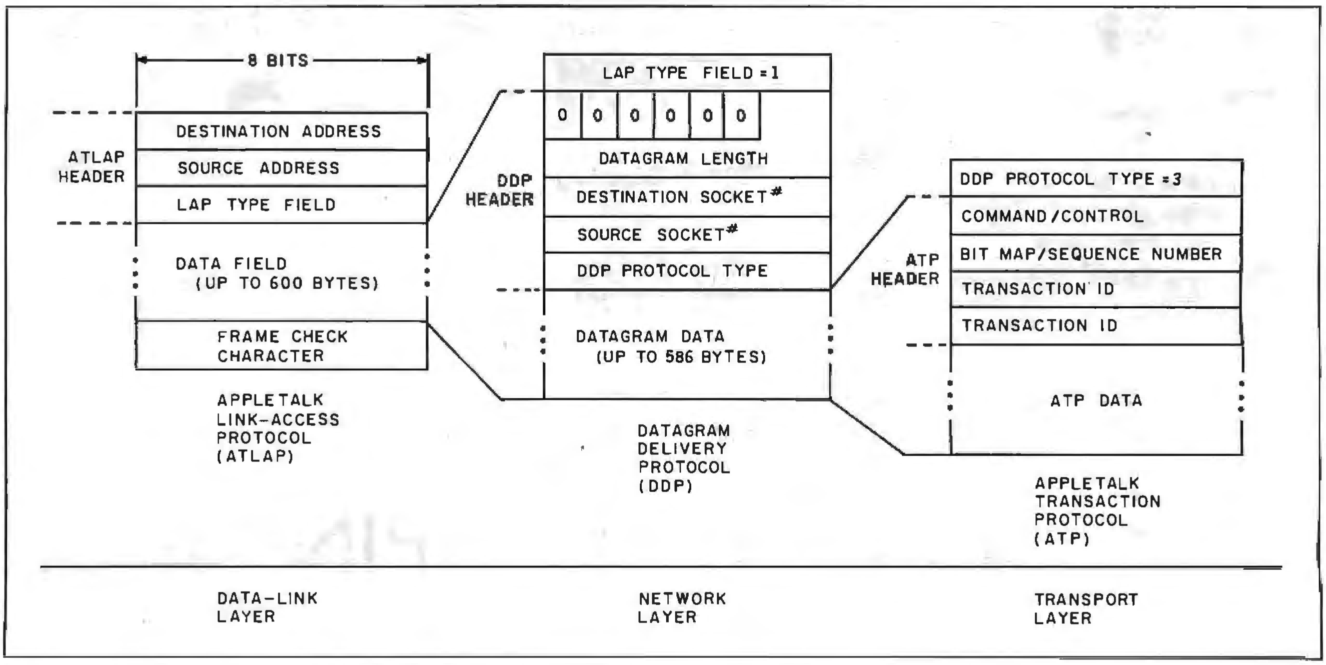

Figure 6: *The* ATLAP *packet format,* DDP *packet format, and* ATP *packet format.*

ple on a party line all trying to make a call at the same time. You need some way of controlling who can use the line and when.

In AppleTalk, the method used to resolve this contention problem is called CSMA/CA (carrier-sense multiple-access with collision avoidance). When two devices try to talk at the same time, a collision occurs. When a collision is detected, each sending device must back off or wait some predetermined amount of time before trying again.

One method to avoid collisions requires each device to listen to the bus. If a device hears some activity on the bus, it knows that the bus is busy, and it waits until the bus is free before transmitting.

When two devices try to talk at once, a collision occurs.

One of the limitations of AppleTalk is that nodes do not have special hardware to detect collisions. This is true simply because of the limitations of the serial interfaces used on most microcomputers: A device (unlike a person) can either be transmitting (talking) or receiving (listening) but not both simultaneously. To overcome this limitation, AppleTalk uses the scheme described above, whereby each device must listen to the bus. If the bus is busy, the node must wait until it is free before sending a message. Once the bus is free (that is, no activity is going on), a device must wait an amount of time based on the generation of a pseudorandom number before transmitting to avoid collisions with other devices waiting to use the bus.

In our party-line analogy, this collision-avoidance method means that each party must listen to the line. If the line is busy, you must wait until you don't hear any voices. Once the line is free, you must wait some random amount of time before dialing.

The third function implemented by the ATLAP is addressing. Each node on the AppleTalk network is assigned a unique 8-bit address known as the node ID (identification). However, a node is not required to have a fixed node address. When a node is switched on, it chooses a node ID by either looking up a previously saved value from nonvolatile memory (like a disk file) or by generating a random number. Once a node has chosen a node ID, it sends a special ATLAP control frame called an enquiry (ENQ) frame to its own address. Any node receiving an ENQ frame must send out a control frame called an acknowledge (ACK) frame. Therefore, if a node

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We love a good story. Better than that, we love a great product. After researching the expansion needs of AT users, we have concluded that the Basic Time AT4X4Plus provides the best array of standard features and upgradeability available. Compare the AT4X4Plus, feature by feature, to the AST Research Advantage!™ expansion board in terms of main board memory, total expansion memory, I/O capability, and price. You will then discover who has the clear advantage.

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sends out an ENQ to the address it has chosen and receives an ACK, it knows that the node ID is already being used. If, after repeatedly sending out ENQ frames, no ACK is received, the new node simply takes the node ID as its own.

THE DATAGRAM DELIVERY PROTOCOL

While the ATLAP provides a delivery service from one node to another, often a node may contain more than one logical source or destination. In AppleTalk terminology, a logical source or destination is referred to as a socket. For example, consider the case of a program that manages a disk-file system that can be accessed by many users. This program could be handling many requests for file reads and writes from many different users. To keep these requests straight, the file manager could require many sockets, in this case, one for each user.

To provide a delivery service that extends the functions of ATLAP to the socket level, AppleTalk provides a protocol called the datagram delivery protocol (DDP). At the network layer, the DDP defines a packet of information called a datagram.

The format of a datagram is shown in figure 6. Note that the datagram is actually contained within the ATLAP frame—thus the concept of layering. The datagram is essentially enclosed within the envelope defined by the ATLAP in the data-link layer.

You can also see that the datagram header directly follows the ATLAP header. If the ATLAP type field is equal to 1, the next 5 bytes are taken as the datagram header.

The datagram header consists of 5 bytes. These bytes contain the following fields: a 10-bit length field, the destination-socket number, the source-socket number, and the DDP protocol type field.

The first 6 bits of the datagram (DDP header) are set to 0. The following 10 bits contain the length of the datagram (from the first byte of the DDP header to the last part of the DDP data field). A datagram packet arriving at a destination node is immediately checked for correct length using the value stored in the datagram's header. If the length of the received datagram does not match the DDP length field, the packet is immediately discarded.

The next byte is the destination-socket number, followed by the source-socket number. Finally, the last byte of the header is the DDP protocol type field. This field specifies the type of protocol used in the next higher layer; that is, it indicates to the destination node the format of the data contained in the DDP data field.

Up to 586 bytes of data may follow the DDP header. Again, because of the layered protocol, the definition of this data depends upon the protocol used in the next higher level.

The DDP also allows for the delivery of packets over a complex network composed of what are called internets. By connecting individual AppleTalk networks (up to 32 nodes) through what are called bridges, an internet is formed. A complex network can be formed by connecting many AppleTalk buses this way.

To handle the addressing on a complex internet, the DDP uses an extended form of the DDP header that contains a source and destination network number, node ID, and socket number. These six values completely specify the address of any source and destination on an internet.

Suppose you have the following situation: A datagram is to be sent from point A to point I on the complex network shown in figure 3. To get from one AppleTalk to another, the datagram must pass through several bridges. Each bridge contains routing tables, which contain the information necessary to forward a datagram to a destination network. By passing through various bridges, a datagram will eventually arrive at the proper network, node, and socket.

There is one additional field in the extended DDP header: the hop count. Each time a datagram passes through a bridge, the hop count is incremented. A datagram containing a hop count of 15 will not be forwarded but instead will be discarded. This prevents a datagram from endlessly circulating through the network.

THE TRANSACTION PROTOCOL

At the next level up is the AppleTalk transaction protocol (ATP). This protocol corresponds to the transport layer of the ISO Open Systems Model. The ATP guarantees that a packet sent to a node is correctly received. It implements this through a series of transaction requests and responses. The requesting end sends a transaction request, specifying, for example, a command to be executed at the receiving end. When the receiving end gets the request, it sends one or more transaction responses, which carry data generated by the execution of the command. The responses also serve as acknowledgment of delivery of the transaction request.

The format of an ATP packet (in figure 6) also consists of a header and a data field. Notice that the ATP header directly follows the DDP header; that is, the ATP packet sits on top of the DDP packet. If the DDP protocol type field is equal to 3, the

(continued)

receiving node knows that the DDP data field contains an ATP packet.

The first 8 bits of the ATP header contain a command and control field. The first 2 bits are used to identify a transaction request (01), a transaction response (10), and a transaction release (11).

The following 8 bits constitute a sequence bit map used to keep track of transactions where multiple responses are necessary. For example, a transaction request could be a read command to a disk. The transaction response would consist of a series of packets containing the data read from the disk. The bit map is used to keep track of what packets have been properly sent. It also provides a means of requesting the retransmission of selective packets, thus avoiding the need to retransmit the entire sequence of packets.

Finally, the last field of the ATP header is the transaction ID. This is a 16-bit number assigned to the transaction request by the sending node. The transaction ID allows each node to accurately track transactions and responses. This is done by including the same value in all requests, responses, and release packets belonging to a particular transaction.

The Name-Binding Protocol

One service Apple provides at the layer corresponding to the session layer of the ISO Open Systems Model is the name-binding protocol (NBP). Recall that in a complex network or internet, the extended DDP header specifies a source and destination network, node, and socket number. Such numerical addresses are efficient when used by network protocols but inconvenient and clumsy for human users who prefer dealing with names and strings of characters. The AppleTalk architecture includes facilities in its NBP for the use of names.

The actual NBP functions are implemented in a series of lookup tables distributed throughout the nodes in a network. These lookup tables correlate names with networks, nodes, and socket numbers. Each node contains a socket dedicated to the NBP function. The user can issue a call to the NBP process requesting the address corresonding to a name. Given the name, the NBP will search through the tables in all nodes in a zone and return the corresponding address, that is, network, node, and socket number.

Higer-Level Protocols

AppleTalk's higher-level (presentation- and application-layer) protocols will allow the formatting of data for specific devices and applications. At the presentation level, Apple has introduced a protocol in conjunction with the LaserWriter printer. To allow

(continued)

APPLETALK

Plans for Apple's "telephone system" are complete.

the Macintosh to send documents to the LaserWriter, Apple has incorporated the features of a language called PostScript developed by Adobe Systems. PostScript allows all AppleTalk devices to communicate with the LaserWriter via a programming language similar to FORTH. Similarly, the AppleTalk filing protocol will provide high-level support for Apple's file servers.

APPLETALK SOFTWARE

While the hardware necessary to support AppleTalk is built into the Macintosh, the software required to use the network consists of a set of device drivers. On the Macintosh this is simply a file that must be installed in the system folder of each Macintosh on the network. This file contains the software that implements the lower levels of the AppleTalk protocols and the software to implement the higher-level protocols necessary to communicate with devices like the LaserWriter.

The core protocols are implemented in a driver referred to as the Macintosh protocol package (MPP). The MPP, along with the driver that implements the ATP, takes up less than 6K bytes on the disk. To use the LaserWriter, an additional driver, the LaserWriter print manager, is also required.

SUMMARY

Plans for Apple's "telephone system" are complete. At this point, the poles have been set up, the cables strung, and conversational rules established. Apple and third-party developers have announced a series of AppleTalk products. Now, the time it takes for AppleTalk to develop into the electronic counterpart of today's telephone system will depend on the availability of network software. ■

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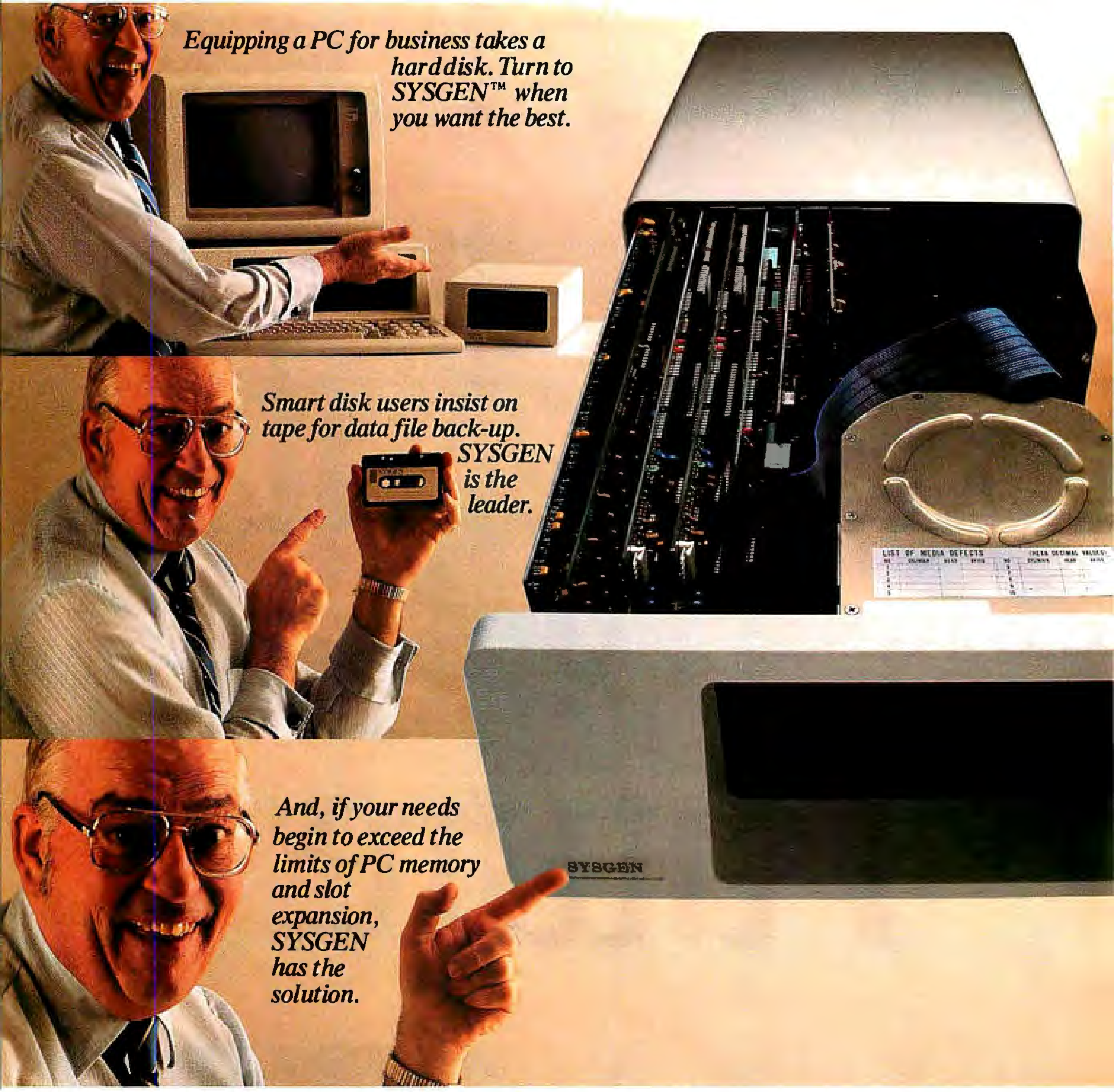

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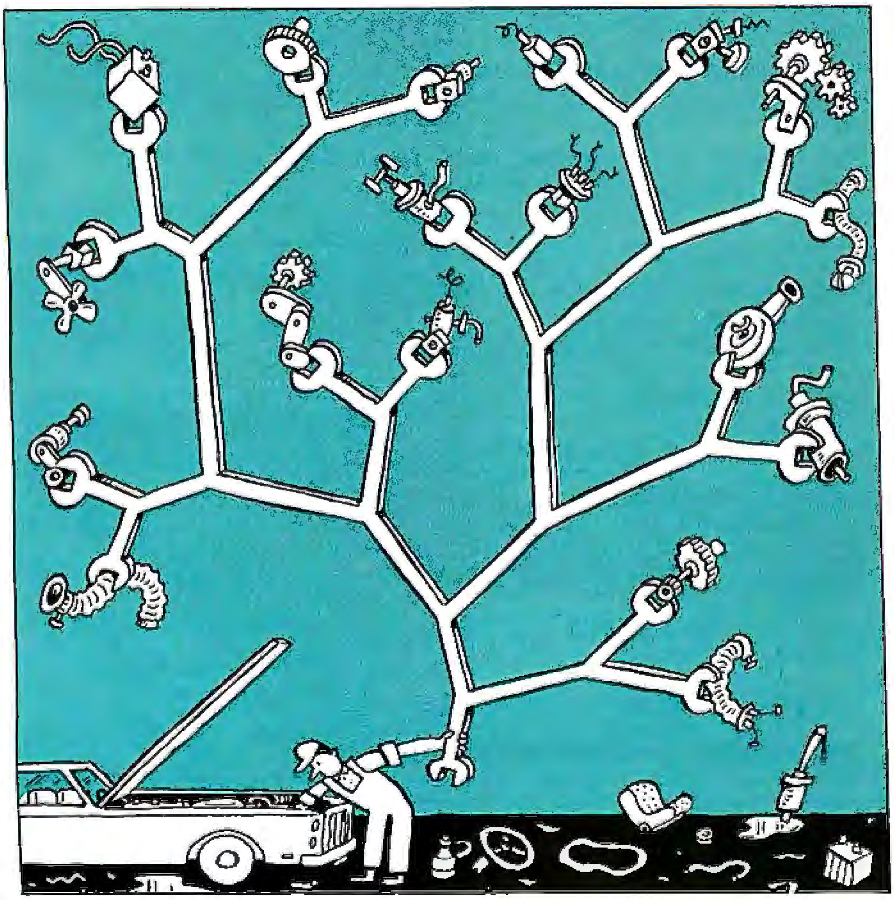
BY MICHAEL FICHTELMAN

THE EXPERT MECHANIC

Expert systems needn't be esoteric or waste resources

Most people who have heard of Logo probably think it is a programming language for kids. Likewise, most people who have heard the term "expert system" probably think it refers to something esoteric on the frontiers of computer science. Both conceptions contain an element of truth, but both are oversimplifications. In fact, Logo can be used to develop an expert system that learns.



DEFINITIONS

Expert systems are exactly that: systems that do what an expert in a given field can do. One of the first expert systems was a program called DENDRAL, developed by Edward Feigenbaum of Stanford University. DENDRAL operated at the intellectual level of a chemistry Ph.D.

Most expert systems are developed using languages like LISP and Prolog. With these languages it is relatively easy to write programs that modify themselves—programs that learn. Of course, you can write an assembler program that dynamically modifies its own code, but that involves considerable effort. Unfortunately, few implementations of LISP and Prolog are available for microcomputers since both languages require fairly large amounts of memory. Logo provides many of their capabilities, and versions of Logo are available for most microcomputers.

Logo was developed by Seymour Papert, a professor of mathematics at MIT. Logo has some of the features of its parent language, LISP, in addition to a powerful graphics capability. In Logo, a program or procedure is a list of lists. Because the process

(continued)

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ILLUSTRATED BY MICHAEL BARTALOS

of recursion is easy to implement in Logo, procedures or lists can refer to themselves. A complete discussion of Logo is outside the scope of this article, but for our purposes knowledge of Logo is important only if you want to understand how to implement an expert system. Once the system is implemented, anyone can interact with and modify its knowledge base.

MAKING AN EXPERT

Mechanic is an expert system that

(continued)

```
***EXPERT MECHANIC***
WE WILL TRY TO DIAGNOSE
THE PROBLEM BY ASKING QUESTIONS.

DOES THE ENGINE START?
    YES
DOES THE ENGINE STALL?
    NO
DOES ENGINE MISFIRE?
    NO
DOES ENGINE LACK POWER/PERFORMANCE?
    NO
DOES ENGINE IDLE ROUGHLY?
    YES
COULD IT BE FUEL VOLATILITY?
    NO
WHEN YOU FIND THE SOURCE OF THE PROBLEM, ADD IT TO KNOWLEDGE
BASE.
WHAT WAS THE CAUSE OF THE PROBLEM?
    CHOKE
PLEASE TYPE IN A QUESTION WHOSE ANSWER
IS "YES" FOR THE CHOKE AND "NO" FOR THE FUEL VOLATILITY

LET'S DIAGNOSE THE NEXT PROBLEM.
```

Figure 1: *Building a knowledge base involves applying human expertise when the correct solution is not yet part of the knowledge base.*

```
***EXPERT MECHANIC***
WE WILL TRY TO DIAGNOSE
THE PROBLEM BY ASKING QUESTIONS.

DOES THE ENGINE START?
    NO
DOES THE STARTER CRANK ENGINE?
    NO
ARE BATTERY TERMINALS LOOSE OR CORRODED?
    NO
DOES STARTER MOTOR FAIL TO OPERATE WHEN POWER IS APPLIED
DIRECTLY?
    YES
COULD IT BE THE STARTER?
    YES

CONGRATULATIONS! NOW FIX THE PROBLEM.

LET'S DIAGNOSE THE NEXT PROBLEM.
```

Figure 2: *Here, Mechanic already has the information to move directly to a correct solution to the problem of why the car won't start.*

Listing 1: *Procedure* DISPLAY.KBASE *shows you the entire knowledge-base binary tree and includes both the information and its logical structure.*

```
TO START UP
      MAKE "STARTUP [MECHANIC]
END

TO MECHANIC
      ND
      PRINT[***EXPERT MECHANIC***]
      PRINT[WE WILL TRY TO DIAGNOSE]
      PRINT [THE PROBLEM BY ASKING QUESTIONS.]
      PRINT []
  SEARCH :KBASE
      PRINT [LET'S DIAGNOSE THE NEXT PROBLEM.]
      HOLD 1000
      MECHANIC
END

TO HOLD:N
      REPEAT :N[]
END

TO SEARCH :POSSIBLES
      IF (WORD? :POSSIBLES) END.SEARCH:POSSIBLES STOP
      LOCAL "RESPONSE
      MAKE "RESPONSE QRY.POS.OR.NEG (QUERY:POSSIBLES)
      IF :RESPONSE=[YES] SEARCH POS.BRANCH:POSSIBLES STOP
      SEARCH NEG.BRANCH:POSSIBLES
END

TO END.SEARCH :POSSIBLE
      LOCAL "LAST.QUESTION
      LOCAL "RESPONSE
      MAKE "LAST.QUESTION (SE [COULD IT BE] ARTICLE :POSSIBLE [?])
      MAKE "RESPONSE QRY.POS.OR.NEG :LAST.QUESTION
      IF :RESPONSE=[YES] PRINT [CONGRATULATIONS! NOW FIX THE
      PROBLEM.]
STOP
      LEARN:POSSIBLE
END

TO QRY.POS.OR.NEG :QUESTION
      LOCAL "ANSWER
      PRINT 1 :QUESTION
      IF "?=LAST LAST :QUESTION PRINT [] ELSE PRINT"?
      MAKE "ANSWER REQUEST
      IF :ANSWER=[YES] OUTPUT [YES]
      IF :ANSWER=[NO] OUTPUT [NO]
      PRINT [PLEASE TYPE "YES" OR "NO"]
      OUTPUT QRY.POS.OR.NEG :QUESTION
END

TO QUERY :BTREE
      OUTPUT FIRST :BTREE
END

TO POS. BRANCH :BTREE
OUTPUT FIRST BUTFIRST :BTREE

END

TO NEG. BRANCH :BTREE
```

(continued)

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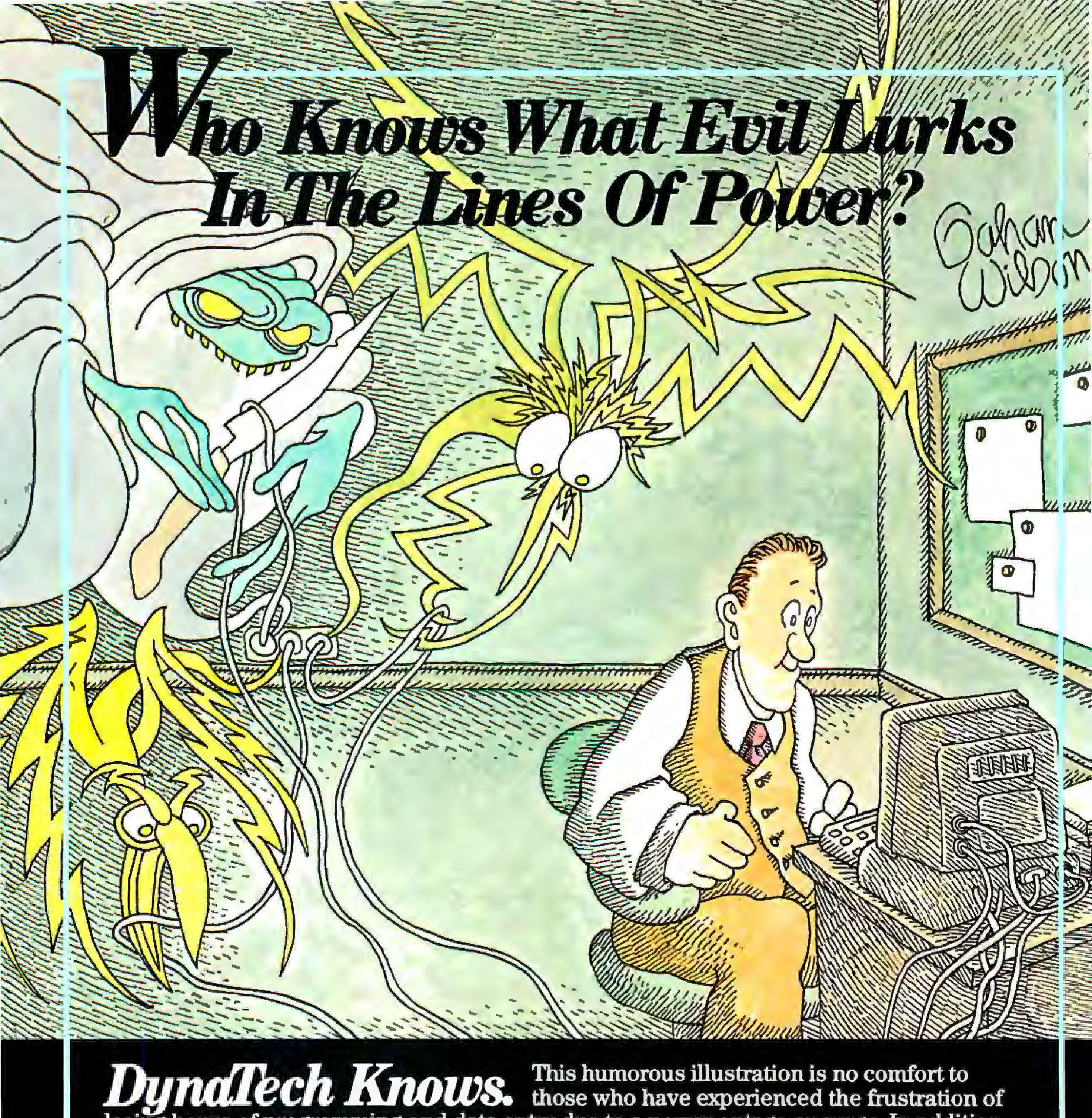

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EXPERT MECHANIC

```
    OUTPUT LAST :BTREE
END

TO ARTICLE :WORD
   OUTPUT SENTENCE "THE :WORD
END

TO LEARN :MISTAKE
   PRINT [WHEN YOU FIND THE SOURCE OF THE PROBLEM, ADD IT TO THE
   KNOWLEDGE BASE. WHAT WAS THE CAUSE OF THE PROBLEM?]
   MAKE "RIGHT.ANSWER (LAST REQUEST)
   PRINT [PLEASE TYPE IN A QUESTION WHOSE ANSWER]
   PRINT ( SE [IS "YES" FOR} ARTICLE :RIGHT.ANSWER[AND])
   PRINT( SE ["NO"FOR] ARTICLE :MISTAKE)
   MAKE "QUESTION REQUEST
   INCREASE.KBASE :QUESTION :RIGHT.ANSWER :MISTAKE
END

TO INCREASE.KBASE :NEW.QUESTION :POS.ANSWER :NEG.ANSWER
   MAKE "KBASE CHANGE :KBASE :MISTAKE(LIST :NEW.QUESTION
   :RIGHT.ANSWER :MISTAKE)
END

TO CHANGE :DATA :WORD :NEW.BRANCH
   IF:DATA = :WORD OP :NEW.BRANCH
   IF WORD? :DATA OP :DATA
   OP (LIST QUERY :DATA CHANGE POS.BRANCH :DATA :WORD
   :NEW.BRANCH CHANGE NEG.BRANCH :DATA :WORD :NEW.BRANCH)
END

TO START.KBASE
   MAKE"KBASE [[DOES THE ENGINE START?] [[DOES THE ENGINE STALL?]
   [[ANY AIR LEAKS IN OR AROUND INTAKE MANIFOLD?} MANIFOLD [[ARE
   VALVES SET TOO TIGHT?] VALVES [[ARE IGN POINTS BURNED, PITTED,
   OR GAPPED IMPROPERLY?]POINTS [[IS IDLE SPEED SET TOO LOW?]
   IDLE-SPEED CARB-MIXTURE ]]]] [[DOES ENGINE MISFIRE?] [[ARE SPARK
   PLUGS FOULED, DAMAGED, TOO HOT, TOO COLD, OR GAPPED
   INCORRECTLY?] PLUGS [[IS HEAD GASKET BLOWN?] HEAD GASKET
   [[ARE POINTS BURNED, PITTED, OR INCORRECTLY GAPPED?] POINTS
   [[ARE VALVES WORN, STICKING, OR VALVE SPRINGS BROKEN, WEAK?]
   VALVES [[IS CARBURETION POOR DUE TO CLOGGED OR LOOSE JETS,
   AIR LEAKS, OR INCORRECT FUEL-TO-AIR MIXTURE?]CARBURETOR
   IGN-TIMING]]]]] [[DOES ENGINE LACK POWER/PERFORMANCE?] [[IS IGN
   TIMING OFF?] IGN TIMING [[HAS VACUUM ADVANCE FAILED?]
   VACUUM-ADVANCE [[ARE POINTS BURNED, PITTED, STICKING, OR
   BOUNCING?] POINTS PISTON-RINGS]]] [[DOES ENGINE IDLE ROUGHLY?]
   FUEL-VOLATILITY CYL-HEAD]]]] [[DOES THE STARTER CRANK ENGINE?]
   [[ARE POINTS BURNED, PITTED, DIRTY, OR FAIL TO FUNCTION?]
   POINTS[[IS COIL RESISTOR BURNED OUT OR OPEN?] COIL [[ARE SPARK
   PLUGS DAMAGED, DIRTY, WET, OR GAPPED INCORRECTLY?] PLUGS [[IS
   FUEL PUMP WORN, LEAKING, CLOGGED, OR INOPERATIVE?] FUEL
   PUMP [[IS CARB FLOAT LEAKING OR SET INCORRECTLY, ARE JETS
   CLOGGED, IS NEEDLE VALVE OR SEAT DIRTY OR WORN, IS CHOKE
   INCORRECTLY SET OR INOPERATIVE?] CARBURETION [[IS DISTRIBUTOR
   CAP, ROTOR, TERMINAL INSULATOR DAMAGED, IS DISTRIBUTOR WET?]
   DISTRIBUTOR [[ARE IGN CABLES CRACKED, WET, CORRODED?] IGN-
   CABLES [[DOES IGN SWITCH REMAIN OPEN WHEN KEY IS TURNED?
   IGN-SWITCH FUEL ]]]]]]] [[ARE BATTERY TERMINALS LOOSE OR
   CORRODED?] TERMINALS [[DOES STARTER MOTOR FAIL TO OPERATE
   WHEN POWER IS APPLIED DIRECTLY?] STARTER [[DOES STARTER DRIVE
   GEAR FAIL TO ENGAGE FLYWHEEL?] SOLENOID BATTERY]]]]]
END
```

(continued)

```
TO DISPLAY.KBASE
    DISP :KBASE 0
END

TO DISP :KBASE :TIER
    IF WORD? :KBASE BDISP :KBASE :TIER STOP
    BDISP (QUERY :KBASE ) :TIER
    BDISP [IF YES:] :TIER
    DISP POS.BRANCH :KBASE :TIER + 1
    BDISP [IF NO:] :TIER
    DISP NEG.BRANCH :KBASE :TIER + 1
END

TO BDISP :BRANCH :TIER
    REPEAT 2* :TIER [PRINT1"']
    PRINT :BRANCH
END

DOES THE ENGINE START?
IF YES:
    DOES THE ENGINE STALL?
    IF YES:
      ANY AIR LEAKS IN OR AROUND INTAKE MANIFOLD?
      IF YES:
        MANIFOLD
      IF NO:
        ARE VALVES SET TOO TIGHT?
        IF YES:
          VALVES
        IF NO:
          ARE IGN POINTS BURNED, PITTED, OR GAPPED IMPROPERLY?
          IF YES:
            POINTS
          IF NO:
            IS IDLE SPEED SET TOO LOW?
            IF YES:
              IDLE SPEED
            IF NO:
              CARB MIXTURE
IF NO:
    DOES ENGINE MISFIRE?
    IF YES:
      ARE SPARK PLUGS FOULED, DAMAGED, TOO HOT, TOO COLD, OR
      GAPPED INCORRECTLY?
      IF YES:
        PLUGS
      IF NO:
        IS HEAD GASKET BLOWN?
        IF YES:
          HEAD GASKET
        IF NO:
          ARE POINTS BURNED, PITTED, OR INCORRECTLY GAPPED?
          IF YES:
            POINTS
          IF NO:
            ARE VALVES WORN, STICKING, OR VALVE SPRINGS BROKEN,
            WEAK?
             IF YES:
            VALVES
          IF NO:
            IS CARBURETION POOR DUE TO CLOGGED OR LOOSE JETS, AIR
```

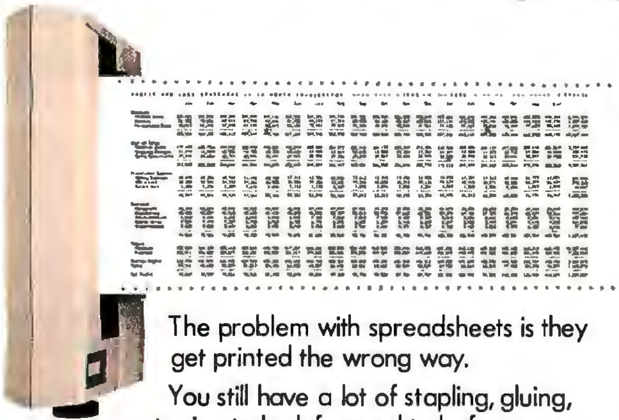
(continued)

EXPERT MECHANIC

```
                LEAKS, OR INCORRECT FUEL-TO-AIR MIXTURE?
                IF YES:
                  CARBURETOR
                IF NO:
                  IGN TIMING
IF NO:
    DOES ENGINE LACK POWER/PERFORMANCE?
    IF YES:
      IS IGN TIMING OFF?
      IF YES:
        IGN TIMING
    IF NO:
      HAS VACUUM ADVANCE FAILED?
      IF YES:
        VACUUM ADVANCE
      IF NO:
        ARE POINTS BURNED, PITTED, STICKING, OR BOUNCING?
        IF YES:
          POINTS
        IF NO:
          PISTON RINGS
IF NO:
    DOES ENGINE IDLE ROUGHLY?
    IF YES:
      FUEL VOLATILITY
    IF NO:
      CYL HEAD
IF NO:
    DOES THE STARTER CRANK ENGINE?
    IF YES:
      ARE POINTS BURNED, PITTED, DIRTY, OR FAIL TO FUNCTION?
      IF YES:
        POINTS
      IF NO:
        IS COIL OUTPUT WEAK OR NONEXISTENT, IS COIL RESISTOR
        BURNED OUT OR OPEN?
        IF YES:
          COIL
        IF NO:
          ARE SPARK PLUGS DAMAGED, DIRTY, WET, OR GAPPED
          INCORRECTLY?
          IF YES:
            PLUGS
          IF NO:
            IS FUEL PUMP WORN, LEAKING, CLOGGED, OR INOPERATIVE?
            IF YES:
              FUEL PUMP
            IF NO:
              IS CARB FLOAT LEAKING OR SET INCORRECTLY, ARE JETS
              CLOGGED, IS NEEDLE VALVE OR SEAT DIRTY OR WORN, IS
              CHOKE INCORRECTLY SET OR INOPERATIVE?
IF YES:
    CARBURETION
IF NO:
    IS DISTRIBUTOR CAP, ROTOR, TERMINAL INSULATOR
    DAMAGED, IS DISTRIBUTOR WET?
    IF YES:
      DISTRIBUTOR
    IF NO:
      ARE IGN CABLES CRACKED, WET, CORRODED?
      IF YES:
```

(continued)

Sometimes the best way to get ahead is to go sideways.



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```
        IGN CABLES
      IF NO:
        DOES IGN SWITCH REMAIN OPEN WHEN KEY IS
        TURNED?
        IF YES:
          IGN SWITCH
        IF NO:
          FUEL

IF NO:
  ARE BATTERY TERMINALS LOOSE OR CORRODED?
  IF YES:
    TERMINALS
  IF NO:
    DOES STARTER MOTOR FAIL TO OPERATE WHEN POWER IS APPLIED
    DIRECTLY?
    IF YES:
      STARTER
    IF NO:
      DOES STARTER DRIVE GEAR FAIL TO ENGAGE FLYWHEEL?
      IF YES:
        SOLENOID
      IF NO:
        BATTERY
```

simulates an automobile mechanic. Due to memory constraints, I decided to limit the knowledge base to include only the expertise required to diagnose engine failure. If you have enough memory, there is no reason why you cannot extend the knowledge base to include comprehensive automobile diagnostics. An alternative would be to build different knowledge bases for each area—one for the electrical system, one for suspension, one for steering, and so on.

The Mechanic procedure applies the concept of the binary tree to perform knowledge-base searches. Each question is a node on the search tree, and every node has exactly two branches. For example, the highest node is the question "Does the engine start?" If the answer to this question is "Yes," the next node is "Does the engine stall?" If the answer is "No," the next node is "Does the starter crank engine?"

In this way, Mechanic navigates the knowledge base until the problem is solved or a new node is added. Figures 1 and 2 are examples of the complete execution of Mechanic. In figure 1, the solution to the problem is not in the knowledge base. Mechanic can take you only to the limit of its expertise. However, the program asks to be informed if you discover a solution. It also asks you to formulate a question that will distinguish the actual solution from the solution Mechanic proposed. In this way, the program learns and the knowledge base grows. The next time someone uses Mechanic, its ability to solve problems can be extended further.

In figure 2, Mechanic moves directly to a solution. It simply suggests that the user fix the problem since computer programs cannot yet replace starter motors.

THE PROCEDURES

The main procedure is MECHANIC. It is recursive and calls the procedure SEARCH. SEARCH is also recursive; if the answer to a prompt is "Yes," it calls the procedure POS.BRANCH. Otherwise, SEARCH calls NEG.-BRANCH to display the next node in the binary tree. If the end of a particular branch is reached before a positive reply is received, END.-SEARCH is called to suggest a solution to the problem. If END.SEARCH proposes the correct solution, a congratulatory message is displayed and MECHANIC executes again. If END.-SEARCH is wrong, it calls the procedure LEARN. LEARN asks the user if the solution was found and adds it to the knowledge base by calling INCREASE.KBASE.

To initialize the knowledge base before it is first used, execute START.-KBASE. This procedure sets the value of the global variable KBASE. Thereafter, you can directly modify the knowledge base by altering the lists in this procedure.

The procedure DISPLAY.KBASE is a utility you can use to display the knowledge-base binary tree. It calls the procedures DISP and BDISP. Listing 1 is this procedure's output, including both the information and its logical structure.

NEW DIRECTIONS

An expert system is only as good as the expertise it contains. I deliberately limited the size of the knowledge base to allow room for experimentation. Obviously, the knowledge base can grow to fill a computer's available memory. When you build your knowledge base, keep in mind that some binary-tree structures are more logical than others. A carefully built structure can expedite problem solving.

Mechanic is a model for developing expert systems using Logo. You can use the procedures described here as a shell for any area of expertise. You can easily modify them to conform to the requirements of different applications and to build a variety of knowledge bases. ■

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Papert, Seymour. *Mindstorms.* New York: Basic Books, 1982.

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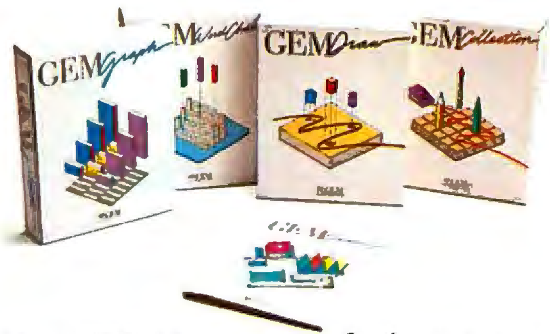

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BY WERNER F. GRUNBAUM

SWITCH

Use color and monochrome monitors simultaneously on your IBM PC

Editor's note: In November 1983, BYTE *presented an assembly-language program for the* IBM PC *entitled Screen ("Enhancing Screen Displays for the* IBM PC," *by Tim Field, page 99), of which one function was the ability to connect both color and monochrome monitors to the* IBM PC *and switch back and forth between them. This article describes a simple program that allows you to do the same thing while developing* BASIC *applications.*

Many IBM PC owners have both monochrome and color/graphics adapters in their computers. Unfortunately, only a few programs take advantage of the opportunity to use both a monochrome and a color monitor at the same time. The programs that do, such as Lotus 1-2-3 and SuperCalc3, simultaneously display graphics on one monitor and a spreadsheet on the other when the monitors are connected to separate cards. Such a setup has advantages, as these two cases illustrate: You can check the spreadsheet data and the graphics at the same time, and you can easily change graphics commands on one screen while viewing the graphics themselves on the other screen.

Switch enables you to write graphics instructions in BASIC on your monochrome monitor and to display the output on a color monitor connected to your color/graphics card. Minimum requirements for using this program are an IBM PC with two monitors connected to separate internal cards, one disk drive, and BASICA.

USING THE PROGRAM

Essentially, Switch is a program kernel to which you can add your own graphics applications. Once you have keyed in the 45 lines of code (listing 1), you can run Switch and begin to experiment, adding your own graphics application beginning at line 1000. Lines 1000 to 7500 are reserved for your application. Listings 1, 2, and 3 are available on BYTEnet Listings at (617) 861-9774.

Two function keys control the program's operation, execution, and screen display. Function key 5 trans-

(continued)

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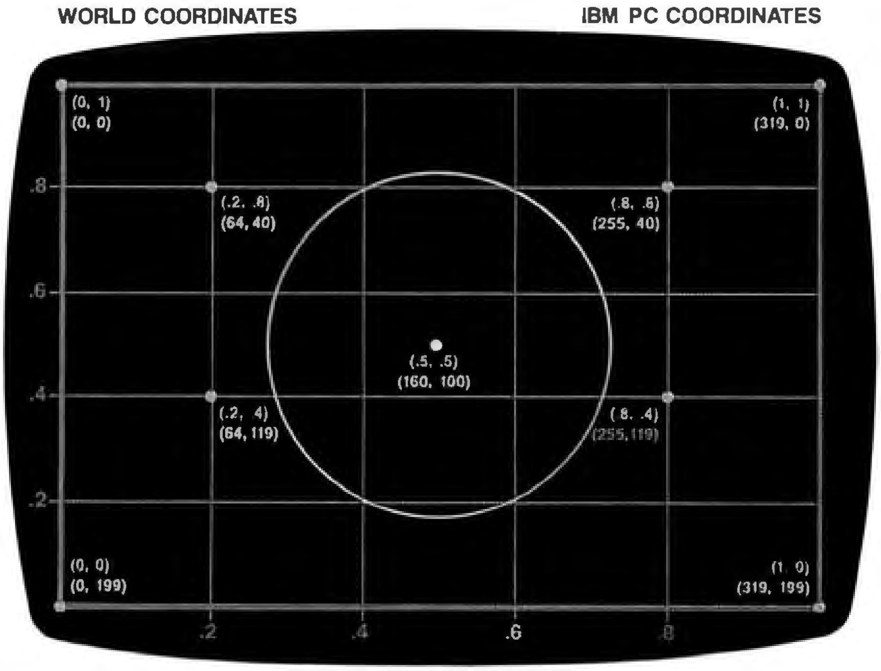

Figure 1: *Nine sample screen locations, shown with both the* IBM PC *screen coordinates and world coordinates.*

fers control to the graphics monitor and then executes the program, which displays the graphics on the color monitor. Function key 4 returns program control to the monochrome monitor and lists the graphics commands in lines 1000 to 7500, to which you can add new commands. You can test these commands at any time by pressing function key 5.

Correcting errors, deleting unwanted commands, and adding new commands is easy with Switch, since the graphics (on the color monitor) are not obscured by commands and new commands are not fouled up by the inclusion of stray bits of graphics or text, as can happen when you're working with one monitor. Screen-refresh time is quite fast for both monitors, and you can make changes quickly, without having to make printouts or relying on your memory.

With Switch, you can make corrections on either monitor. Correcting minor errors is faster and easier on the color screen than switching monitors. After you make the corrections on the color monitor, press function key 2 (RUN) to try the program again. To correct major errors, it is better to switch back to the monochrome monitor, because the color monitor can display only 40 characters of text and because the graphics display will be at least partially blanked by major corrections.

If your graphics contain text, it is best to position the text on the color screen as it will appear when the program is executed. This way you can check the layout before you write the commands that will print the text.

Once the screen layout of the text is satisfactory, you can save it by using the LOCATE (row, column) statement immediately before your normal PRINT statements. To do this, determine the row number for screen text locations by starting the cursor at the upper left-hand corner of the screen. Use the cursor to count down (rows) and to the right (columns) to where the text is located. Use the row and column numbers in the LOCATE statement, which is placed just before the appropriate print statement, as in:

10 LOCATE (*row, col.*)
20 PRINT "Graphics Screen"

For another way to locate the row and column, without counting, see the text box on page 226 of this article.

When you are satisfied with the output of your graphics application—assuming that you have run GRAPHICS.COM under DOS 2.0 before you wrote the application—you can press Shift-PrtSc and get a graphics dump of the screen. If you do not have DOS 2.0, several commercial graphics dumps run under earlier versions.

A couple of warnings. Remember not to execute graphics on the monochrome monitor. It can run graphics only if it is connected to a special card designed to run graphics on IBM monochrome monitors, such as the Hercules card. BASICA will respond with an Illegal Function Call error message if you try to run graphics on the monochrome monitor. If this error occurs, press function key 5 to run your program on the other monitor. Also, don't try to use Switch without a monochrome adapter, or the program will hang up when you press F4.

Program Description

Switch consists of a main section that performs the housekeeping functions, space for graphics commands, and two subroutines that transfer monitor control. The code for the subroutines that transfer monitor functions appears in the IBM BASIC manual, Appendix I, page I-8. The code instructions to reset the monitor appear to be straightforward. However, a programming trick is added to synchronize the color screen after switching monitors. IBM's trick becomes obvious when the color screen rolls just before the screen is refreshed. There appears to be no way to overcome this problem, but, fortunately, it is only cosmetic. Finally, the main program and each subroutine contain their own screen menus, which do not scroll.

Switch also includes a scaling function, which allows graphics mode commands, such as LINE and CIRCLE, to be expressed in what are known as "world coordinates." As shown in figure 1, the usual IBM PC screen coordinates start at the top of the screen (rather than at the bottom, as in normal graphics applications) and range from (0,0) to (319,199). World coordinates start at the lower left of the screen and range from (0,0) to (1,1). Neither of these coordinates should be confused with the coordinates for text, which range from (1,1) to (24,40) and are used with the LOCATE command.

In practice, it is easier to specify, for example, the midpoint of the screen by using (.5,.5) in world coordinates, rather than (160,100) in IBM PC units. However, you can use both types of coordinate systems in the program. You can use IBM's screen coordinates without modification, but world coordinates must follow this format:

FNY(y) for the *y*-coordinate
FNY(x) for the *x*-coordinate

(continued)

Listing 1: *Switch, a monochrome to color/graphics monitor switching program.*

```
   10 REM *********************************************************
   20 REM "SWITCH" graphics design aid to support simultaneous graphics and text
   30 REM display for the IBM PC by Werner Grunbaum, July 1984.
   40 REM *********************************************************
   50 KEY OFF
   60 KEY 4,"GOSUB 8000"+CHR$(13) 'Switch to monochrome monitor
   70 KEY 5,"GOSUB 9000"+CHR$(13) 'Switch to color monitor, medium resolution
   80 LOCATE 25,1
   90 PRINT "1:LIST 2:RUN 3:LOAD 4:MONO 5:COLOR"
  100 DEF FNY(Y)=CINT(199-(Y*199))
  110 DEF FNX(X)=CINT(319*X)
  120 IF FLAG=1 THEN GOTO 150 'Displays graphics on color monitor
  130 FLAG=1: GOSUB 9000
  140 '
  150 '          Begin graphics text at line 1000.
 7960 '
 7970 LOCATE 1,1  'Sets graphics image at Row 1, Col. 1, for printing
 7980 GOTO 10000
 7990 '
 8000 '          Switch to monochrome monitor
 8010 '
 8020 DEF SEG=0
 8030 POKE &H410, (PEEK(&H410) OR &H30)
 8040 SCREEN 0
 8050 WIDTH 40
 8060 WIDTH 80
 8070 LOCATE ,,1,12,13
 8080 LOCATE 25,1: PRINT "1:LIST 2:RUN 3:LOAD 4:MONO display 5:COLOR
      display"
 8090 LOCATE 1,1: PRINT "Ready for text editing at line 1000": LIST 1000-7500
 8100 RETURN
 8110 '
 9000 '          Switch to color monitor
 9010 '
 9020 PRINT "Color subroutine reached."
 9030 DEF SEG=0
 9040 POKE &H410, (PEEK(&H410) AND &HCF) OR &H10
 9050 SCREEN 1,0,0,0
 9060 CLS
 9070 WIDTH 40
 9080 LOCATE ,,1,6,7
 9090 COLOR 1,2
 9100 LOCATE 25,1:PRINT "1:LIST 2:RUN 3:LOAD 4:MONO 5:COLOR"
 9110 GOTO 100
 9120 RETURN
10000 END
```

Listing 2: FLOWCHRT.BAS, *a flowchart application that describes, and was developed using, Switch.*

```
1000 CIRCLE (FNX(.505),FNY(.9)),23,1 '        Flowchart application
1010 LOCATE 3,19: PRINT "Start"
1020 LOCATE 7,14: PRINT "Initialization"
1030 LOCATE 9,18: PRINT "Display"
1040 LOCATE 10,13: PRINT "Graphics Screen"
1050 LOCATE 12,9: PRINT "Fn4      Select       Fn5"
1060 LOCATE 13,17: PRINT "Monitor"
1070 LOCATE 15,5: PRINT "Mono Mntr.          Color Mntr."
1080 LOCATE 16,4: PRINT "Edits Text          Displays"
1090 LOCATE 17,8: PRINT "at                Graphics"
1100 LOCATE 18,4: PRINT "Line 1000ff        Stop"
1110 LOCATE 22,7: PRINT "Retr                Retr"
1120 CIRCLE (FNX(.2),FNY(.14)),18,1
1130 CIRCLE (FNX(.8),FNY(.14)),18,1
1140 LINE (FNX(.295),FNY(.78))-(FNX(.7),FNY(.71)),2,B
1150 LINE (FNX(.295),FNY(.685))-(FNX(.7),FNY(.6)),2,B
1160 LINE (FNX(.295),FNY(.57 ))-(FNX(.7),FNY(.47 )),2,B
1170 LINE (FNX(.06),FNY(.28 ))-(FNX(.36),FNY(.44 )),2,B
1180 LINE (FNX(.64),FNY(.28 ))-(FNX(.95),FNY(.44 )),2,B
1190 CIRCLE (FNX(.5),FNY(.3)),24,1
1200 LINE (FNX(.5),FNY(.805))-(FNX(.5),FNY(.78)): DRAW "NH4 E4"
1210 LINE (FNX(.5),FNY(.71))-(FNX(.5),FNY(.685)): DRAW "NH4 E4"
1220 LINE (FNX(.5),FNY(.6))-(FNX(.5),FNY(.57)): DRAW "NH4 E4"
1230 LINE (FNX(.5),FNY(.47))-(FNX(.5),FNY(.4)): DRAW "NH4 E4"
1240 LINE (FNX(.7),FNY(.52))-(FNX(.8),FNY(.52)),,,&HCCCC
1250 LINE -(FNX(.8),FNY(.44)),,,&HCCCC: DRAW "NH4 E4"
1260 LINE (FNX(.8),FNY(.28))-(FNX(.8),FNY(.21)): DRAW "NH4 E4"
1270 LINE (FNX(.295),FNY(.52))-(FNX(.2),FNY(.52)),,,&HCCCC
1280 LINE -(FNX(.2),FNY(.44)),,,&HCCCC: DRAW "NH4 E4"
1290 LINE (FNX(.2),FNY(.28))-(FNX(.2),FNY(.21)): DRAW "NH4 E4"
```

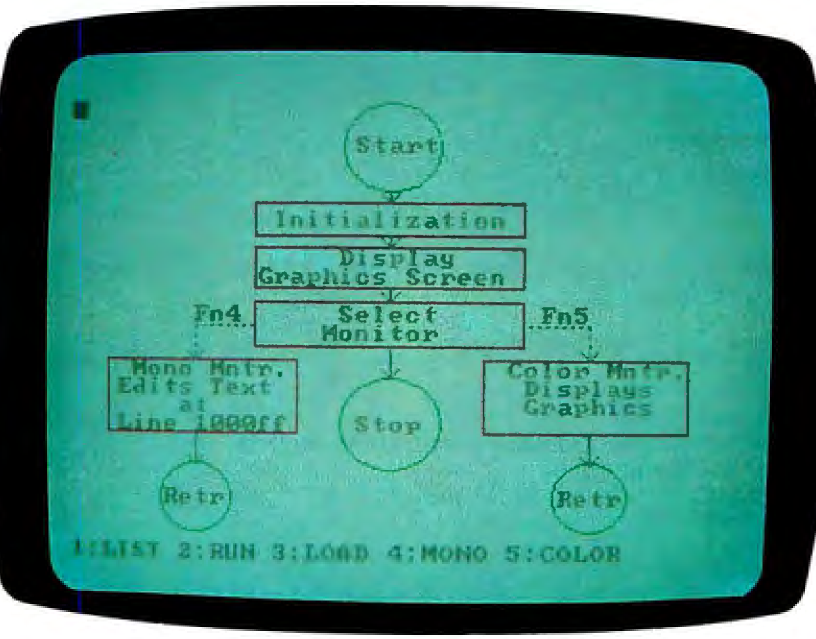

Photo 1: A *screen display of the flowchart application in listing 2.*

The scaling function is performed by line 100 (listing 1), which scales the *y*-coordinate, and by line 110, which scales the *x*-coordinate, translating them into IBM PC screen coordinates.

Although using world coordinates requires extra keystrokes, it simplifies graphics layout. Just as important is that, when you use world coordinates, programs require only minor changes for adaptation to high-resolution mode as well as adaptation to plotters, different computers, and other types of output devices.

AN APPLICATION

Listing 2 is a sample application that creates a flowchart to illustrate Switch. The color graphics display produced by this application is shown in photo 1. Note that the code in listing 2 uses world coordinates for the graphics commands, as discussed above.

Initially, I drew the flowchart on paper and made a screen layout by positioning the text on the screen. I determined the column and row cursor positions by moving the cursor and keeping a record of cursor positions. Then I composed the appropriate PRINT command statements on the monochrome screen.

I programmed the graphics commands around the text, then tested and corrected the instructions in small groups. Finally, I added the arrows with the DRAW command and put in the broken lines with the bit pattern found in the BASIC manual.

The same application could also be adapted to high-resolution mode, which allows more text to be shown but provides only monochrome output. This would require making changes in the SCREEN and WIDTH commands, deleting the COLOR command, changing the text locations to fit 80 columns, and so on.

CONCLUSION

In addition to developing your own graphics applications, you can use Switch to edit output from a number of commercially available graphics packages that provide output in the form of BASIC files. You can then

(continued)

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CURSOR LOCATION MADE EASY

If you'd rather not spend your time counting rows and columns in order to locate text in the right places for your graphics applications, try Blackboard (listing A). This add-on to Switch lets you position the cursor where you want text to begin, hit Return and receive the screen location from the computer. The code fits into the unused lines 9500 to 9800 in Switch and adds line number 75 to initiate Blackboard when you press function key 6. You can also add to lines 90 and 9100 of Switch so that function key 6 is identified as the Blackboard key.

To use Blackboard, position the cursor using the cursor arrow keys and hit Return. After identifying the desired cursor location, Blackboard will switch you back to the monochrome monitor, where you can incorporate the row and column into a LOCATE statement.

Listing A: BLACKBRD.BAS, *an optional cursor-location subroutine for Switch.*

```
75 KEY 6,"GOSUB 9500"+CHR$(13) 'Switch to Blackboard
9500 '          *********
9510 '          Blackboard
9520 '          *********
9530 PRINT "See color monitor and press F6 for Blackboard screen."
9540 DEF SEG= H800: Z = PEEK (&H410)
9550 IF Z= 125 THEN 9030 ELSE 9560
9560 ON KEY (11) GOSUB 9730
9570 ON KEY (12) GOSUB 9750
9580 ON KEY (13) GOSUB 9770
9590 ON KEY (14) GOSUB 9790
9600 SCREEN 1,0,0,0
9610 SCREEN 0: COLOR 7,0,1
9620 LOCATE 25,1: PRINT "Move cursor with arrows. RETURN to mark."
9630 LOCATE 1,1,1,2,6
9640 FOR I=11 TO 14:KEY(I) ON:NEXT
9650 A$=INKEY$:IF A$<>CHR$(13) THEN 9650
9660 X=POS(0)
9670 Y=CSRLIN
9680 FOR I=11 TO 14:KEY(I) OFF:NEXT
9690 LOCATE 25,1
9700 PRINT USING " Location ##,##. SWITCHED to monochrome.";Y;X;
9710 LOCATE Y,X: GOSUB 8000
9720 RETURN
9730 IF CSRLIN>1 THEN LOCATE CSRLIN-1,POS(0),1 ELSE LOCATE 24,
     POS(0),1
9740 RETURN
9750 IF POS(0)>1 THEN LOCATE CSRLIN,POS(0)-1,1 ELSE LOCATE
     CSRLIN, 40,1
9760 RETURN
9770 IF POS(0)<40 THEN LOCATE CSRLIN,POS(0)+1,1 ELSE LOCATE
     CSRLIN, 1,1
9780 RETURN
9790 IF CSRLIN<24 THEN LOCATE CSRLIN+1,POS(0),1 ELSE LOCATE 1,
     POS(0),1
9800 RETURN
```

enhance or modify such files to suit your needs.

With Switch, you can use one of the features of expensive CAD/CAM systems in your office and home: displaying graphics on one screen and graphics commands on another. By experimenting and adding a few routines, you should be able to add other features to the program. ■

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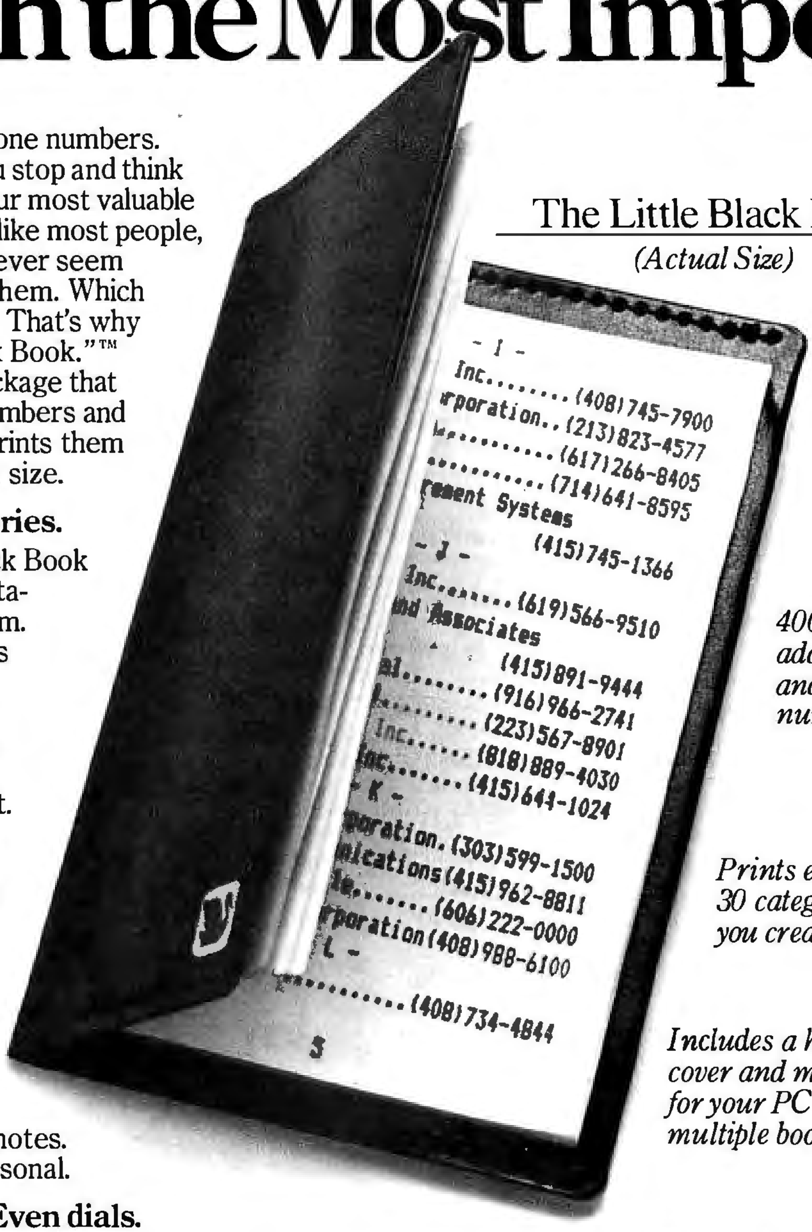

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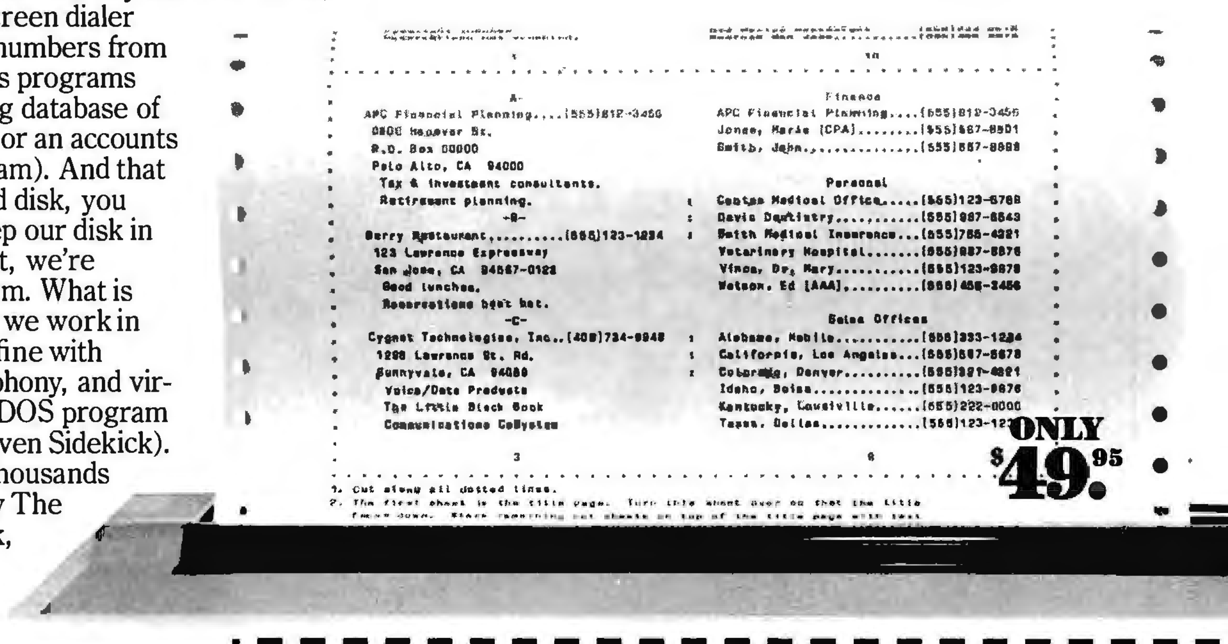

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Two's-Complement Numbers Revisited

A new tool for dealing with the fundamentals of number storage

Converting positive numbers from their binary to their decimal form (and vice versa) is generally easy to understand. Here, traditional conversion methods (and there are many) work just fine. One such method involves the use of a diagram known as a "value box" (see figure 1). Notice that the value on the far right in the box is 1 and each succeeding position to the left is double in value.

For example, let's say that you want to find the decimal value of the binary number 01011111. Since this is an 8-bit binary number, you can use the 8-position value box shown in figure 1. Insert the binary number into the empty boxes from left to right; add the numbers above each slot that contains a 1, and you'll arrive at the answer, 95 (see figure 2).

It is also possible to convert decimal numbers to binary using the box in figure 1. For instance, to find the binary number corresponding to 43, first see if there is a 43 on the top row of the value box. If there isn't (and there isn't), take the next smaller number. This would be 32. Place a 1 in the corresponding slot in the box, subtract 32 from 43, and repeat the above process on the remaining amount (11) until 0 is reached. Finally, fill in the empty slots with 0s and "read out" the binary number (see figure 3).

Conversion becomes more difficult when you consider negative numbers on the computer. This involves finding the number's "two's complement," a representation that handles the problem of having to indicate a number's "negativeness" using only 1s and 0s. At the same time, it maintains the proper functioning of mathematical operations, so that addition, subtraction, etc., of positive and negative numbers yield correct results. Rather than describe the traditional two's-complement conversion technique (which you can find in any introductory programming book), we'll show you another method that yields the same result. We believe this new method is unique, easy, and more insightful than the traditional negative-number conversion method. For simplicity, we will continue to use 8-bit binary numbers.

To find the two's-complement binary representation of both positive and negative numbers, use the standard value box with one simple modification—change the largest (leftmost) value in the box to a negative number (see figure 4).

To illustrate the ease of converting negative numbers, we will use the value box in figure 4 to convert the binary number 10000011 to its decimal form. We put the digits 10000011 into the value box, and by adding up the slots with 1s in them, we get $-128 + 2 + 1 = -125$. The traditionalists among you can verify that 10000011 works out to -125 using the conventional procedure.

The beauty of the value-box technique is that it connects a two's-complement binary number visually to its decimal value. As you can see in figure 4, the most negative two's-complement binary number that can be represented using 8 bits is -128. Any other nonzero bit will simply add a positive amount to the number. Additionally, it is clear that a negative number must have a 1 as its leftmost bit and a positive number must have a 0 as its leftmost bit. From this you can see that the largest positive 8-bit

BY GARY BRONSON AND KARL LYON

binary number is 01111111 or 127.

Do you want to find the two's-complement representation of −120? Using the value box illustrated in figure 4 reduces the conversion to finding what positive values, when added to −128, equal −120. Since −128 plus 8 is −120, the two's-complement representation of −120 is 10001000. Notice that you can almost read 10001000 directly as a decimal number.

For the aficionados among you, the new technique is related directly to the original mathematical basis of two's-complement numbers. Actually, two's-complement numbers is a misnomer. Two's complement is a procedure for converting a negative decimal number into a weighted-sign binary number. Weighted-sign simply means that the leftmost bit of the binary number represents both a sign and a value. A 1 as the leftmost bit corresponds to a minus sign and a 0 corresponds to a plus sign. The value assigned is equal to 2 raised to the $n-1$ power, where n is the number of bits in the binary number.

The value-box technique presented here is simply another procedure for performing decimal to weighted-sign binary conversions and finding what is commonly called two's-complement numbers. ■

Dr. Gary Bronson is a professor in the department of computer and decision systems at Fairleigh Dickinson University. He has been a regular visiting instructor to Bell Laboratories' in-house continuing education program and is a consultant to AT&T documentation and educational organizations. He can be reached at 891 Ridgewood Rd., Millburn, NJ 07041. *Karl Lyon is currently a senior studying computer science at Fairleigh Dickinson University. He is interested in all aspects of computer science and can be contacted at* 21 Orchard Pl. E, East Hanover, NJ 07936.

128	64	32	16	8	4	2	1

Figure 1: *An eight-position value box.*

128	64	32	16	8	4	2	1
0	1	0	1	1	1	1	1

64 + 16 + 8 + 4 + 2 + 1 = 95

Figure 2: *Using the value box to convert the binary number* 01011111 *to its decimal equivalent.*

128	64	32	16	8	4	2	1
0	0	1	0	1	0	1	1

43 = 32 + 8 + 2 + 1

Figure 3: *Using the value box to convert the decimal number* 43 *to its binary equivalent.*

−128	64	32	16	8	4	2	1

Figure 4: *An eight-position two's-complement value box.*

Programming Techniques

LEO BRODIE SAID IT BEST in the preface to his book *Thinking FORTH*: "Building models in the mind is both the challenge and the joy of programming." It's true. For most of us, software reigns supreme—we like what it does, and we like to make it do new things. Of course, we can't do it without hardware, but hardware is more like the canvas and paint that makes the painting itself possible.

Because it is such a complex activity, programming requires both craft and insight. We hope that the articles in this theme section will help you become more intimate with both the theory and practice of programming.

"Choosing a Programming Language," by Gary Elfring, explores a decision that many of us usually don't think about: "What computer language should I use for this problem?" It is said that a (human) language determines the thoughts a person can have, and the same is true with programming languages. The fit between the language and the problem to be solved is only one of several issues that Elfring talks about in his article.

Reinventing the wheel is a common human experience, bad enough when I reinvent *your* wheel but even worse when I reinvent my own. With some planning, you can develop a library of tested, reliable subroutines for your own work that reduce the amount of repetitive programming, allowing you to concentrate on the novel aspects of your current program. Arthur Huston's "Structuring BASIC" and Bruce Webster's "Subroutine Libraries in Pascal" present two schemes for doing this in two popular languages.

The flowchart is a ubiquitous but mediocre design and documentation tool, but the data-flow diagram is a simple, useful tool that too few people know about. Wayne P. Stevens's article, "Using Data Flow for Application Development," explains one use of data-flow diagrams in the design process.

Because we have not yet developed a computer that does what we *mean*, not what we *say*, program debugging still consumes a significant part of a programmer's energy. In my article, "Debugging Techniques," I try to classify and explain the debugging techniques available to most of us.

The 6502-family microprocessor is present in many of the most popular personal computers, but this relatively old chip still contains surprises for the unsuspecting programmer. Joe Holt's "6502 Tricks and Traps" explains how best to use the 6502 if you have the occasion to program in 6502 assembly language.

Finally, "Software-ICs," by Lamar Ledbetter and Brad Cox, describes an approach to building reusable software. We asked the authors to describe the philosophy behind their product, Objective-C, because it ties a conventional language available on many microcomputers—C—to the increasingly popular concept of object-oriented languages, which have traditionally been associated with more powerful machines than today's micros.

By learning more about programming, we become better programmers and create better software. Enjoy this month's theme section.

—*Gregg Williams, Senior Editor*

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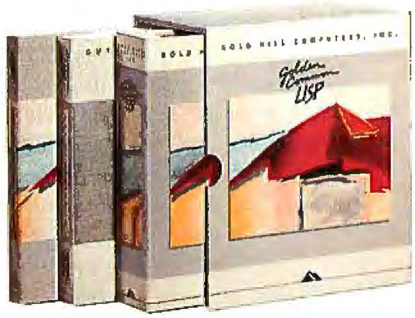

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CHOOSING A PROGRAMMING LANGUAGE

BY GARY ELFRING

It's a three-step process

IF YOU WERE a carpenter building a new house, the first thing you would do would be to collect your tools. The tools you'd select would vary depending on the type of job. The same thing should be true if you are a programmer. You have a wide range of tools available, and you just choose the right tools for the job. Your tools are the languages that you program in and the environments needed to support those languages.

How do you go about selecting the right tool for the job? There are more programming languages available for microprocessors than most people could learn in a lifetime. What you need is a methodology that can be used to select one language from all the rest for a given application.

This article presents a practical method for comparing programming languages. It has an inherent bias toward compiled high-level languages. Compiled languages are faster than interpreted ones, and most interpreted languages also offer a compiler version. Since program speed is often an issue, I chose compilers over interpreters.

The actual process of evaluating a group of programming languages can be broken down into three major steps. The first step is to characterize the application the language is being selected for. Then you must identify the features that a language should have in order to deal with the previously described application. Finally, you should take into account practical considerations to further narrow down the language selection.

THE APPLICATION

You can't choose a tool unless you know what you intend to do with it. You have to describe your application. Once you have this information you can then proceed to determine whether or not the existing language choices are the right tools for the job.

To describe an application, you must consider both the type and size of the application. These questions must be answered before you can proceed any further in the language evaluation:

What is the type or class of application?
What level of language is needed?

There are a number of different classes of program applications. An application can belong to a single class or several. Identifying the class of your application is relatively simple and helps narrow the list of acceptable languages. Some of the more common classes include scientific, business, and system programming; text processing; expert systems; and real-time control.

Most programming languages are better suited to solving one particular class of problem than another. COBOL is one example. While it is easy to write maintainable business programs with COBOL, no one would expect to use this language to solve real-time control problems.

Another consideration is the level of programming that the application will require. If you need low-level control of various machine-dependent features, then a very high level language

(continued)

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would be a bad choice.

Is it too big to be expressed as one module?
Is it too big to be fully understood by one programmer?

Just how big is the potential application? Large programs should not be squeezed into a single module. This implies that the language chosen must support separate program module compilation. It is always easier to compile many small programs and combine them into one large version than to compile one gigantic program.

Related side questions consider the complexity of the application itself. Can a single programmer understand it? If not, then the language chosen must support multiple program modules and some way of managing them. Also, remember that a number of programs start out small and end up growing quite large.

LANGUAGE FEATURES

After characterizing the nature of the software application, the next step is to identify what features are required or desired to implement it. This list of features can then be used to rate each available language. The result of this process will be a short list of acceptable programming languages.

What audience was the language designed for?
What class of problems was the language designed to solve?

Some languages were designed for a specific audience instead of a class of applications. This type of language was typically designed to do something like teach programming techniques. A language that was designed to solve a specific class of problems will generally do a much better job at that task than one designed to teach the techniques of programming.

Most languages were designed with some class of applications in mind. This inherent bias toward certain classes of problems will affect the way a language is used on other classes of problems. A short history of each language under consideration is necessary to aid in the evaluation of that language. For example, knowing the history of COBOL and APL will allow you to reject them immediately as languages for programming a real-time control application.

Can the syntax be understood?
Is it terse or verbose?
Is it consistent?

The syntax of a language should be both readable and intelligible. A syntax should aid the mechanical aspects of reading it and help you understand what the program is doing.

A syntax should be concise, yet expressive. Verbose languages can turn what should be a one-page program into a multipage listing. Since, generally, the longer a program is, the harder it is to follow, such verbose syntax can actually defeat its own purpose of increasing the understandability of a program.

Inconsistency in syntax makes a language hard to learn. It also increases the possibility of error significantly. The syntax should be an aid to programming, not a hindrance.

What data types are supported?
How are data types treated?

The organization and representation of data is an important part of programming. Some basic data types on microprocessors are 8-, 16-, 32-bit integers, single- and double-precision floating point, records/structures, pointers, bit fields, and arrays of all data types. Some compilers even allow you to create user-defined data types.

Structures or records, in particular, are important data-handling tools. They let you group items of different data types together so they can be referenced as a unit. The more control a language gives over the use and construction of structures, the easier it will be to handle data.

The use of data types not only gives you great flexibility in how you manipulate data but also lets a good compiler do a considerable amount of error checking. The compiler can check for mismatches in the use of data types and flag them as errors. This will catch a large percentage of the simple errors that a programmer makes, well before the program enters the debugging stage. For these reasons a language should offer as rich a selection of data types as is possible.

Does the language support structured programming?
Are exceptions possible?

Languages that support structured programming are inherently more safe to use than those that do not. A programming language should at least offer you the choice of using structured programming techniques. Modern structured programming generally requires, at a minimum, a grouping syntax (either functions or procedures), two types of decision statements (generally the IF and CASE statements), and two types of loops (counted and uncounted).

Sooner or later exceptions will arise that must be dealt with in some manner. Languages that allow no exceptions can make it quite difficult to write certain kinds of programs. Some languages totally rule out exceptions or can deal with them only in an uncontrolled fashion such as with a GOTO. One structured way of handling exceptions, the BREAK command, is used as an escape from counted and uncounted loops. It is preferable to the use of a GOTO and is featured in languages like Ada, C, and Modula-2.

Is portability needed?
How portable is the language?

The portability of programming languages is becoming more and more important in the world of microprocessors. Large amounts of time and money are spent developing software that becomes obsolete when the next microprocessor comes out. Some method is needed to protect this large investment in software. The answer is portability.

There are several levels of portability. At the lowest level, the language is portable from compiler to compiler on the same microprocessor. The next level of portability covers the ability to port code from one micro-

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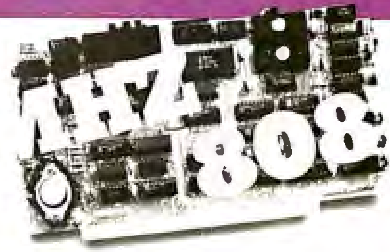

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processor to another of the same level, for example, between 16-bit microprocessors. A final level of portability is between any two microprocessors.

If an application can be ported from an 8-bit microprocessor to a 32-bit one (say from Intel's 8051 to Motorola's 68020), then the language is truly portable. Note that it is probably unreasonable to expect that any application be ported all the way down from a 32-bit microprocessor to an 8-bit one, but you should expect a language to offer upwardly compatible extensions.

How is I/O (input/output) handled?
Is access to other programming languages needed?
Is stand-alone product support required?
Is real-time control needed?

Not all programs need file or terminal I/O. However, almost anyone would agree it is a useful function. Device-independent I/O is preferable to any other kind. Languages that make no distinction between different types of I/O devices are easier to program in. They are inherently more consistent since they don't differentiate between hardware devices.

Some applications require the use of more than one language. The second language is typically assembly language. If your application needs an interface to another language, then the amount and type of support for the other language must be assessed.

Is the software application going to be for a stand-alone product (such as a microprocessor-controlled blender) or a product run on a computer with an operating system (such as a database-management system)? A language for a stand-alone application must be able to get "close" to the hardware; that is, it will need features that allow absolute control over addressing, I/O, and interrupts. It will also generally have to run from some kind of ROM (read-only memory). However, a product such as a database-management system interacts with the hardware through the operating system and runs from RAM (random-access read/write memory).

Yet another consideration is real-time control. Does the intended language support it, or will it at least allow itself to be modified or extended to do so?

PRACTICAL CONSIDERATIONS

There is more to selecting a programming language than a simple comparison of features. In the real world a number of practical considerations enter into the picture. They range from considerations about existing compilers to questions about the development tools for a particular language. This series of qualifications is

(continued)

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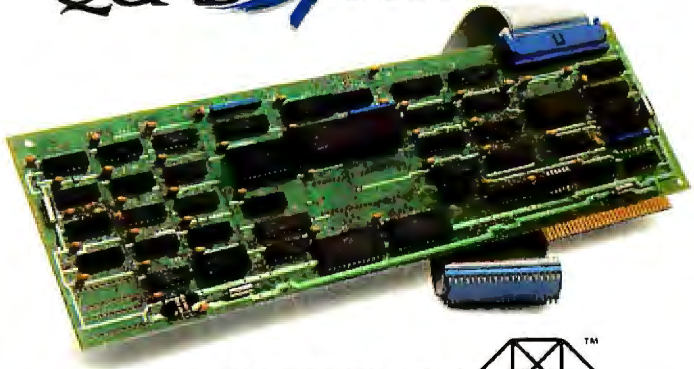

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Inquiry 343

used to further narrow the language choices based on real-world criteria.

How available is the language?
How popular is the language?

How many different compilers are available for this language? Are they compatible with each other? How hard is it to locate compilers for this language? Answers to these questions describe the availability of a language. Generally, the more available a language is, the safer it will be to use.

It is important to choose a language that has an established history and predictable future. Will the language you choose be around tomorrow or does it belong to the "Language of the Month" club? Brand-new languages may offer many desirable features. But the future of both the language and its new features can be uncertain. If it doesn't catch on, the language and its special features may die.

How do you learn the language?
What is the source of this information?

If the language chosen is not in your programming repertoire, you are going to have to learn it. How do you learn to program in the language? Are there good reference materials or outside help available to teach you the language? The best language in the world is no help to you if you can't figure out how to use it.

What are the characteristics of the compiler?
Is the code produced quick, compact, and predictable?

Theory and practice must merge in the creation of a compiler. The compiler should operate quickly and be reliable. It should not require a great deal of memory or disk space. Finally, the amount of support from the manufacturer is important.

Compilers translate high-level instructions into code that a particular computer can execute. The code that they produce must be efficient both in size and speed. Furthermore, the execution time and size of the code produced by the compiler should be reasonably predictable. That is, the compiler should be consistent in the quality of the code it produces.

What hardware-development tools are available?
What software-development tools are available?
What kinds of software libraries are available?

The types of tools associated with a programming language are important considerations in that language's evaluation. Tools make you significantly more productive and ease your work load.

Tools come in many different forms. Hardware-development tools, such as an in-circuit emulator, are indispensable in the development of software-controlled products. The availability of this type of tool could easily alter a choice of a programming language.

Another form of tool is software-oriented. Software-development, debugging, and management tools are quite popular but not compatible with all programming languages. A good directory program for file maintenance is also a tool. The purpose of these tools is to make the job of programming as easy as possible.

One final type of tool is the software library. It is often more feasible to purchase a library of software functions than to write your own. Examples of software libraries include graphics and real-time control packages. The availability of good software libraries at low cost is an important practical consideration in the choice of a language.

Language Suitability

Now that you know how to describe the application, programming features, and practical considerations, the selection process can begin. The end result of this evaluation process is a list of from one to three languages that are ideally suited to your particular application. If you end up with more than one language on your list, then any one of these can be selected. This is the only point in the language-selection process where you can apply your own personal bias and not affect the quality of the final language choice. ■

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STRUCTURING BASIC

BY ARTHUR HUSTON

Creating a library of subroutines

COUNTING ALL of its dialects, BASIC is now among the world's major languages. Even so, many programmers complain that it lacks features found in more structured languages. By creating a library of procedures and functions, however, you can compensate for some of the language's shortcomings and write more powerful programs in less time.

Most structured languages have two types of library routines: functions and procedures. In BASIC the former is a subroutine that returns only one value; the latter returns more than one, or none. It's not possible, however, to incorporate into BASIC the concept of local variables or to pass variables of different names into subroutines. And since BASIC requires line numbers, inserting a subroutine into a program could overwrite existing code.

For these reasons, BASIC programmers usually rename the variables and renumber the code when they reuse a subroutine in a new program or, worse, they only use subroutines to eliminate redundant code in one program. With some discipline, however, you can force BASIC to mimic true procedures and functions and thus eliminate redundancy between programs as opposed to within a single program.

Newer dialects of BASIC, including recent versions of DEC VAX BASIC, the Microsoft Business BASIC Compiler, Better BASIC from Summit Technology, and True BASIC from True BASIC Inc., implement these concepts and bring much-needed structure and power to the language. I will concentrate instead on the garden-variety Microsoft BASIC interpreter and such offshoots as GW-BASIC, Applesoft BASIC, and Commodore 64 BASIC.

Mimicking more structured features requires that you invent a set of programming rules and adhere to them rigidly. You may find at first that the discipline required inhibits your programming, but consider the benefits of assembling a library. When you start a program you can concentrate on its purpose rather than worry about chores like menus and date manipulation. Your programs will have a consistent user interface, and entire sections of code will be thoroughly debugged before you start. Anyone familiar with your library can maintain your code, and porting your programs to a different computer will be easier—you simply convert your library.

LINE-NUMBERING RULES

Without line-numbering rules, merging in a subroutine might mean overwriting existing code or require scanning programs for a free set of line numbers (and then loading, renumbering, and saving the subroutine, reloading the program, and finally merging in the subroutine). With line-numbering rules, you need only break a program into logical parts and assign line numbers to each part.

Programs always begin with initialization, or declaration. A set of remarks should tell you what the program does, and the early lines allocate string space and dimension all arrays. Ideally, you should initialize every variable with special meaning in the program code and add a remark that explains its function. Reserving line numbers 0–999 leaves more than enough room.

Some programmers like to put initialization at the end of the program

(continued)

Arthur Huston (154 Park St., Stoughton, MA 02401) is a programmer of financial software in Boston.

and call it with a GOSUB. I find such programs less readable; more important, they are incompatible with most compilers, which require that the code dimension arrays before referencing them.

Program code comes next. You will want to make judicious use of your subroutine library; this code simply calls the subroutines in the correct order and gives your program its uniqueness. Let's set aside lines 1000–9999.

Next are program subroutines, which are not part of your library but are of use only to the program in which they appear. Line numbers 10000–14999 should be enough.

Specific applications require application subroutines. A payroll system, for example, might use a routine to read employee names from a file; a stock portfolio might have a procedure to calculate which stocks to buy. Reserve lines 15000–24999.

Last are the system subroutines—your software library, which is useful in every program you write. Let's set aside the lion's share of your programming space, lines 25000–65000. You'll be surprised at how quickly you'll fill it up.

We can differentiate the system subroutines further into their logical functions. Lines 25000–29999 might handle user-interface routines such as menus; 30000–34999 could be reserved for file handling; 35000–59999 for all-purpose subroutines like data handling and string manipulation; lines 60000–65000 for ON ERROR GOTO routines. See table 1 for a summary of these line-numbering rules.

In some versions of BASIC, placing the subroutines immediately after initialization results in faster program execution. The BASIC code stored in memory is simply a linked list, with each line pointing to the next one; it follows that lines near the beginning of a program will be found faster than those at the end. The current versions of Microsoft GW-BASIC, however, search for the line number the first time it is called and thereafter branch directly. The time saving is so minimal for this popular version of BASIC that I have not placed my subroutines at the beginning.

There are, however, a number of caveats to using this system. When you create your library, make sure there's no overlap from one routine to the next. If you must add features or debug a routine, insert new code between lines rather than extending the routine. Lastly, renumbering your programs in increments of 10 would render the entire scheme useless. You can, however, renumber the program code and program subroutines sections.

These line numbers are not cast in stone; the point is to predict how many lines each section of your code will require and then allocate them accordingly. You'll notice, for instance, that I gave the largest section to system subroutines. Few of these are used in any one program, but all of them will be needed to accommodate your library.

Some programmers never begin subroutines with remarks because many compression programs delete the REMs, leaving undefined lines. I always reference remarks, but I use more sophisticated compression routines that avoid the conflict. Some of these packages include The BASIC Development System from SoftTool Systems on the IBM PC, GPLE from Beagle Bros. on the Apple, and the Snapp Utilities from Snapp Inc. on the TRS-80. All three packages contain other utilities to ease programming. Note that an alternative method would place remarks just prior to the referenced line (e.g., placing REMs on lines 5196–5199 for a subroutine beginning on line 5200).

Table 1: *This line-numbering scheme is only a suggestion; the important thing to do is predict how many lines each section of your code will require. In addition, the initialization part should always be the first section of code. Note that in some versions of BASIC, placing the subroutines immediately after initialization will speed up program execution.*

Code Section	Lines
Initialization (declaration)	0 – 999
Program code	1000 – 9999
Program subroutines	10000 – 14999
Application subroutines	15000 – 24999
System subroutines	25000 – 65000
—user interface	25000 – 29999
—file handling	30000 – 34999
—all-purpose routines	35000 – 59999
—ON ERROR GOTO	60000 – 65000

NAMING RULES

Giving subroutines descriptive names certainly helps to explain their use, but the eight-character filename limit of many BASICs is severely restricting. For a naming convention, therefore, I suggest that the starting line number of the subroutine follow a two-character prefix (SS, for example, for your system subroutines). Application subroutines could assume the prefix from the application's name (PR for payroll, for example). Using this method, you can quickly identify the type of subroutine—application or system—and its line numbers. Rely on your written documentation to tell you what the subroutine does.

Variable-naming rules prevent "collisions," or "side effects," which occur when program code and a subroutine use the same variable for different purposes. For example, if the program code used the variable PR to record payroll and a subroutine used PR as a flag to see if the printer were on line, calling the subroutine would change the value of the variable.

To avoid the problem, you can simulate the concept of local variables by assigning groups of variables to logical sections of code. For example,

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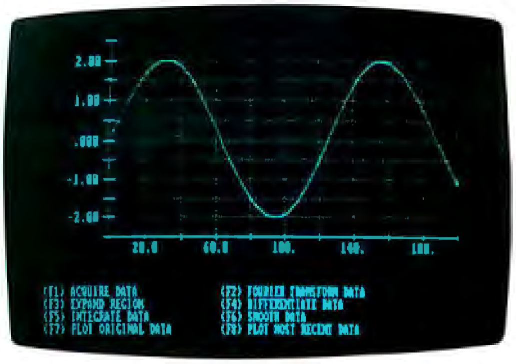

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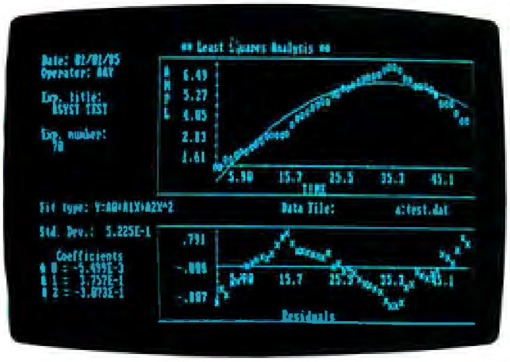

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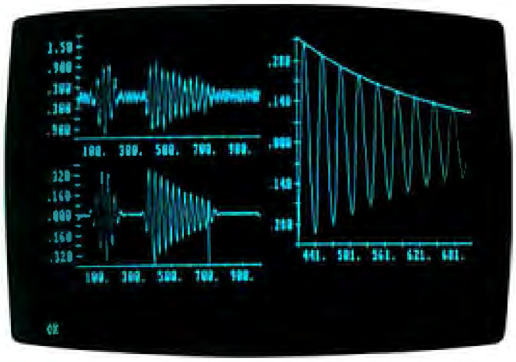

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you can set aside variables beginning with A–H for program code and program subroutines, I–J for program code loops (following the programming convention started with FORTRAN), K–P for application subroutines, and Q–Z for system subroutines. Table 2 summarizes these variable-naming rules.

I suggest breaking variables down even further. Each section of code uses two sorts of variables: "throwaways," which are used in calculations and then discarded, and permanent variables, which have a consistent meaning throughout a program or within a given application. Program variables, for instance, could use A–D as throwaways and E–H as permanent variables. In addition, you can break down the system variables according to the same logical functions as the corresponding line numbers.

When you call a subroutine, simply set the local variables required by the subroutine to the values you want to pass. On return, transfer the values you want to save into program variables before calling other subroutines, which otherwise might change the values.

I suggest using descriptive variables only in the program code, program subroutines, and application subroutines, and then only for permanent variables. Avoid using descriptive variables in system subroutines because that eliminates their usefulness elsewhere (exceptions are variables like *true* and *false* that always have the same definition. Be aware of potential conflicts in BASICs in which only the first two letters of the variable names are significant.

Table 2: *Variable-naming rules give* BASIC *the ability to mimic local variables. They ensure that the variables in your subroutines will not collide with program variables and create bugs. You can differentiate variables further into throwaway and permanent variables. You can also organize system variables according to the logical functions of the system line numbers.*

Code Section	Variable Name
Program code	A–H, I–J for FOR . . NEXT loops
—Throwaway	A–D
—Permanent	E–H, descriptive variables
Program subroutines	A–H (shared w/program code)
—Throwaway	A–D
—Permanent	E–H
Application subroutines	K–P
—Throwaway	K–M
—Permanent	N–P
System subroutines	Q–Z
—Throwaway	Q–R
—Permanent user-interface variables	S–T
—Permanent file-handling variables	U–V
—Permanent all-purpose variables	W–X
—Permanent ON ERROR GOTO variables	Y–Z
—System variables like true, false, screen-control strings, etc.	

— Remarks to describe the purpose of the program
— DEFINT, DEFSTR, DEFSNG, DEFDBL, used to specify the data type of variables without constantly using the %, !, and $ notation
— DIM statements, to dimension your arrays
— COMMON statements, used to pass variables between programs
— ON ERROR GOTO
— DEF FN, to define functions
— Declare program variables, e.g.,

```
100 REM 100-199 Declare program variables
110 REM Today's date, user name, # of items changed
120 E0$=DATE$(0) : E1$="" : E0=0
```

Figure 1: *I recommend this initialization order, which is similar to those of more structured languages and will make your code compatible with most* BASIC *compilers.*

STARTING YOUR LIBRARY

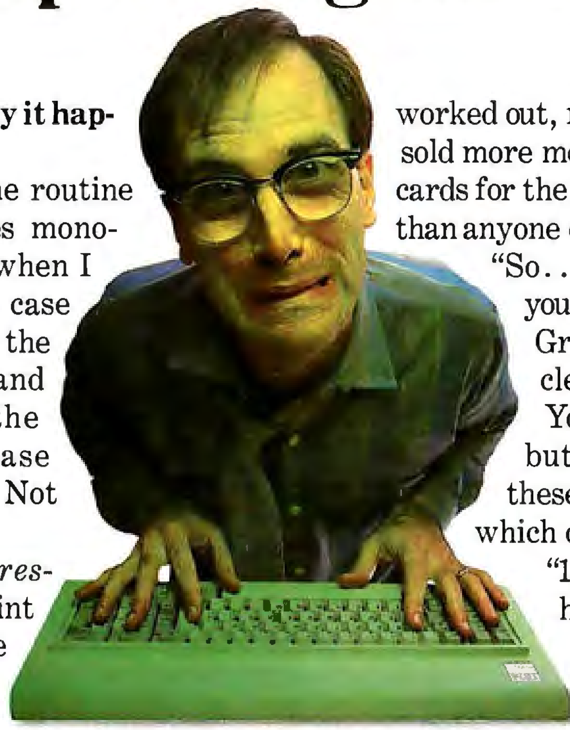
Now is the time to break your anti-documentation habit. To turn these programming conventions to your advantage, take the time to write them down systematically (napkins are out). Having written copies of your line-numbering, subroutine-naming, and variable-naming rules will make them easier to apply. Make copies for everyone who has to work with your code.

Once you have established your programming rules, create a skeleton program to use every time you start development. The first part could establish a simple order for the initialization process, to keep it logical and to ease compilation of your programs. Figure 1 contains a suggested order for this code. The second part of this program could contain a set of remarks describing where everything goes. Line 1000, for instance, might read 1000 REM MAINLINE CODE 1000–9999.

Before adding a routine to your library, ask yourself whether it is useful in many programs and whether it is general enough without losing functionality. If the answer to both questions is "Yes," you probably have a good candidate. Some examples are "Press <Return> to Continue," strip leading and trailing blanks from a string, evaluate a string to see if it's a valid numeric, and so on. More elaborate routines might include a classy menu operating with the cur-

(continued)

If you don't have a Hercules Graphics Card, you could end up looking like this:



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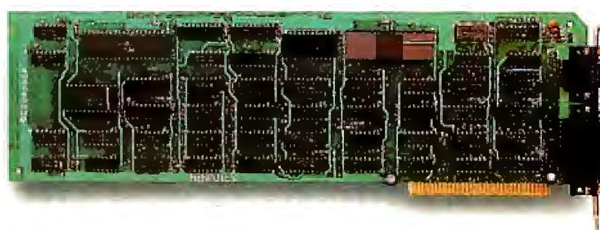

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sor and Return keys.

Use your imagination to put power into your programming. For instance, an input routine that takes a string from the keyboard up to a given number of characters would be even better if it allowed you to program the function keys, permitting messages like "Enter Search Code. <F1> to Go Back. <F2> to Go Forward. <F3> to Quit."

You might create some subroutines with the DEF FN construct, allowing you to define functions similar to those of structured languages. Many versions of BASIC restrict you to a one-line equation, but even this would be handy for a function such as centering messages on the screen.

Document your routines both in the code and on paper. The first three lines of each routine should list the purpose of the routine and both the required and returned variables. The written documentation will allow you to identify subroutines and will explain how to use them correctly. Figure 2 suggests a format for the documentation.

By providing everyday tools, the subroutine library allows you to concentrate on "the good stuff." Those interested in taking the concept a step further can assemble a library of utilities to handle large tasks like file management. It would be a simple matter to decide what variables you need to describe a file and its fields, to write subroutines to read the file descriptors and file into memory, and then to write a program to manage the file. ■

```
   Subroutine Name = CT35510
            Line #s = 35510-35550
            Purpose = Compare a string to a list of valid passwords and return a
                      flag on the result
 Required Variables = Q$ = String to compare to password list
 Returned Variables : QO = Number of the password, or zero if invalid

Notes: This subroutine requires that CT24340 (Input a string from keyboard) be
       present in the same program.
```

Figure 2: *A subroutine documentation form should identify the purpose of the routine, the required and returned variables, the line numbers it occupies, and any other prerequisite subroutines.*

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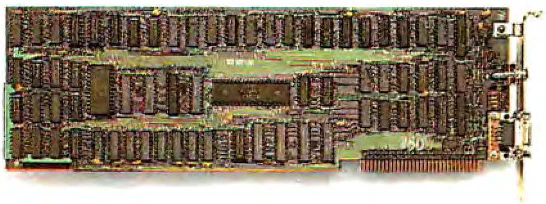

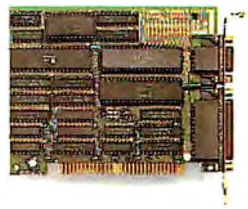

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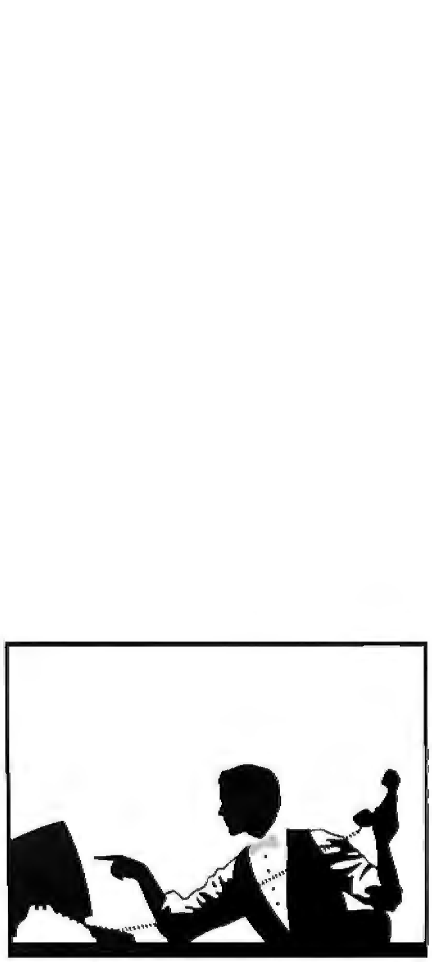

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SUBROUTINE LIBRARIES IN PASCAL

BY BRUCE WEBSTER

A look at some of the facilities available for creating these libraries

ONE PHRASE OFTEN USED in software development—indeed, in almost all aspects of computers—is "reinventing the wheel." It's what you often find yourself forced to do, over and over, with each new software project. Most programs need to perform certain functions, such as user I/O, file access, and specific types of computation. Fortunately, there's one way you can avoid rewriting the same routines: Use subroutine libraries.

A subroutine library is basically a collection of useful, trustworthy routines that can be used by different programs. The advantages of using subroutine libraries are obvious. First, you can break programs into smaller chunks that are more easily edited. Second, you can do the job right once and then never worry about it again. It's as if you are extending the language to meet your needs. Third, all of your programs will behave in predictable ways, at least as far as the library routines are concerned. Each program will carry out the same actions in the same way. This not only means that the user interface can be consistent but also makes it easier for different programs to share resources and information. Fourth, subroutine libraries make group software projects easier. Effort isn't duplicated by each person writing his or her own clear-screen routine.

To create a subroutine library, you gather together those routines that have general use. It makes little sense to create a library of routines so specialized that they will be used in only one program. Then you test the routines thoroughly to make sure that they are bulletproof. A subroutine that can blow up or otherwise produce poor results is a dangerous thing to place in a library. Finally, use the libraries as often as you can, improving and modifying them as errors and deficiencies show up. Amending your programs will give you better libraries and will give your programs a degree of consistency that will make them easy to maintain.

The original definition of Pascal does not contain any provisions for creating subroutine libraries beyond reusing the same routines in each program. However, most microcomputer implementations of Pascal contain at least one of two extensions to aid in using libraries. The simplest involves include files, which are files of subroutines that can be pulled in during compilation. The second uses units to group related definitions and routines into precompiled chunks. Let's take a look at each method.

INCLUDE FILES

Almost every version of Pascal that runs on microcomputers lets the user define include statements that direct the compiler to read and compile the contents of another file before continuing. These statements take the form of a compiler option giving the name of the file to be read. Figure 1 illustrates what a program containing an include statement might look like. When the compiler gets to the statement {$I utility.lib}, it starts reading from the file utility.lib, just as if the

(continued)

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contents of that file were present after the declaration of Indx and Jndx and before the start of the procedure Test1.

The technique is simple enough, but it has some problems. The most common is a conflict between identifiers in the library and identifiers in the program itself. (An identifier is the name given anything—a constant, a data type, a variable, a subroutine, and so on.) For example, if the file utility.lib contained a subroutine named Initialize, then the compiler would generate an error when it found the procedure Initialize in the program TestLibrary. Similar problems might arise if you were using more than one library and both libraries contained routines, variables, or data types with the same identifiers.

One solution to the conflicting identifier problem is to have a unique prefix precede the identifiers in a given library. For instance, all identifiers in utility.lib could start with the characters Util. The library routine Initialize would now become UtilInitialize and would not conflict with any routines in the main program. This has the added advantage of reminding you from which library each routine used in your program came. There are some problems, though. First, typing the extra four characters for each identifier may become tiring after a while. Second, the version of Pascal that you are using has some limit on the number of "significant" characters in an identifier. If this limit is small—around eight characters, say—then the prefix may significantly reduce what you've got to work with.

Suppose you had two library routines, ClearEOL and ClearEOS, which cleared to the end of a line and the end of the screen, respectively. If you add the prefix Util, then the resulting identifiers are identical past the eight-character limit. Even if you reduce the prefix to Ut, you'll still have to shorten the names to something like UtClrEOL and UtClrEOS. This raises the third potential problem: Short identifiers with prefixes may lose some of their mnemonic value. ClearEOS explains itself more clearly than UtClrEOS.

Another solution is to forget about the prefixes and keep a list of all identifiers within each library. You can do this at the start of the library file within comment statements. When you include a particular library file, you would then refer to its list to avoid identifier conflicts within the program using it. This, of course, is not without its drawbacks. It may be tedious to maintain the identifier list, especially for large libraries. And it doesn't solve the problem of similar routines with identical names in different libraries; you have to solve that by choosing distinct names for each.

A less common problem can occur if your library gets big. The compiler may not be able to handle all the additional identifiers, resulting in some sort of symbol-table overflow error during compilation. Or the program may compile fine, but the resulting code file may be too large for the available memory. If you have these problems, there's a good chance that your library contains unused or redundant subroutines. If that's the case, you have several options. First, you can create another library that contains only the routines you need for that specific program. Second, you can break the library up into two or three sublibraries; one could contain the most commonly used routines and the others could hold less-needed functions. Third, you may be able to replace a large group of specialized routines with a few routines that use parameters to choose the specific action. For example, instead of having separate routines to perform different screen actions—clear screen, clear line, clear to end of screen, clear to end of line, and so on—you might have a single routine, DoScreen, that performs all of those actions based on one or two parameters.

Yet another problem involves routines that use a nonstandard data type as a parameter or as a variable within the routines themselves. This might involve a specific example of a predefined data type (such as a set of characters or a string of a certain length), or it might require a user-

```
program TestLibrary;
var
   Indx,Jndx : Integer;

{$I utility.lib} { pull in subroutine library}

procedure Initialize;
begin
.
.
.
end; { of proc Initialize }

procedure DoTest;
begin
.
.
.
end; { of proc DoTest}

begin { main body of program TestLibrary }
   Initialize;
   DoTest
end. { of program TestLibrary }
```

Figure 1: *An illustration of how to include library routines in a Pascal program.*

(continued)

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defined data type, such as a record of some sort. If the compiler allows free mixing of declarations and routines, as do Turbo Pascal and a few other implementations of Pascal, the appropriate declarations can be made as needed. However, if the order of declaration is more strict, then a second include file containing only declarations (constants, data types, and variables) can be created and included at the proper spot (usually before all of the program's declarations).

Libraries based on include files can be used with almost every microcomputer-based Pascal available. However, a number of Pascal implementations have a more sophisticated mechanism for libraries, known as units. Let's take a look at these.

UNITS

The UCSD p-System pioneered the use of unit subroutine libraries. Units can also be found in the Apple and Microsoft (IBM) Pascal implementations. (An even more powerful form, the module, is found in the languages Modula-2 and Ada.) A unit is a subroutine library with two parts. The first part, the interface, is visible to the program using the unit. It contains all the declarations that the program needs to use in that unit. The second part, the implementation, holds the actual code of the routines declared in the interface as well as any other routines and/or declarations needed. Those other routines/declarations are invisible to the program using the unit and can be referenced only by the code found in the implementation. Hence, you can hide how the routines in the units are implemented.

The other great advantage of units is that they are compiled separately from the program. When a unit is compiled, the text of the interface is saved, but the implementation is converted to machine code (or, in the case of the p-System, p-code). The compiled unit is then placed in a library. When you compile a program using that unit, the compiler just reads the interface to get the declarations it needs; the implementation is not recompiled. This can save a lot of time, especially if the unit or units involved are large.

Since the unit isn't recompiled, the question of what happens to the code arises. The answer depends upon the particular implementation, but there are two basic approaches. The first involves code-based units (in Apple Pascal, this is known as a regular unit). The code from such a unit is directly copied from the library into the program's code file, either at compilation time or in a later linking step. This produces a single executable file with all the code needed to run. If several such programs occupy the same disk,

(continued)

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each will have its own copy of the unit(s). In Apple Pascal, all units are code-based (regular) unless otherwise specified.

The second approach uses library-based units (known as intrinsic units in Apple Pascal). Such a unit remains in the library file until needed, which may be when the program using it is started or not until some routine in the unit is actually called. At this time, the unit is loaded into memory. This requires, of course, that the library file containing the unit be available (i.e., on a currently mounted disk and in a known location) when the program is executed. All units in UCSD Pascal (version IV.0 and later) are by default library-based; a utility known as the *Librarian* must be used to make them code-based.

A library-based scheme works best when several programs on the same disk use the same unit(s). One "real-world" example is the computer game SunDog, of which I was the principal programmer. One side of the SunDog disk contains three code files—a demo program, a utility program, and the game itself—along with a library file containing seven intrinsic (library-based) units. All three code files use most of the units in the library. If the units' code had to exist in each program file, an additional 20K to 30K bytes of disk space would be needed—space that just isn't there.

Some of the problems mentioned with include files also exist for units, though usually to a lesser degree. There is the same potential for conflicts between identifiers, and the same solutions are available. Overtaxing the compiler becomes less likely, since only those identifiers absolutely needed by the program need be declared in the interface, and units can give you greater control over the code size of the finished product. The problem of correct data types disappears altogether, since you can freely declare constants, data types, and variables in both the interface and the implementation sections. All in all, units tend to be easier and more flexible to work with.

Units represent a major step forward in subroutine libraries, but additional steps can yet be taken. Two newer, Pascal-derived languages have more powerful features for library creation. Modula-2, designed by Niklaus Wirth as a successor to Pascal, can be thought of loosely as a language using nothing but units, allowing an entire program to consist of separately compiled chunks. Ada, designed by the Department of Defense as a replacement for everything, also has units, which come in several flavors. (Both Modula-2 and

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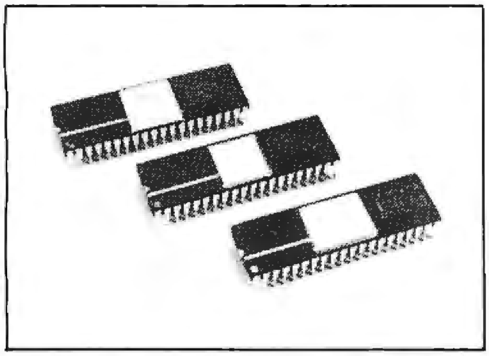

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Unit subroutine libraries allow for information hiding and separate compilation.

Ada started with Pascal, but the two went in opposite directions, Modula-2 toward a simple language definition, Ada toward a complex one. It will be interesting to see which proves to be more successful.)

UPDATING LIBRARIES

Like all other portions of your programs, your libraries will change with time. You will find and fix bugs, add and delete features, and generally improve your libraries. But if they change, what of your programs that use them?

For include files and code-based units, the answer is the same: If you want the changes reflected in your programs, you'll have to recompile the programs. (For code-based units, you'll have to recompile the units first.) As a rule it is probably best that you recompile all programs using a given library after each major change to that library. This maintains consistency and predictability for each of your programs.

Library-based units are another story altogether. If you make changes to the interface portion of a library-based unit, then you must recompile all programs using the library file where that unit resides. Failure to do so could cause the programs to crash or behave erratically. Why? Because the interface that the unit now has and the interface that the program "remembers" are no longer the same. All sorts of problems may arise, due to changes in data structures, differences in variable addresses, and relocations of subroutines.

On the other hand, if you change only the implementation portion, you don't need to recompile anything except the unit itself. This is the real vir-

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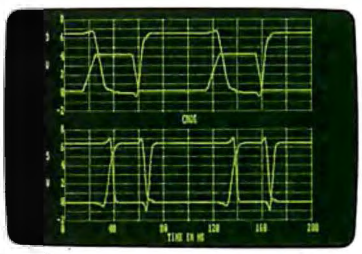

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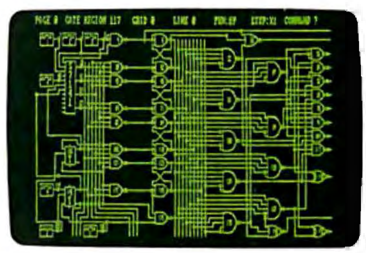

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MICROCAP and MICROLOGIC are available for the Apple II (64k), IBM PC (128k), and HP-150 computers and priced at $475 and $450 respectively. Demo versions are available for $75.

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Inquiry 384

Subroutine libraries maintain consistency between programs.

tue of the "hidden" portion of a library-based unit: You can implement the unit however you want, and the program doesn't care as long as the interface remains the same. This can make a big difference when several large programs use the same library and recompilation might end up taking a few hours.

SAMPLE LIBRARIES

Two actual subroutine libraries are available for downloading from BYTEnet Listings at (617) 861-9774. The first—an include file—is a rather extensive 56K-byte source text library designed for Turbo Pascal running under MS-DOS. I was unable to learn the author of this public-domain file; it was uploaded to my bulletin board, and a copy can be found on the BYTEnet Listings bulletin board. The file is named TURBUTIL.PAS.

The second library, an intrinsic (library-based) unit designed for Apple Pascal, contains a number of routines for low-level manipulation of memory, variables, and pointers. The unit actually has two parts, one in Pascal, the other in 6502 assembly language. The first part must be compiled, the second assembled, and then the two are linked together. These files, too, are posted on BYTEnet Listings and are named LOWLIB.PAS and LOWLIB.ASM, respectively.

CONCLUSIONS

Subroutine libraries save time, maintain consistency between programs, and speed up the entire software-development cycle. Their importance is evident in the large role they play in newer languages, such as Modula-2 and Ada. Take it from someone who spent over two years developing a large (20,000+ lines), complex set of Pascal programs: Libraries can be a real lifesaver. ■

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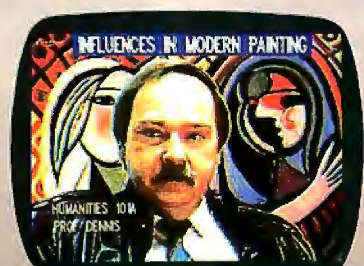

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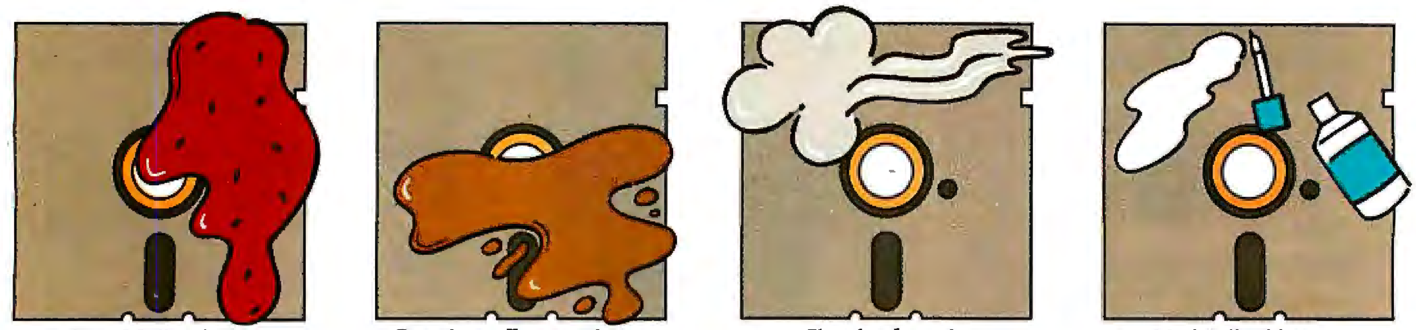
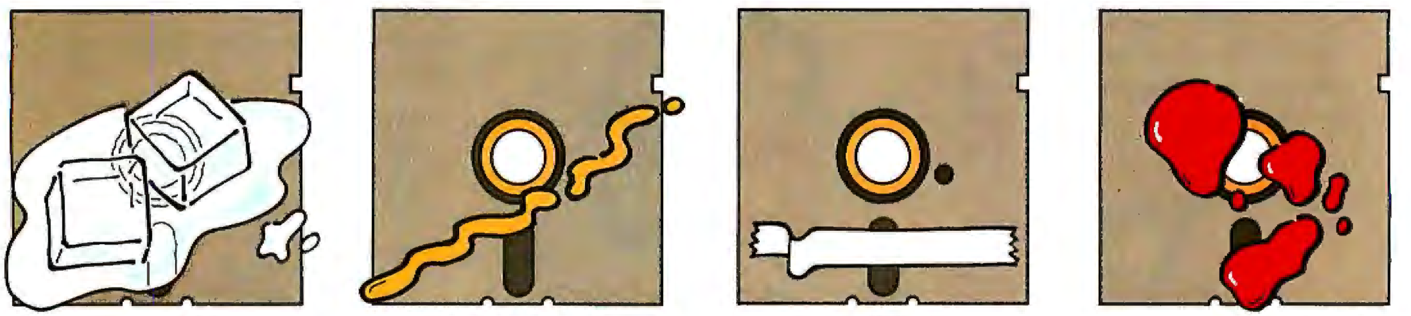
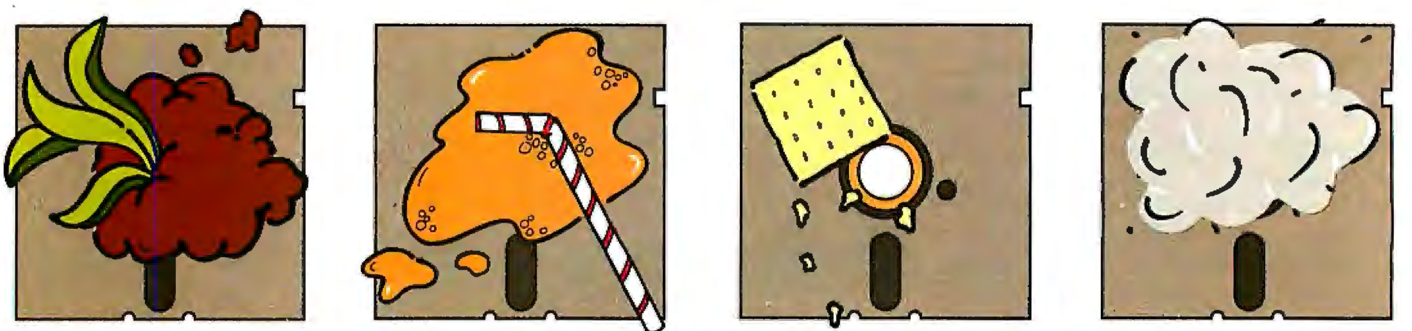


Aunt Molly's jam | Regular coffee, two lumps | Clouds of smoke | Maria's liquid cover



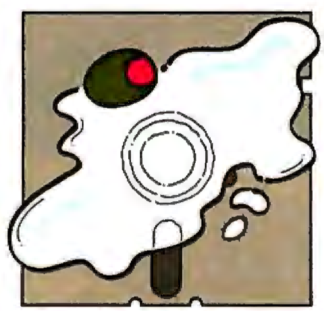
The big chill | Hot dog mustard | Tacky white tape | Lunchcounter ketchup



Potted plant–no pot | Fizzy orange soda | Cracker crumbs | Dust (cough-cough)

One scoop of ice cream | Sudsy soap bubbles | Chocolate fingerprints

d, your dog-eared, your mistreated:

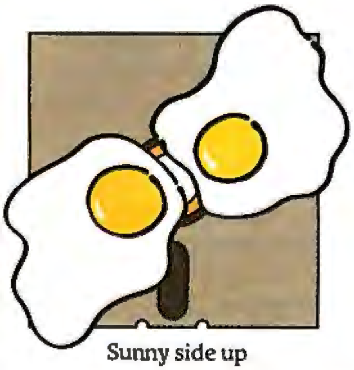


Dry martini, one olive

Boss's cigar ashes

Spilled milk

Dog-eared jacket



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English breakfast tea

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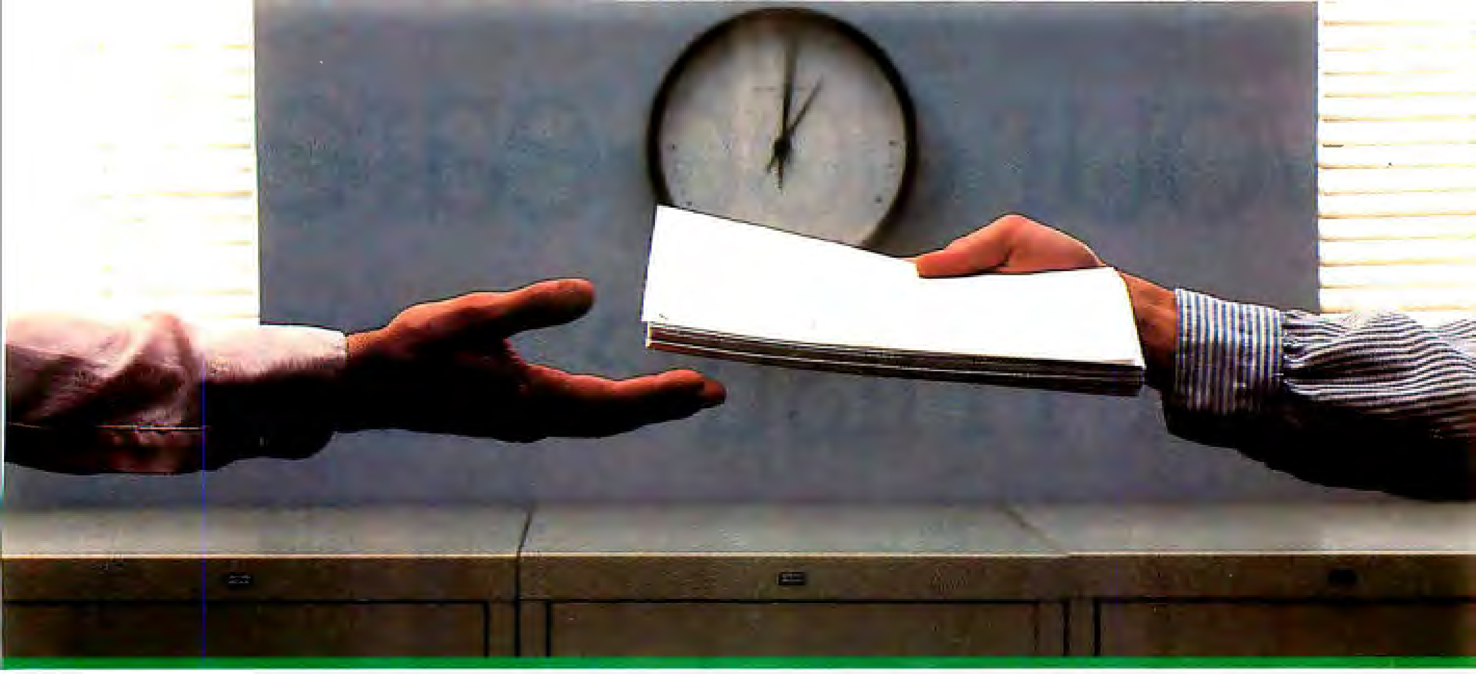

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USING DATA FLOW FOR APPLICATION DEVELOPMENT

BY WAYNE P. STEVENS

This form of linkage results in functions that are easier to understand, develop, and maintain

DATA FLOW IS the technique of connecting functions only by flows of data. Data-flow diagrams, which depict the flows of data among functions, are a natural way to document and design applications. The resulting applications are much easier to develop, test, and maintain, and the various functions are easier to reuse than those connected in other ways.

The terms "data flow" and "data-flow diagrams" have gained popularity in the last 5 to 10 years. However, the concepts they represent have been used in the computer industry since its inception. Job steps are connected to each other by flows of data through the files and databases they reference. And systems flowcharts, the diagrams that depict the flows of data among job steps, are not flowcharts in the normal sense, but rather charts of data flow—data-flow diagrams (see figure 1).

KINDS OF CONNECTIONS

Almost all connections between functions in computer applications include the sharing of data. With data flow, only one function can access the data at a time. Connections between functions can also include passing control or sharing a common data area, neither of which involves data flow. The following are various ways in which one function in an application can relate to another:

- follow or branch to another function in the same program
- do a source include or reference a macro
- perform or branch and link to another function in the same program
- call another function
- pass only data to another function

When functions follow each other in the same program, the computer automatically executes the second one after executing the first. The connection consists of passing control from the first to the second. While they are also connected by any variables they can both reference, there is no *flow* of data. The same is true if one function branches to the other.

Source includes, which bring a referenced function into the program at compile time, enable multiple programs to include a particular function. However, once included, its connection to the functions around it is the same as above. It is connected by passed control and shared common data rather than by data flow.

A perform or branch and link to a function within the same program involves a more reusable routine. However, the connection between the functions is still one of passed control and shared common data.

When you package functions into separate modules, usually with a separate compile, you can pass data between them. A called function receives data from its caller, does its job, and can pass data back to its caller. The data passed is accessed only by the called routine until it returns control to the caller. This passing of control makes the functions more dependent on each other than those connected *only* by data flow.

(continued)

Wayne P. Stevens (IBM Corporation, 1241 East Main St., Stamford, CT 06904) works in IBM's Information Programming Services doing planning for future development tools. He has an M.S. in electrical engineering from MIT.

Functions connected by data flow are not dependent on adjacent functions. They simply do their jobs, sending and receiving data as available. This independence is what makes it easier to develop and maintain data-flow-connected functions.

Connections that pass control require that the functions be on the same computer at the same time, and many require that the functions be written in the same language.

In contrast, functions connected only by data flow, such as job steps, need not be on the same computer at the same time, or ever. For example, an independent job step can execute as long as its input data is available and it can dispose of its output data. It is not dependent on whether the previous step is or was ever on the same machine, or even if it was accomplished on any machine—it may be a manual step. The only constraint is that the passed data be available.

Actually, most connections between functions are data flow. Job steps are data-flow-connected; so are commands in on-line development systems. Consider the commands that read in a file, sort it, and print. These commands operate independently and can be used to process the data

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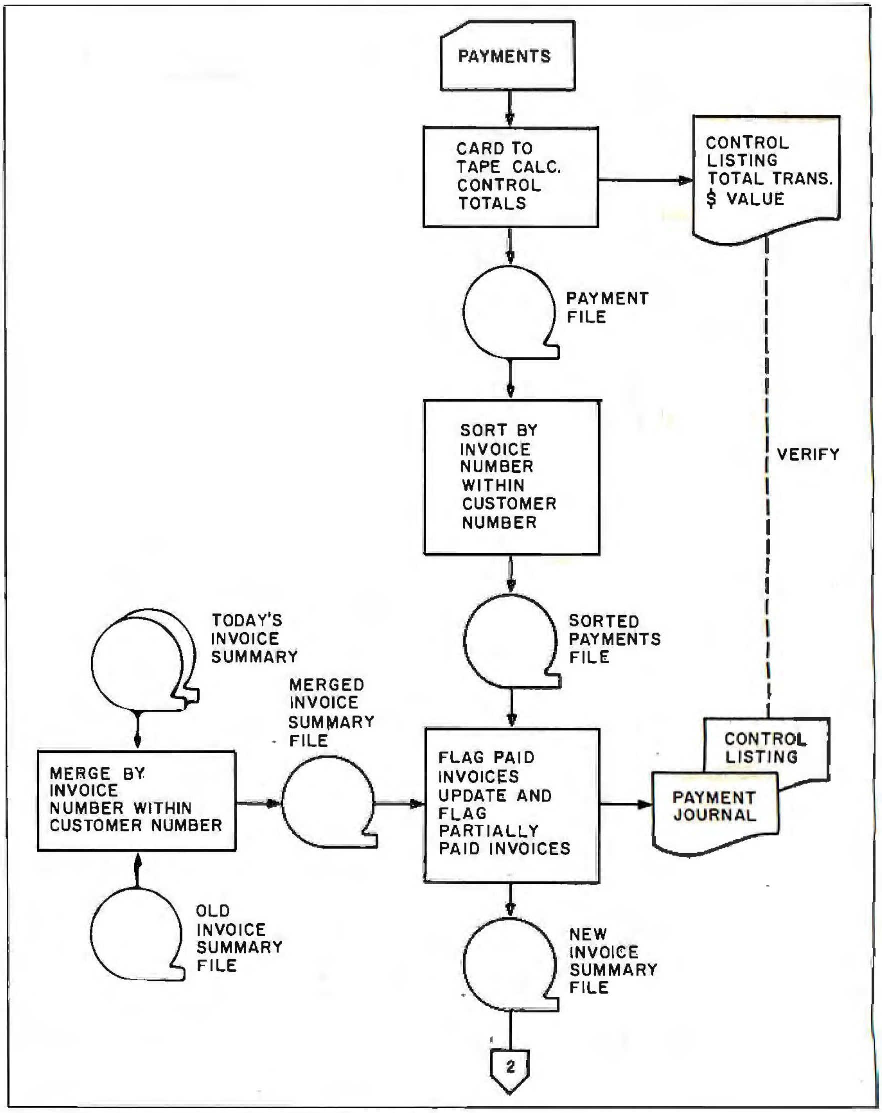

Figure 1: A *systems flowchart—also a data-flow diagram.*

the previous command produced as output, that is, read, sort, and print the same file. Similarly, data flow connects the commands or transactions in on-line applications. The interfaces between computer applications and their users are also based on data flow. And functions in distributed applications operate independently, passing data to one another.

The various commands within text editors are also data-flow-connected. They do not call each other, they just act on the data in the file being edited. You can execute them in any order. And the text editors are data-flow-connected to the text processors that format and print the data. The UNIX shell can connect independent modules with data flow via *pipes*. IBM PC-DOS uses a similar technique to let programs pass data to generalized I/O (input/output) routines.

Using Data Flow

You and I use data flow every time we communicate with someone else, pass a form or letter along, or enter data into a computer. In fact, it is hard to avoid using data flow. Let's apply this inherent knowledge to the process of developing applications.

The basic tool for utilizing data flow is the data-flow diagram. This is similar to a systems flowchart but with slightly different symbols. Data-flow diagrams do not indicate the medium on which the data will be passed (tape, disk, printer, etc.). Data-flow diagrams using the Gaine and Sarson notation (see reference 1) include five symbols (see figure 2). Functions are represented by rectangles, and flows of data among them by arrows. Files and databases are represented by a U-shaped symbol on its side (or just parallel lines). Squares represent external entities that are sources or targets for data (e.g., user departments). Small circles are used for off-page connectors. And typically, data flows from left to right in the diagrams.

One advantage of this notation is its ability to include both the limited system name for a function or file and a longer, descriptive label. There are other notations (see figures 3 and 4), but the meaning is the same. They all show functions connected by flows of data to other functions, to files, and to external entities.

The key to developing data-flow diagrams that are easy to work with is to keep them to 7 ± 2 functions. Our short-term memory can handle only 7 ± 2 *chunks* easily and accurately. (This is why, for example, local telephone numbers were limited to 7 digits.) An 8½- by 11-inch piece of paper also contains approximately the amount of information we can easily handle at one time. It is no accident that data-flow diagrams kept to 7 ± 2 functions will fit on a single page.

You can represent larger numbers of functions without exceeding 7 ± 2 functions in any one diagram by using hierarchies (see figure 5). Any function on a data-flow diagram can represent

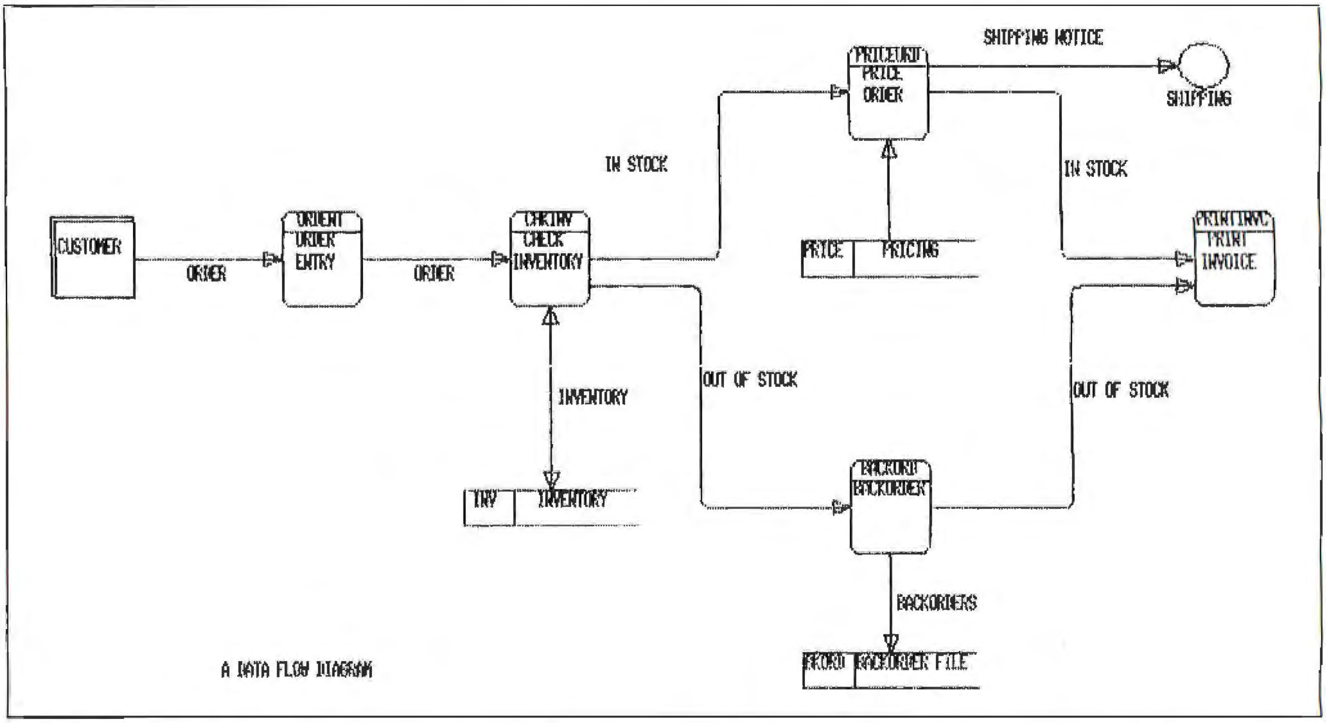

Figure 2: A *data-flow diagram. Rectangles represent functions (notice that each rectangle contains a short description of the function and, above it, the name of the computer module that implements it), arrows represent flows of data, squares represent external sources or destinations of the data, and sideways Us represent files or databases. This figure was drawn by* EXCELERATOR, *a program that manages and manipulates data-flow diagrams.*

a lower-level data-flow diagram, and so on. The process stops when you are going to implement a function via a different technique, for example, as an individual module or as a hierarchy of called modules. It is not necessary to decompose all the functions at any given level in the hierarchy. Any one or more may be decomposed, while others in the same diagram can be bottom-level modules.

In hierarchies of data-flow diagrams, a function's lowest-level diagram must show the data flows into and out of it (see figure 5). However, higher-level diagrams can repeat files and external entities shown on a lower-level diagram or not, as desired. In fact, often the highest-level diagrams only show the major flows of data. The files are relegated to the lower-level diagrams. It is helpful, though, to show files shared between two functions on the highest-level diagram that contains the two functions.

How do you design the flows of data within a single diagram? If you are documenting an existing manual or automated application, you can do the following:

- Record existing functions and the data that flows among them.
- Include existing files and external sources and targets for data.
- Name each function, flow of data, file, database, and external entity. Note that functions *do* something to the data, and thus typically their descriptions start with a verb (e.g., READ THE SCREEN, EDIT THE DATA). Flows of data are objects. Their descriptions are usually nouns, often qualified by an adjective (e.g., MASTER RECORD, FORMATTED RESULTS, TRANSACTION). Files and databases typically have names that indicate their contents (e.g., PAYROLL, ORDERS, TRANSACTION LOG). An external entity can be a manual step, another application, input data, or an output report. Its name usually reflects the name of the user, application, data, or report.

Some approaches and tips that can help when you design a new data-flow

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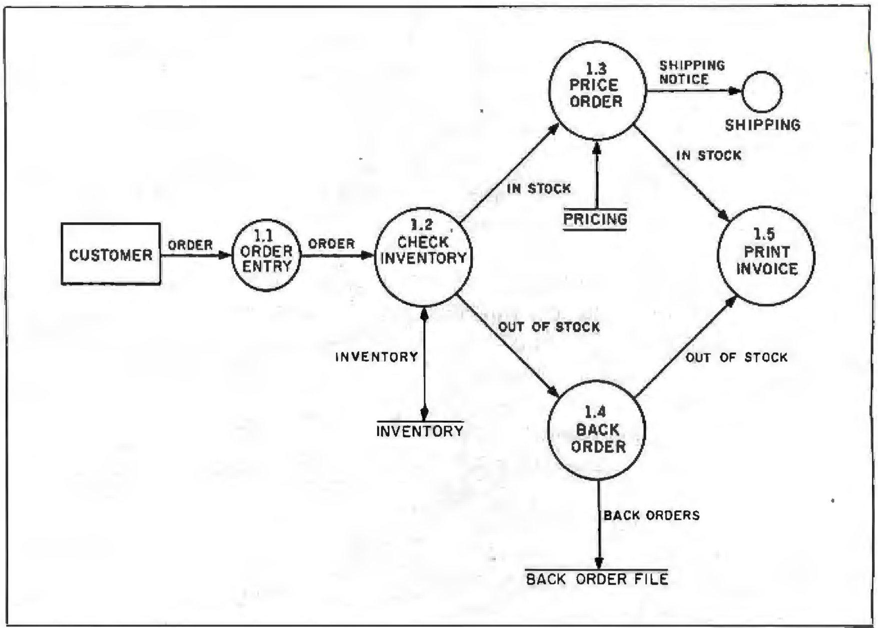

Figure 3: *A Yourdon data-flow diagram. This diagram is equivalent to figure 2 but is in the notation used by Yourdon Inc.*

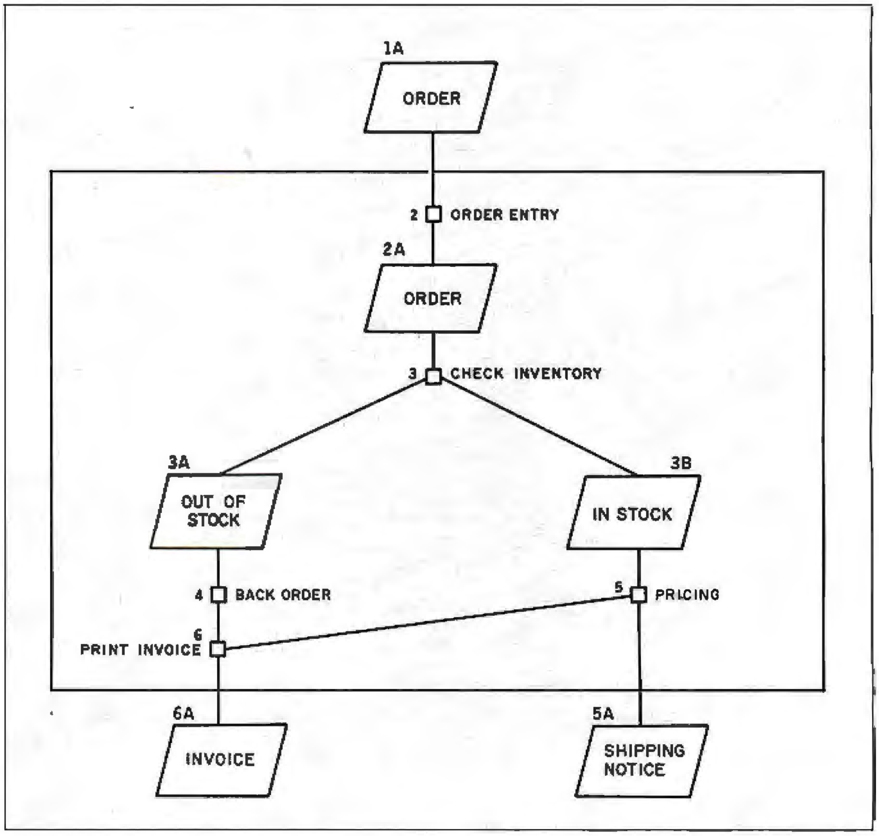

Figure 4: *A data-flow diagram in Swedish notation. This diagram is equivalent to figures 2 and 3 but uses a different notation. Note: The large boxes are forms and the small ones are functions.*

diagram are the following:

- When designing flows between new functions, do it as if the functions were people at desks who send forms to each other.
- Group data that logically goes together into forms (similar to designing a flat-file record).
- Do *not* try to send the minimum data to each function, as in structured design (see reference 2). Sending subsets of data is only applicable when each function must return its data to its caller. In data-flow diagrams, a function typically sends data forward to another function rather than back to the function that sent its data. So, unless all the data is sent forward together, it is usually necessary to reassemble it later in the diagram, and this is a complex and unnecessary task.
- Since a big advantage of data-flow connections is easy reuse, take advantage of existing usable functions. Of course, using an existing function determines the data flows between it and adjacent functions.
- Draw data-flow diagrams to describe either existing and/or new physical systems. Drawing old and new *logical* systems seems to be difficult and creates unnecessary steps.

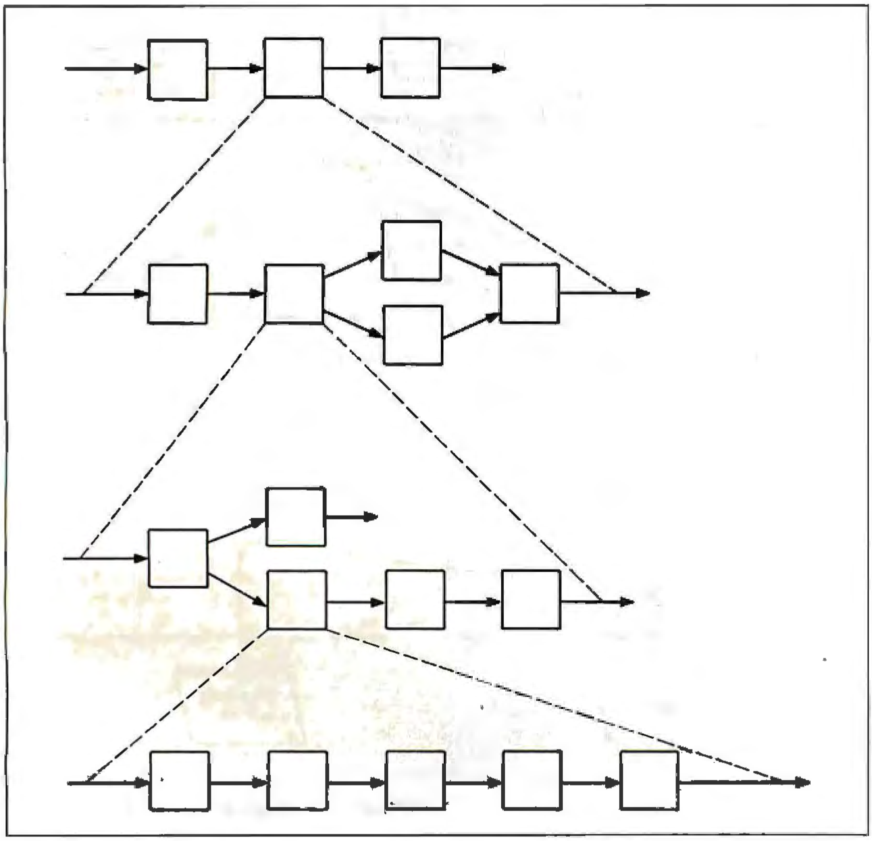

Figure 5: *Skeleton hierarchies of data-flow diagrams.*

THE BENEFITS OF DATA FLOW

Connecting functions only by flows of data has several advantages.

- It is a consistent, natural way to view connections between functions.
- The resulting applications are simpler to understand, develop, and maintain.
- Testing and making changes are both much easier.
- Such functions are easier to reuse than functions connected in other ways.

Developing applications involves viewing them at several phases in the development process. First, there are the manual applications that are being automated or to which an automated application must interface. You can describe manual applications with data-flow diagrams. In fact, data-flow diagrams may be the best way to picture many manual applications so that people not trained in data processing can easily understand and relate to them.

The development phases include application identification, analysis and design, implementation, and maintenance. The purpose of application identification is to determine the major functions to be performed and the flows of data among them. This is the information that data-flow diagrams depict. Structured analysis is the technique of using data-flow diagrams for the analysis and design phase. Most of the advantages of structured techniques come from the ability to consider part of the application relatively independently of the rest. The segmentation of structured programming, the modules of structured design, and the functions of HIPO (hierarchy plus input, process, output) provide the pieces we can consider separately. Hierarchies provide these advantages for data-flow diagrams.

Functions must share data in order to be part of the same application. Data-flow diagrams can picture the flows between many of the functions during implementation, for example, jobs, job steps, and on-line commands. And you can use the same diagrams for maintenance that you used for design and implementation. Often, applications in these various phases are seen differently. This requires translating between the different views as development proceeds, which adds complexity and introduces errors. However, you can use the data-flow view of an application in all phases of the development cycle.

There are significant advantages to using data flow as a consistent application view. First, you can include both manual and automated functions in the same diagram. Second,

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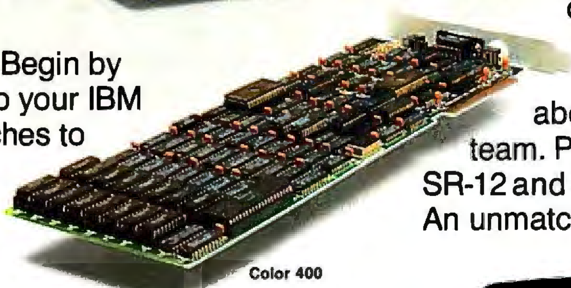

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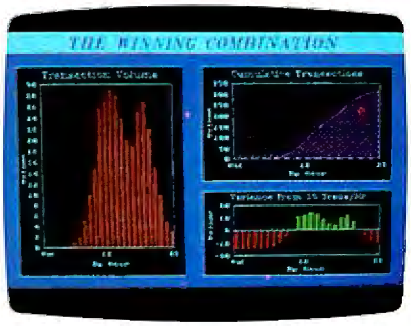

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you can automate various functions within a diagram at different times without having to modify it. And third, cycling back for corrections is much easier since it doesn't require translating between various different application views.

Data flow is the natural way to connect functions because that is how people interact with each other. We go about our business independently until we exchange information with others by talking with them, passing along forms, etc. In the same way, application functions connected by data flow operate independently and interact with each other by exchanging data.

Data-flow diagrams can describe applications from the simplest to the most complex, whether on-line, batch, or distributed. With data flow, on-line applications differ from batch only by doing input and output to terminals rather than to readers and printers. Distributed applications are naturally data flow since they consist of functions that execute independently and send data to each other.

The complexity of developing applications rises exponentially as their size increases. For example, a two-page program is more than twice as hard to develop as a one-page program. Not only must each of the two pages be developed, but the connections between the two pages must also be handled, especially if different people developed the two pages. You can reduce this complexity if you can divide the application into parts that can be developed relatively independently. The more independent the pieces are, the simpler the development.

Hierarchies of data-flow diagrams have a significant advantage over call hierarchies. With data-flow diagrams, you can consider each level separately. But call hierarchies make sense only if two or three levels are viewed together. You must consider at least two levels of a call hierarchy in order to even see the relationships between functions. Data-flow connections, on the other hand, are between functions on the same level. Thus, you can consider each level of a data-flow diagram independently, making them easier to work with and understand.

The most easily reusable functions are those you can use without having to understand their internals. It is easier to reuse modules that have been separately compiled so that you don't have to synchronize the local variables and labels with those of the including module. However, modules in a call hierarchy have the definition of the hierarchy imbedded within them. Thus, it is difficult to reuse any but the bottom-level modules in another hierarchy without recoding them; obviously, recoding requires

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RECOMMENDATIONS

1. Use data-flow diagrams to document all types of applications throughout the development process.
2. Obtain reference books on data flow (see references 1 and 3).
3. Keep data-flow diagrams to 7 ± 2 functions by constructing hierarchies.
4. Decompose functions to as small a module as your environment allows. If this is larger than one page of specifications (e.g., coding or generator input), implement the remainder using call hierarchies (see reference 2).
5. Design flows of data as though the functions were being done manually and connected by flows of forms.
6. Obtain a good tool to help draw the diagrams, and one that captures the information for use later in the development cycle.

knowledge of their internals. Data-flow-connected modules don't even know the adjacent modules exist. This makes them more easily reusable.

AVAILABLE RESOURCES

Designers of data-flow diagrams have, up to now, struggled with several complications we no longer face, including lack of education and documentation and lack of adequate automated tools to help draw the diagrams. Today there are companies and consultants who teach data-flow concepts; you will probably find people in your own company who already use data flow. Good reference books include those by DeMarco (generally considered to be the father of structured analysis—see reference 3) and Gaine and Sarson (reference 1). The text listed as reference 4 provides a description of the advantages of data-flow mechanisms at the module level.

Several good products have emerged in the past year or so that automate the process of drawing and maintaining data-flow diagrams. Various personal computer software packages are adequate for drawing and maintaining data-flow diagrams. I recommend you look for several characteristics in such a tool. It should let you enter and change the diagram easily. It should enable you to construct hierarchies of data-flow diagrams and, preferably, to move between these hierarchies while drawing them. It should allow you to enter definitions of functions and data into a dictionary for later use in the development process. And it should allow for selective input and output of such specifications so they can be shared with other people and used by other tools. One example of such a tool is EXCELERATOR, available from Index Technology Corp. (Cambridge, Massachusetts) for $8400.

SUMMARY

Data-flow connections are the most prevalent connection between functions in computer applications. They exist among job steps, on-line transactions, manual processes, jobs in the same application, and distributed applications. You can describe them with data-flow diagrams (which are similar to systems flowcharts). These diagrams provide a natural way to describe applications. You can use them throughout the development process and for all sizes and types of applications. Since we naturally interface with each other in a data-flow manner, common skills are used to draw the diagrams. And applications constructed from data-flow-connected functions are easier to understand, develop, and maintain. ■

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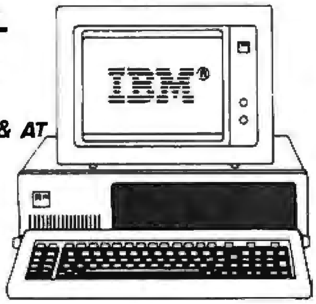

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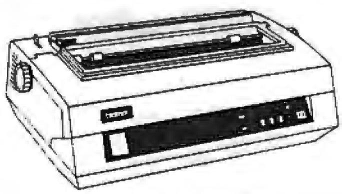

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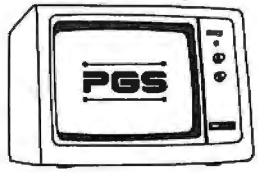

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DEBUGGING TECHNIQUES

BY GREGG WILLIAMS

There are no magic formulas but there are tools, and the most powerful one is your own brain

NOBODY LIKES TO debug a program. It is tedious, time-consuming, and often maddening. Debugging your own code is bad enough, but debugging someone else's (often someone who is no longer available for questions) can be argued to be cruel and unusual punishment—nevertheless, it has to be done.

This article is a compilation of debugging techniques gathered from my personal experiences programming in a commercial environment, the experiences of other BYTE editors and programmers, and published texts. The news is not good: There are no magic techniques; debugging is accomplished mostly through the sustained use of a perceptive, disciplined mind. Still, you will find the techniques described here useful if you aren't already acquainted with them.

Although I have tried to make the article as general as possible, I'll assume that you are running a high-level language—BASIC, probably—and that you don't have access to any sophisticated debugging tools.

BEFORE DEBUGGING

If you are fortunate enough to be writing your own code, you can make the debugging process easier. Here are some suggestions:

- Use structured programming. This does not mean that you have to give up GOTO statements, only that you not misuse them. You can use structured programming techniques with *any* computer language, not just so-called structured languages like Pascal and Modula-2. Structured programming is a discipline; adopting it will improve your programs more than anything else mentioned in this article. If you do not know much about it, you can find plenty of books and articles on the subject.
- Design your programs modularly. Consider the program diagramed in figure 1 (each block is a module of code). If the program is considered as a monolithic whole, you will have to test the 30 (3 × 2 × 5) separate paths the program can go through to debug it properly. If you debug the modules separately, you must test 11 things—each of the 10 modules plus the containing program that glues them together.
- Program for clarity and optimize later. Write your code to be readable, not clever—the performance gain from terse code is usually not worth the extra programming time that the code will consume over the life of the program. If you *must* optimize the program, get it working first, then examine it to determine where optimization will be the most effective.
- Avoid—or at least isolate and document—system-dependent code. This is more important if you are writing programs at work (where you may switch computers someday), but it never hurts to call attention to program behavior that is not determined solely by the code itself.
- Document your program well, using both program comments and printed documentation.

DEBUGGING THEORY

Too many of us go about debugging haphazardly and so spend more time at it than we need to. To be effective, debugging must be led by the "perceptive, disciplined mind" mentioned

(continued)

Gregg Williams is a senior technical editor at BYTE *whose programming credentials include an* M.S. *in computer science and several years programming* COBOL, BASIC, *and* APL. *He can be reached at* POB 372, *Hancock,* NH 03449.

above. But what discipline do we follow?

My experience leads me to say that debugging is best driven by a combination of the scientific method and hunch playing. The scientific method, which is the cornerstone of all scientific discovery, can be modified for debugging and described as follows:

1. Describe the error.
2. Gather data about the program's behavior.
3. Guess what caused the error (consistent with all the data gathered so far) and take steps to fix it.
4. Test your guess. (Does the program now work?)
5. If your guess does not fix the error, go to step 2; otherwise, you have just found and fixed the error.

Actually, confirming the error and fixing it may be two separate operations. You may confirm that a certain variable is causing the error by verifying that the variable contains an incorrect value at a certain point; in this case, fixing the error is a separate step.

In the scientific method, you are trying to find a hypothesis that fits all the facts. In debugging, your hypothesis is "x is causing this error," and you test this hypothesis by correcting x. If the error disappears, your hypothesis is correct and you have found and corrected the error. If it does not (and this is very important), you now have another piece of data—that is, "x does not cause this error"—and your next hypothesis must be consistent with this added data.

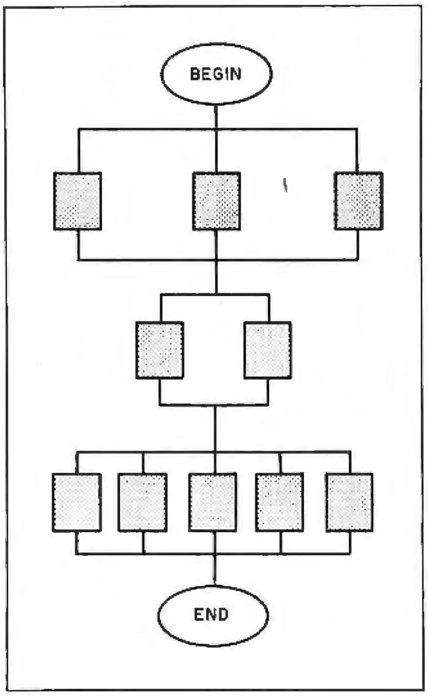

Figure 1: A *modular program diagram. To test the program as a whole, you would have to test* 30 (3 × 2 × 5) *different paths.*

ASSUMPTIONS IN DEBUGGING

An error (also called a bug) can come from several sources. It may be caused by errors in the syntax of the program, er ors of logic that cause the computer to malfunction, errors of logic that cause the computer to give plausible but incorrect answers, and errors generated outside the program (by the software or hardware used).

Because of this, you must be careful not to eliminate any area that might contain the source of the error. On the other hand, computer hardware is *not* at fault 99.9 percent of the time, and system software (the operating system, language, and utilities) is not at fault 99 percent of the time. I have summarized these realities in the following three assumptions:

1. The computer is never at fault.
2. The system software is almost never at fault.
3. Everything except this rule is suspect (even assumptions 1 and 2, but at different levels of probability).

In other words, never rule out hardware or system software errors, but pursue these hypotheses only after extensive testing has failed to find all the more probable causes of error.

Table 1: *An entry from my debugging log. Such entries may, in the future, help you debug later programs.*

Environment: While debugging a Microsoft (binary version) BASIC 2.0 program on a 128K-byte Macintosh computer, I keep getting a "Type Mismatch" error on the execution of the SUB (subprogram) "get.field(new.item$,1)" (get.field is defined as "SUB get.field(msg.string$,button.pressed) STATIC"); new.item$ can have any value (it goes in as a blank string), and 1 is a valid value for the second parameter (which can be either 1 or 2).

Debugging: I get the same error with any other value in the second place (2, 3, etc.). The program works fine when I assign the value to a variable and use a variable in the call, but I check the variable and determine that its value hasn't somehow changed. The program also works if I use "3/3" but not if I use "1 + 0". Why?

Cause: It turns out that "1" is of type "integer" and "button.pressed" is of type "single-precision real" in this version of BASIC. This caused the type mismatch when I used the constant but not when I used the variable. I suspect that "3/3" evaluates as a single-precision constant but that "1 + 0" remains an integer result.

Solution(s): (1) Pass values only through variables. (2) Change the dummy variable to an integer using DEFINT or by appending "%" to it (i.e., "button.pressed%"). (3) Change the constant to a single-precision real by typing it as "1.0" or "1!".

In the future: Be aware of variable types in Mac MBASIC 2.0.

DEBUGGING PRACTICE

Here are some collected notes on debugging:

- Keep an interactive, written record of your debugging. The form is irrelevant, but it should include a statement of the error being sought; hypotheses, their tests, and the results; unanswered questions; and whatever else comes to mind. (Table 1 shows an entry from my debugging log.)
- Equally important, always save a copy of your p ogram before you add the latest "fix." If the fix makes things worse, don't try to undo the damage. Instead, revert to the previous version. You might also profit from keeping versions of the program at different stages of debugging.
- When you are reading a printed

listing, make sure it is current. To be safe, print a new listing periodically.

- Test multiple variations of the program, each of which changes *one* thing about it, and analyze the results carefully. The effects can then be attributed to the change itself. This may give you a clue to the nature of the error you are trying to correct.
- Learn from negative results—even tests that don't seem to tell you anything actually do.
- Don't ignore the possibility of rewriting the code rather than debugging it; this is especially valid when enough previous errors have been patched that the program is more patches than code. If the code is in bad enough shape, you may be able to rewrite it faster than you can debug it, and the resulting code will be easier to read and maintain.
- Be aware of the particular problems of the language being used (for example, inadvertently duplicated variable names in BASIC, misuse of pointers in C, the peculiar behavior of a register, flag, or instruction in assembly language).
- Watch out for often-confused symbols (the letters capital I, capital O, lowercase l, the numerals 0 and 1) and missing spaces and carriage returns.
- Develop literal (for reading code) and speculative (for hypothesizing causes) modes of thought and learn how to strengthen each and switch between the two.

DEBUGGING TECHNIQUES

I have divided these techniques into three broad categories: techniques for eliminating visible errors, finding hidden errors and verifying program correctness, and anticipating future errors. The sections that follow describe techniques that fall into these categories. The three categories begin with the headings "Indirect Methods," "Testing vs. Debugging," and "Preventive Debugging," respectively.

INDIRECT METHODS

Many program errors are quite visible—you know something's wrong because you can see it—but their causes are not. One way to find the cause of an error is to *play computer*; in other words, with program listing and scratch paper in hand, you execute the program manually, keeping track of variable values on paper. This method is time-consuming and tedious, but it often catches subtle errors. However, you must know exactly what each program statement does, and you must be very literal in simulating code execution; otherwise, you will keep making the mistake that is the cause of the bug. (A variant of playing computer is explaining the error to someone else. Even if the other person doesn't know much about computers and can't offer a solution, you often discover the factor you've overlooked.)

You can sometimes find an error when you look at the structured pseudocode, flowchart, or whatever similar documentation you have. Because this documentation is at a higher level than actual program code, it may be easier for you to see a logical error in the design of the program.

Finally, browse through your debugging notebook for ideas; you may realize that your current problem is similar to an error you have already fixed.

PRINT STATEMENTS

PRINT statements are probably the most often used debugging tool, but they are not often used effectively. They can be used to gather data about the program's behavior (i.e., "Is this variable doing anything unusual?"), to test a hypothesis ("Is this variable giving the incorrect value *x*?"), or to confirm the correct operation of the program ("Is this variable now giving the correct value *y*?").

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PRINT statements are most valuable when they are used effectively. Three factors are critical: *what* you are using the PRINT statement for, *what variables* are being examined, and *where* they are being examined. If you misjudge either of the last two factors, you will be gathering data that wastes your time and gives you no insight into your situation.

PRINT statements can be either unconditional, like this:

```
6808 PRINT "At 6808, X = ";X;
   " A$ = ";A$
```

or conditional:

```
6808 IF A$ = "" THEN PRINT
   "At 6808, A$ empty, X = ";X
```

The unconditional PRINT statement is the simplest to insert into a program, but it may cause a distracting number of relatively useless diagnostic statements—if, for example, line 6808 is in the middle of a triple-nested DO loop. The conditional PRINT statement is more useful because it displays itself only when some significant condition occurs (in the second example above, the programmer knows that A$ is of interest only if it is empty).

Also remember that PRINT statements (and the print-oriented debugging techniques mentioned below) can go to at least three devices: screen, printer, or disk file. Video output gives you an interactive display of the relationship between cause (the printed variable's value) and effect (the effect on the program), but it may destroy the normal output to the screen. Printed output gives you a printed record that can be studied later along with the program code. Disk output is useful when you *must* generate a lot of PRINT statements; it is faster than printed output and can be searched and examined quickly using a word processor. It is your responsibility to choose the technique best suited to a given situation.

You will sometimes have a visible error and no idea of its cause. You can then use PRINT statements in a "divide and conquer" scheme. To do this, find a point in the program where things are okay and another one where they are not. Then repeatedly place a PRINT statement between the two and decide which half contains the error. Eventually, you will have isolated the error to a small enough area that the number of possible causes is also small. (Here, you are advised to consider—and apply—Sherlock Holmes's famous statement, "When you have eliminated the impossible, whatever remains, *however improbable*, must be the truth.")

BREAKPOINTS

If you are able to stop your program, examine and change the values of variables, and resume execution at the point you stopped the program, you have *breakpoint* capability. You can do this in assembly language if you run your program along with some kind of debugger/monitor program. In most Microsoft BASICs, you can stop a program with a Control-C from the keyboard or a STOP from the program, then examine and even change variable values and resume by executing the CONT (continue) statement. In many cases, you will want to print out the values of some variables before you stop the program.

Breakpoints let you debug your program interactively. They have most of the characteristics of PRINT statements: They can be executed conditionally or unconditionally; they can be used to gather data for your next debugging guess, to confirm a guess, and to pinpoint the location of an error; and their effectiveness depends on the forethought used in planning the breakpoint and evaluating its results. Many programmers use breakpoints as a mechanism through which to do an open-ended exploration of the program in the hope that they will

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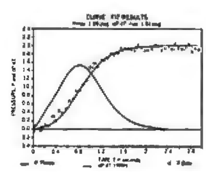

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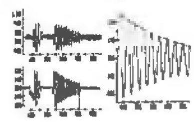

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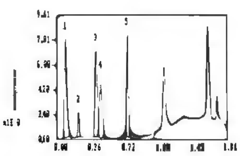

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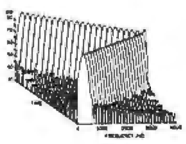

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stumble over some clue. This is usually unproductive and should be attempted only when you are at a complete loss as to what to do next.

Through breakpoints, you usually have access to the *state* of the machine—that is, all the data needed to completely recreate the computer's configuration at a given moment—even though you may not make use of it. Because of this, a breakpoint is a measure halfway between a PRINT statement and a snapshot, discussed below. Breakpoints and snapshots differ in two ways: Breakpoints are not always available, and snapshots are harder to use but more thorough.

SNAPSHOTS

A *snapshot* is a printed record of the state of the machine. Because a snapshot *completely* describes the program at the point it is taken, it is the final authority on what's "inside" the program at that instant. This is both good and bad—good because you have all the information you could possibly need, bad because you may not spot the data you need in the sea of data you have. A snapshot is also *printed* documentation of the program's state at a given point; because it can be referred to later, it may save you from having to recreate the situation. (In the darker moments of debugging, when your current results seem to contradict your memory of past results, a snapshot is often welcome verification that you are *not* going crazy.)

Snapshots are usually not used interactively (but they can be if you want to wait for the printout). They are usually used with a fresh listing of the program to hunt for clues about the cause of the error. Because snapshots are very long, they are also inconvenient to set up and take a long time to print out (in some cases, you might consider writing them to disk). For all these reasons, snapshots are usually used as a last resort.

For a high-level language snapshot, make a list of all the system and program variables (a cross-referencing program will help in this); then write a subroutine that prints these (preferably in alphabetic order). To use the snapshot, add a line to your program that prints some reference to itself and calls the snapshot subroutine—for example, in BASIC:

```
3305 PRINT "Snapshot at end of
       input routine":GOSUB 9950
```

When debugging assembly-language programs, capture the contents of *all* memory and record the address of the snapshot and the values of the processor's flags and registers. If you can, store the contents of memory as a formatted dump that shows bytes as both hexadecimal numbers and ASCII (American Standard Code for Information Interchange) characters. You can make your snapshot shorter by not capturing certain areas (those containing video-display memory or system ROMs—read-only memories), but always keep in mind that you have left something out—occasionally, it may be what you need to find the error!

TESTING VS. DEBUGGING

Before I can talk about finding hidden errors and verifying program correctness, I need to point out the difference between debugging and testing. *Debugging* is the process of correcting all the errors you find in a program; it ends when you can find no more bugs. *Testing* is a more deliberate, methodical process that attempts to prove that a program's behavior is correct in all cases; it ends after you have devised tests that reasonably justify the claim, applied them (with positive results), and documented your methods and results for current and future critics.

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Inquiry 3

errors in your program—it's ready to go, right? Wrong. You've corrected all the *visible* errors; the program's been debugged, but it hasn't been tested. You can never be sure that a program is completely error-free, but you can test it to be reasonably certain that it works correctly. *Forcing* and *checking with sample data* are two methods used to find hidden bugs and verify program correctness.

Forcing involves simplifying the program so that the relationship between input and output is known or is easily calculated; then you can exercise the program with test data and compare the predicted output with the actual output. In some cases, you can enter a set of data that is considerably simpler than other sets might be (for example, in a statistical-analysis package, you might enter 3 data items instead of 10 or 100). In other cases, you may need to change the program so that, at some point, it uses constant values instead of calculated values in some places.

This second method is the type of forcing you'll use most often (this is a variation of the change-only-one-thing technique discussed above). By setting certain variables to constant values, you can observe the behavior of the program as it is influenced by the remaining variables. If you spot an

(continued)

error in this way, you can use this observed relationship to infer which variables are causing the error. Once you have found them, force the other relevant variables to known values; then you should be able to find the error by studying the actual behavior of the system compared to its expected behavior.

Another use of this method is to force execution of a given section of a program. When a program has few enough alternate paths in it that you can afford to test each one manually, you can use forcing to ensure that you are in fact testing each section of code.

Forcing is a special case of *checking with sample data*, a method that is used to rigorously verify the correctness of a program. The design and selection of test data heavily influences the validity of the testing process, so it should be done with great care.

A meaningful discussion of this subject is beyond the scope of this article, but I mention it to point out that the use of sample data is an important tool for even the most casual programmer. When you are working with a program that deals with a range of data, take the time to run the program with input data that is just inside, on, and just outside the range of valid data. For example, if your program computes the average of between 1 and 20 numbers, try it with 0, 1, 2, 19, 20, and 21 numbers. In general, you will be surprised at the number of times that your program fails to act correctly.

Recommended Books

Much has been written about the theory and practice of design, coding, and debugging. Here is a selected list of especially useful books that I have on my bookshelf. Some are handy references, others challenge the very foundation of your beliefs on how one should write a program.

Bruce, Robert C. *Software Debugging for Microcomputers*. Reston, VA: Reston Publishing Company, 1980. A good catalog of debugging techniques.

DeMarco, Tom. *Structured Analysis and System Specification*. Englewood Cliffs, NJ: Prentice-Hall, 1979. A very good book on the design of large systems; it contains extended information on the use of the data-flow diagrams (DFDs) and data dictionaries.

Ledgard, Henry F. *Programming Proverbs*. Rochelle Park, NJ: Hayden Book Company, 1975. A book of good common-sense advice on programming.

Ledin, George Jr., and Victor Ledin. *The Programmer's Book of Rules*. Belmont, CA: Lifetime Learning Publications, 1975. A book of hierarchically ordered rules that remind you of your alternatives at various stages of the design/code/debug cycle.

Meek, Brian, and Patricia Heath, eds. *Guide to Good Programming Practice*. New York: Halsted Press (division of John Wiley and Sons), 1980. A good collection of essays on various topics; the essays do not fit into an organized whole, but each has good information in it.

Page-Jones, Meilir. *The Practical Guide to Structured Systems Design*. New York: Yourdon Press, 1980. A detailed but pragmatic book on the proper decomposition of large systems into modular subtasks; it has good sections on data-flow diagrams and the factors that influence the effectiveness of a modular system or program.

Peters, Lawrence J. *Software Design: Methods and Techniques*. New York: Yourdon Press, 1981. An invaluable survey book that describes dozens of design methodologies, techniques, and notations—excellent for browsing to find the method that makes the most sense to you.

Smith, Truck. *Secrets of Software Debugging*. Blue Ridge Summit, PA: Tab Books, 1984. A well-written book that digs deeply into the psychology of debugging and illustrates its points with three chapter-long microcomputer examples; this is my favorite book on debugging.

Ward, Paul T. *Systems Development Without Pain*. New York: Yourdon Press, 1984. Describes a new design technique that emphasizes good communication between the designers and the users; the method modifies and simplifies the concept of structured analysis.

Yourdon, Edward Nash, ed. *Classics in Software Engineering*. New York: Yourdon Press, 1979. Contains reprints of and commentary about all the pivotal papers on structured programming and structured analysis, the debate among Dijkstra, Knuth, and others about GOTO statements, and many essays on structured programming.

Yourdon, Edward, and Larry L. Constantine. *Structured Design*. Englewood Cliffs, NJ: Prentice-Hall, 1979. This is the first major book on structured analysis; it uses data-flow diagrams but puts heavy emphasis on structure charts. It also contains several theoretical chapters that debate how best to modularize a program.

Preventive Debugging

Two debugging techniques fall into the category of *preventive debugging*—that is, practices that will alert the future user to the occurrence of an error. The first is the simple technique of using "sleeping" debugging instructions, while the second is a little-known technique called firewalling. Both techniques are available to people who are coding the program they will later maintain, though they can sometimes be added to existing programs. They are most useful in a program where error detection and quick diagnosis and correction are important.

Sleeping debugging instructions are conditional diagnostic routines that execute only if a predefined abnormal condition wakes them up. These can be as simple as a PRINT statement that notifies the user that an error has occurred or as complicated as a subroutine that analyzes the state of the program and writes a file of useful debugging information to the disk.

The best time to add such instructions into a program is when you are writing (and, later, debugging) it, while you have the greatest insight into how the program works. Ask yourself ques-

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tions like these: "What's the most damaging thing that could happen while this program is running? What can the program do to spot it? What ranges of data will always be invalid? What could the user do that the program will have to guard against or correct?" With careful planning and design, you can add sleeping debugging instructions that will alert you to program errors and help minimize their effect.

FIREWALLING

Firewalling is a preventive debugging technique available to highly modular programs. If you have designed your modular program correctly, each module is completely self-contained and interacts with other modules only through a known list of variables. A fire wall is a special kind of sleeping debugging instruction that checks the validity of data as it comes out of a module. The idea behind firewalling is to ensure that, even if an error occurs, it is not allowed to spread from its origin to other modules. This method is most useful in large systems that pass data from one program to another, but you may find occasion to use it in smaller programs of your own.

CONCLUSIONS

As I said at the beginning of this article, there are no magic techniques—but there are tools, and the most powerful one is your own brain. Debugging is part technique, part art, part luck, and the most difficult part of it is to be *thinking hard* when the situation calls for it. I hope I have presented some useful tools; if you have any other useful techniques, I would enjoy hearing from you.

The temptation is to take it easy, to skip the hard parts, to keep rummaging through the program for more clues instead of thinking about the ones you already have—but all that is like the man who kept looking for his lost car keys under the streetlight because the light was better there. Although luck and intuition contribute in debugging, there is no substitute for thoughtful, sustained analysis. ■

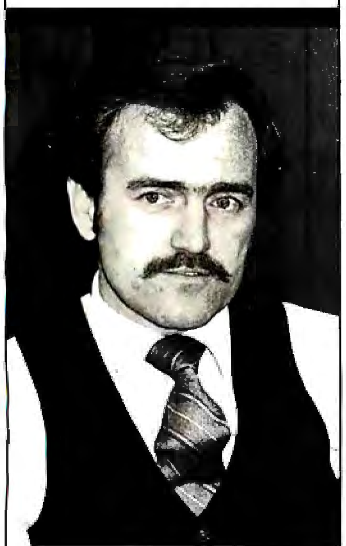
"...compatibility has been a cruel hoax used to mislead the public."

(This is one of a series of design philosophy discussions with Rod Coleman, President of Stride Micro (formerly Sage Computer).)

RC: One of the biggest mistakes being made today is that many in this industry underestimate how much the public is willing to take. Today's microcomputer buyer is far more sophisticated than those who were buying systems just 24 months ago.

Q: How does that affect a manufacturer?

RC: In our case, I think it means



"...I'm often amazed that our competitors continue to introduce products that don't really relate to their own machines above or below them."

that our designers and engineers have to be more honest. By that I mean that you can't simply rely on clever marketing techniques to overcome hardware shortcomings.

Q: Give me an example.

RC: The best one I can think of is the overused buzzword of "compatibility." It has been a cruel hoax used to mislead the public. Indeed, dozens of these compatible machines are interchangeable with one another; but, in reality, users don't trade one system for another of the same capacity. Instead, they're looking to upgrade, link or expand their capabilities. That's when the so-called compatibility ends. One major manufacturer changes to a different CPU chip between entry-level and mid-range machines, and then changes again to move into a high capacity environment. Another competitor is only compatible until you decide you want multiuser or local area networking; at that point you've got to change operating systems and software.

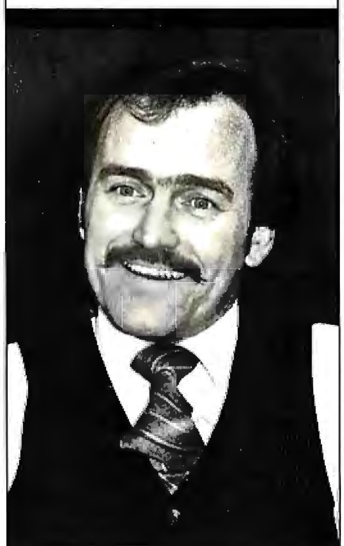
Q: How has Stride approached this problem?

RC: From the start, we knew we had to select a microprocessor and basic system design that had enough power and flexibility to meet the needs on both ends of the spectrum. Without a capable CPU, your system will never be state-of-the-art. Thus all machines in the Stride 400 Series were designed to accommodate the same 68000-based CPU board. This board provides for all the standard features such as VMEbus, multiuser, LAN, etc. Then, when a customer decides to move up, it's a simple matter of providing more RAM, storage, backup devices, etc. Since every system in the family has a common CPU board, compatibility is guaranteed. The idea is so basic, that I'm often amazed that our competitors continue to introduce products that don't really relate to their own machines above or below them.

Q: Do most customers buy Stride machines for that flexibility to expand?

RC: Many do, but we are also getting a lot of response from those looking for a big system as the cornerstone to a growing network of smaller machines. This is where local area networks really shine, but the incompatibility between the large hard disk machines and the smaller workstations has prevented users from capitalizing on this technology. Again, since Stride's LAN is a standard feature of all systems, and they share a common board, this is a natural application.

Q: Is the 68000 microprocessor the key to that compatibility?



RC: To a large extent, yes. Although it's been on the market for some years, we feel this processor still holds a significant advantage over other architectures. When we evolved from Sage Computer to Stride Micro, we closely examined the state of the microprocessor market. We elected to remain with the 68000 family because it was the only proven product that would handle everything from our floppy-based 420 machine up to the top-of-the-line Stride 460 with 22 users, 12M bytes of RAM and 448M bytes of Winchester hard disk storage. An extra benefit of this is that we were able to boost the already-impressive performance of the Sages by increasing the clock speed from 8MHz to the Stride's standard 10MHz and optional 12 MHz without changing architectures. That would have been impossible with most other chips.

Q: Do you see others following your lead?

RC: Yes and no. The good signs are that more and more interest is being generated in portable languages and operating systems that work across a broad range of system capabilities. Yet, then I see an announcement from a leading hardware supplier that their newest multiuser machine is only compatible with the smaller systems when it's in single user mode. Overall, I think Stride will remain unique for some time to come.

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6502 TRICKS AND TRAPS

BY JOE HOLT

Tips for surviving 6502 assembly-language programming

WITH THE ADVENT of complex microprocessors whose operation codes (op codes) begin to resemble some high-level languages, the days of the 6502 seem numbered. Indeed, a microprocessor with only three 8-bit registers and a 64K-byte address space is apparently no match for a piece of silicon that can walk through 4 gigabytes of memory in 32-bit strides and work with hundreds of bits worth of registers. I won't try to fool you: The 6502 will *not* be around forever. But when the last of its species emerges from the forge, it will be joining an installed base of more than 3 million 6502-based computers. There is merit, therefore, in discussing the peculiarities of this dying breed, the ins and outs of this most nonorthogonal microprocessor.

The 6502 has three 8-bit registers (only one of which can be used in arithmetic and Boolean operations), a single-page (256-byte) fixed stack, and optimized performance when dealing with the first 256 bytes of memory. But what may be considered a tight architecture is befuddled by an instruction set full of inconsistency and seeming favoritism to certain combinations of addressing modes and op codes. Steve Wozniak even admitted that the only reason he put a 6502 in his Apple II was because it was cheap.

In order to gain the most benefit from the 6502, an assembly-language programmer must understand these idiosyncrasies and use them to his or her advantage.

PECULIARITIES

I will assume for the sake of brevity that you are already familiar with the 6502's architecture and operation codes (and assembly language in general) and perhaps have access to an Apple or Atari with a decent assembler. If not, you might want to pick up a good reference book on the 6502 and sit down with an assembler and experiment. An intimate knowledge of your machine is the greatest boon to any programming task.

ZERO PAGE

The first two pages (512 bytes) of address space have special meaning to the 6502. The first page, called the Zero page, consists of memory addresses 0000 to 00FF [*Editor's note: All addresses are in hexadecimal unless otherwise specified.*] and is considered prime real estate for variable storage. Memory references to the Zero page by most op codes can be reduced to 1 byte because the 6502 has a special addressing mode strictly for this area of memory. Not only are programs that place variables on the Zero page shorter, but they also run faster because the microprocessor need only fetch 1 byte from the program to determine the memory address. The upper byte of the address (00xx) is supplied internally. For example, the following sequence assembles to 6 bytes and executes in eight clock cycles:

```
300:AD 80 03   LDA  $380   ;get value
303:8D 81 03   STA  $381   ;and stuff it elsewhere
```

The equivalent sequence using Zero-page variables assembles to only 4 bytes and executes in six clock cycles:

```
300:A5 80      LDA  $80    ;get Zero-page value
```

(continued)

Joe Holt is a freelance technical writer. He can be reached at 476 West Main Rd., El Centro, CA 92243.

```
302:85 81        STA  $81      ;and stuff it elsewhere
```

Where speed and space are critical, there is no better solution than to put oft-used variables on the Zero page. But beware: Other programmers before you have done the same, so it's important not to alter Zero-page memory locations already used by your computer's ROM (read-only memory) routines or DOS (disk operating system).

THE STACK

The second page consists of memory addresses 0100 to 01FF and is the location of the 6502's stack. Because the entire stack can be addressed by 9 bits, the stack pointer is 8 bits wide with the upper bit (01xx) supplied internally. You can only set this 8-bit stack pointer via the X register; you must place the value in the X register and transfer it to the stack pointer with the TXS (transfer X register to stack pointer) op code. Because the stack grows downward, it is good practice to initialize the stack pointer at the beginning of any 6502 program with the following code:

```
300:A2 FF   LDX #$FF   ;set pointer to very top of stack
302:9A      TXS
```

Conversely, the only way you can read the stack pointer is through the X register, with the TSX (transfer stack pointer to X register) op code. This instruction is handy for "locating yourself" in a relocatable program, a topic I'll describe later.

The stack never grows so low that it clobbers the Zero page. Instead, the stack pointer wraps from 0100 back up to 01FF, possibly causing confusion if you've already got a page full of variables or return addresses pushed onto the stack. This situation can be kept in check by limiting the use of recursive subroutines.

FLAGS

The 6502 is notorious for how it handles its flags, especially the Carry flag. Where most processors set the Carry flag when a borrow occurs from a subtract operation, the 6502 produces a *clear* Carry to indicate a borrow. The following is an illustration with the SBC (subtract with Carry) instruction:

```
300:38      SEC              ;be sure the Carry's set
301:E9 01   SBC  #1          ;decrement the
                              accumulator
303:90 ..   BCC  BORROW;a borrow occurred
```

You've probably noticed the lack of add and subtract op codes on the 6502 that do not include the Carry flag. This oversight necessitates setting (for SBC, as above) or clearing (for ADC—add with Carry) the Carry before performing one of these operations.

The backward Carry for subtract operations is not in itself confusing, that is, until you realize that compare operations (CMP, CPX, CPY) are actually subtracts in compares' clothing. Logical compares are accomplished within most microprocessors by simply subtracting from the value being compared the value to compare with and tossing away the result. In other words, comparing 5 to 6 would be a matter of subtracting 6 from 5 and setting the appropriate status flags. In this situation (5 minus 6) a borrow would occur, indicated by a *clear* Carry. Therefore, after a compare operation, a clear Carry indicates less than, and a set Carry indicates greater than or equal. This is *backward* from the logic of all other popular microprocessors.

The other flag that you should be wary of is the Decimal flag. When set, all arithmetic operations are performed in BCD (binary-coded decimal). This is wonderful if you intend to perform BCD mathematics, but it can cause all kinds of unexplainable problems if not. Consequently, you should start any 6502 program with a CLD (clear Decimal flag) operation. Set the Decimal flag only when necessary and clear it immediately afterward.

The way the 6502 decides to set or clear its flags after different operations is not immediately obvious, and the logic behind this is somewhat different from that of most other microprocessors. For example, the Carry flag is only affected by arithmetic (ADC, SBC, and compares) and shift operations (ASL, LSR, ROL, and ROR), except when explicitly changed (with CLC, SEC, or PLP). Operations that affect the Carry flag on many other processors, such as Boolean operations (AND, EOR, and ORA), do not modify the Carry at all. Increment and decrement operations do not affect the Carry either, but this is only a problem when testing if a register or memory value was decremented past 0, in which case you have to execute an explicit comparison:

```
300:CA      DEX               ;count down
301:E0 FF   CPX  #$FF         ;past zero?
303:F0 ..   BEQ  ROLLUNDER    ;yes
```

The two flags that are set or cleared in conjunction with most operations are the Negative and Zero flags. The Negative flag reflects the state of the eighth (most significant) bit of the result of the operation, and the Zero flag is set whenever the result is equal to 0 (all bits cleared). All operations that work with a value set these flags, including the load (LDA, LDX, and LDY) and transfer (TAX, TAY, TSX, TXA, TXS, and TYA) op codes.

THE BIT INSTRUCTION

Although the 6502's instruction set includes no operations for bit manipulation (short of Boolean operations), a special instruction can be used to examine the eighth (most significant) and seventh bits of a value in memory. This is the BIT op code, and when used it will place the eighth bit of the memory referenced in the Negative flag and the seventh bit in the Overflow flag without affecting the contents of any register. This has the most benefit when you use it to test if a Boolean variable (that is, one that is either 00 or FF) is set or not:

(continued)

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6502 TRICKS AND TRAPS

```
300:24 80   BIT  ALLDONE   ;are we done?
302:30 ..   BMI  DONE      ;yes
```

The BIT operation also has the side effect of setting or clearing the Zero flag depending on the result of a logical AND operator between the memory value and the accumulator. This feature (really the main purpose of the BIT operation) has little use outside of testing status bits in a memory-mapped I/O machine.

SAVING X AND Y

To complete the discussion of the 6502's peculiarities, I should mention that there is no provision to push or pop the contents of the X or Y registers. If you need to preserve the contents of either of these registers, there are two paths you can take. The first and most logical one is to save the contents on the stack, but you can only do this by transferring the register to the accumulator and then pushing the accumulator onto the stack. To restore the register, you must pop the accumulator from the stack and transfer its contents back to the appropriate register:

```
300:8A    TXA    ;save the X register
301:48    PHA
          ...
325:68    PLA    ;now restore the X register
326:AA    TAX
```

The disadvantage of this method is obvious: The original value in the accumulator is destroyed, and it is not a simple matter of pushing and popping the accumulator around each sequence to preserve it. You must temporarily save the contents of the accumulator either in the remaining register or in some memory location. Neither situation is desirable. (Of course, if the accumulator isn't holding anything of any consequence, then this disadvantage can be ignored.)

Your alternative is to store the register in memory somewhere and then load it back when required. This has the advantage of placing the register's content where it can be easily accessed (by LDX, STX, LDY, and STY op codes), but it forces you to set aside a specific location just for preserving a register. Things get really messy when this occurs in a recursive routine or if the location for saving the register is also used someplace else for the same purpose. In either case, havoc will ensue. The bottom line is that no solution is perfect, and you must examine the situation carefully to decide what will work best.

TRICKS

Tricks (or "hacks") are techniques that use a feature or deficiency in the programming environment to an advantage not anticipated by the system designer. If you use them with caution, they can result in faster, more compact object code.

In the 6502's case, there are dozens of these optimization tricks, each of which saves bytes and cycle time. Some

(continued)

of the tricks described here are not necessarily applicable just to the 6502 but are simply good programming practices. Nonetheless, they are essential to using the 6502's full potential.

BRANCHING

One of the glaring holes in the 6502's instruction set is the absence of an unconditional relative jump (or branch). This makes writing relocatable code difficult, and many times it seems a waste to have to use 3 bytes for a jump instruction just to skip over 1 or 2 bytes. One way you can get around this is by using a conditional branch when the state of a flag is guaranteed. For example, because a load operation always modifies the Negative and Zero flags, this type of sequence is possible:

```
300:C9 05     CMP #5          ;less than 5?
302:B0 ..     BCS NOTLESS     ;no
304:A9 01     LDA #1          ;yes, set to 1
306:D0 ..     BNE CONTINUE    ;-- always taken
```

Because the accumulator is loaded with 1, the Zero flag will always be clear, in which case the BNE (branch if not equal) will always be taken.

If you do not know the state of a flag for certain, but you must use a branch instead of a jump (perhaps you are writing some relocatable code), you can always force one of the flags to a known state and branch on that condition. Because the Overflow flag is seldom used, it finds itself the most likely candidate:

```
300:B8      CLV           ;clear overflow for branch
301:50 ..   BVC SMORE     ;-- always taken
```

This sequence takes just as many bytes as an equivalent jump (JMP) instruction, with the one disadvantage common to all 6502 relative branches: They can only jump forward 127 bytes or back 128 bytes.

One other trick involves the misuse of the BIT operation. Because the BIT operation does not affect any registers and only the Zero, Negative, and Overflow flags, it can be put to good use as a "skip over the next 2 bytes" instruction. For example,

```
300:C9 05          CMP #5        ;less than 5?
302:B0 03          BCS NO        ;no
304:A2 FF          LDX #$FF      ;yes, set to true
306:2C             DFB $2C       ;-- BIT trick
307:A2 00   NO:    LDX #0        ;no, set to false
309:86 80          STX AFLAG     ;save true/false status
```

If the condition is true (less than 5), the X register will be loaded with the value FF, then a nonsense BIT instruction occurs, after which execution continues. If the condition is false, NO will be branched to, which loads the X register with 00. In one sense, the operation immediately following the LDX #$FF is a BIT operation with memory address 00A2, but in another sense, that memory address operand (00A2) disassembles to the instruction LDX #0.

6502 TRICKS AND TRAPS

This trick of hiding code within the operand of other code is an old one but should nonetheless be used with caution.

This BIT technique can also be used to skip over 1 byte by using the Zero-page addressing mode for BIT, in which case the value for the DFB (define byte) pseudo-operation would be 24.

ADDING AND SUBTRACTING

Because of the lack of add and subtract operations that do not include the Carry, the sequences CLC, ADC and SEC, SBC are common ones. There is one way to avoid having to explicitly set or clear the Carry, but only if the Carry is in a known state. For example,

```
300:C9 05     CMP #5          ;less than 5?
302:B0 ..     BCS NOTLESS     ;no
304:18        CLC
305:69 05     ADC #5          ;yes, put it above 5
```

Because the Carry flag will *always* be clear if the branch is not taken, the CLC before the ADC instruction is unnecessary. You must be careful to ensure that the condition of the branch does not change, however.

If the Carry flag is in the wrong (but known) state, it can still be used to your advantage if the operand for the ADC or SBC is immediate:

```
300:C9 05     CMP #5     ;less than 5?
302:90 ..     BCC LESS   ;yes!
304:69 04     ADC #5-1   ;(or 4)
```

In this example, the ADC operation will still add 5 to the accumulator because the Carry will always be set and will therefore be added along with the 4.

INITIALIZATION

There are many places in a program where a number of variables must be set to certain values. Usually, the code looks like this:

```
300:A9 FF     LDA #$FF     ;set a few true/false vars
302:85 80     STA VAR1
304:85 81     STA VAR2
306:A9 00     LDA #0       ;clear this one
308:85 82     STA VAR3
30A:A9 01     LDA #1       ;and initialize another
30C:85 83     STA VAR4
```

If the X or Y register can be sacrificed, the fact that the values being stored are consecutive can be exploited:

```
300:A2 FF     LDX #$FF     ;set a few true/false vars
302:86 80     STX VAR1
304:86 81     STX VAR2
306:E8        INX          ;now we're up to 0
307:86 82     STX VAR3     ;clear this one
309:E8        INX          ;now we're up to 1
30A:86 83     STX VAR4     ;and initialize another
```

(continued)

Note that this only reduces the size of the code; there is no savings in speed (an INX op code takes just as many clock cycles as an LDA #).

Locating Yourself

Often it is necessary to know the location of code that is executing in a relocatable environment. If there is within the system the location of a known RTS instruction (perhaps in ROM), this can be accomplished by calling this RTS, then examining the remains on the stack. The following example will determine what page the executing code is on:

```
300:20 58 FF  JSR  KNOWNRTS   ;get return address
                                on the stack
303:BA        TSX
304:BD 00 01  LDA  $100,X     ;now get what
                                page we're on
```

There is a special consideration when using this type of code. If there is the possibility of a 6502 interrupt occurring (from a real-time clock or a communications device), the return address above the stack would be destroyed by the 6502's interrupt processing. It would be wise in this case to turn off interrupts before this bit of code (SEI), then reenable them immediately after the LDA $100,X (CLI). [*Editor's note: These instructions are two more examples of the 6502's confusing mnemonics. At first glance, you would think that* SEI *would mean "set interrupts." However,* SEI *means "set interrupt disable flag"; its execution shuts off the 6502 interrupts.* CLI *means "clear interrupt disable flag," and a* CLI *instruction actually* enables *interrupts.*]

Nonindexed Indirect

One of the nicest features of the 6502 is its abundance of addressing modes, but there are times when even these are not enough. A prime example is the situation when a *non*indexed indirect reference must be made. Most of the time, the Y register is sacrificed in this way:

```
300:A0 00   LDY #0           ;index of zero
302:B1 80   LDA (POINTER),Y  ;nonindexed
```

But if the Y register is already being used, a similar method involving the seldom (if ever) used preindexed indirect addressing mode can be used, at the expense of the X register:

```
300:A2 00   LDX #0           ;use some register
302:A1 80   LDA (POINTER,X)
```

Of course, you should take advantage of an index register that already contains 00.

Indirect Jumping

Last but not least is a technique for branching to different routines depending on an index value. This can be used for interpreting keyboard commands or executing alternate parts of code based on a certain number. The only limitation is that all the routines must reside on the same page in memory, but a little extra programming can overcome this. This technique uses an RTS instruction as a kind of indirect jump:

```
300:A9 03     LDA  #HIPAGE     ;high byte of
                                 address routines
                                 are on
302:48        PHA              ;stick it on the
                                 stack
303:BD 20 03  LDA  ADDRTAB,X   ;X contains the
                                 function number
306:48        PHA              ;fake a 'return'
                                 address
307:60        RTS              ;go to the routine
```

The table ADDRTAB would contain the low byte of each routine *minus one* due to the fact that the 6502's program counter is incremented after the address is obtained for the RTS. This portion of code expects the function number in the X register. First, the high byte of the routines' addresses is pushed onto the stack, then the low byte is obtained from the table and pushed onto the stack. At this point, the stack contains the address of a routine to execute just as if an instruction right before that routine had been a JSR (jump to subroutine; note: JSR actually stands for "jump and save return address"). When the RTS executes, it pulls the address off the stack, increments it, then continues program execution at that address.

The 65C02

Just when you get used to the idea of having to use all these tricks and have plastered your wall with 6502 peculiarities (as I've done), along comes the 65C02. The 65C02 is a revision of the 6502 that is built into the Apple IIc, is offered as an upgrade to the Apple IIe, and solves many of the problems and voids many of the hacks described above. For example, the 65C02 includes a branch-always instruction, eliminating the need for the known-condition branching tricks. Also included are push and pop X and Y instructions, which eliminate the need for all the tricky register transfers or loading and storing. Another nice addition is the inclusion of increment- and decrement-accumulator instructions, so that it is no longer necessary to resort to arithmetic just for this. A few bugs within the 6502 have also been fixed in the 65C02.

The Future of the 6502

After all is said and done, has all this been purely academic? I think not. Despite its simplicity and peculiarities, the 6502 is still an attractive microprocessor for semi-dedicated machines (that is, game machines, low-priced home computers, etc.). It is a fast microprocessor with a very efficient design. And to tell you the truth, I enjoy programming the 6502 for the very quirks I've been complaining about. I believe there are others who feel the same way, and this if nothing else should guarantee a long and prosperous life for the 6502. ■

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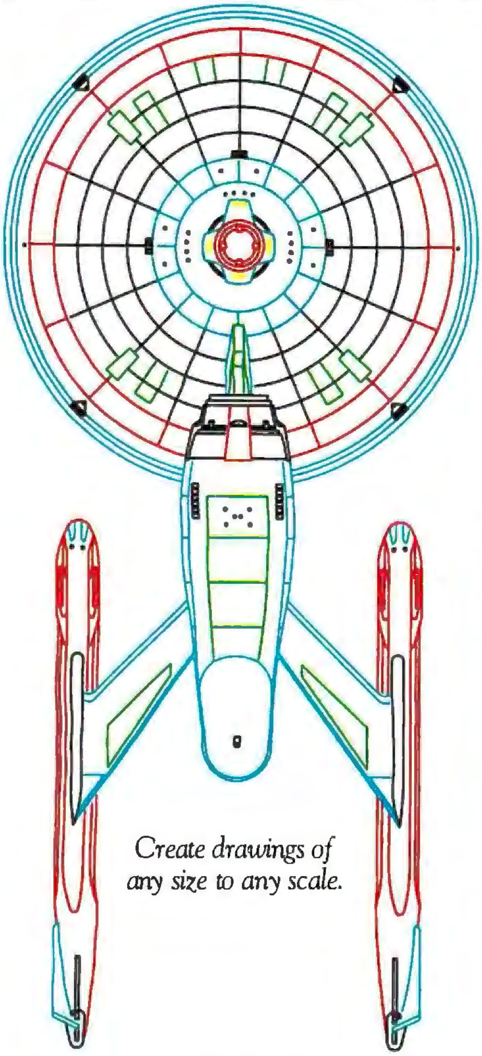

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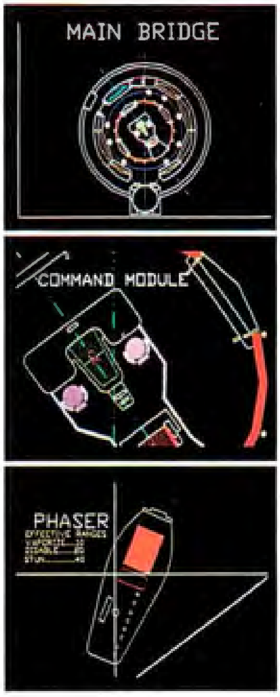

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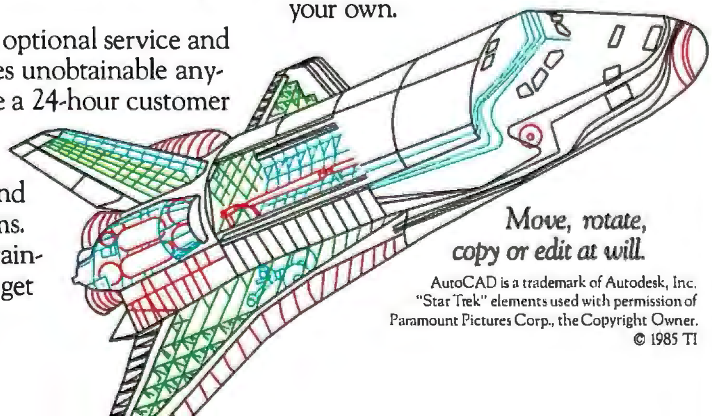

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SOFTWARE-ICs

BY LAMAR LEDBETTER AND BRAD COX

A plan for building reusable software components

THE SOFTWARE WORLD has run headlong into the Software Crisis—ambitious software projects are hard to manage, too expensive, of mediocre quality, and hard to schedule reliably. Moreover, all too often, software delivers a solution that doesn't meet the customers' needs. After delivery, if not before, changing requirements mean that systems must be modified.

We must build systems in a radically different way if we are going to satisfy tomorrow's quantity and quality demands. We must learn to build systems that can withstand change.

Some system developers are already building software much faster and of better quality than last year. Not only that, the systems are much more tolerant of change than ever before, as a result of an old technology called message/object programming. This technology, made commercially viable because of the cost/performance trends in hardware, holds the key to a long-awaited dream—software reusability. A new industry is developing to support the design, development, distribution, and support of reusable Software-ICs (integrated circuits). A forthcoming series in *UNIX/World* will address message/object programming.

MESSAGE/OBJECT PROGRAMMING AND SOFTWARE-ICs

In this article we'll look at the concepts of message/object programming and how they support the building of "Software-ICs," as we call them, by satisfying the requirements for reusability.

A Software-IC is a reusable software component. It is a software packaging concept that combines aspects of subroutine libraries and UNIX filter programs. A Software-IC is a standard binary file produced by compiling a C program generated by Objective-C.

The notion of *objects* that communicate by *messages* is the foundation of message/object programming and fundamental to Software-ICs. An object includes data, a collection of procedures (*methods*) that can access that data directly, and a selection mechanism whereby a message is translated into a call to one of these procedures. You can request objects to do things by sending them a message.

Sending a message to an object is exactly like calling a function to operate on a data structure, with one crucial difference: Function calls specify not *what* should be accomplished but *how*. The function name identifies specific code to be executed. Messages, by contrast, specify what you want an object to do and leave it up to the object to decide how.

REQUIREMENTS FOR REUSABILITY

Only a few years ago, hardware designers built hardware much as we build software today. They assembled custom circuits from individual electrical components (transistors, resistors, capacitors, and so on), just as we build functions out of low-level components of programming languages (assignment statements, conditional statements, function calls, and so on). Massive reusability of hardware designs wasn't possible until a packaging technology evolved that could make the hardware environment of a chip (the circuit board and adjoining electrical components) rela-

(continued)

Lamar Ledbetter is director of special projects and Brad Cox is vice president of Productivity Products International (27 Glen Rd., Sandy Hook, CT 06482), which produces Objective-C.

tively independent of the detailed workings of that chip. The IC quickly developed to the point that multiple chip vendors now vie to sell their hardware design effort in a market for reusable hardware designs.

One concept that stands out in hardware systems is that many of the components perform unique services. Services are provided upon request, and the requester need not be concerned with the internal methods or data used, only the result. The equivalent software concept, *encapsulation*, is fundamental to success in software reusability. Encapsulation defines a data structure and a group of procedures for accessing it. Users access the data structure only through a set of carefully documented, controlled, and standardized interfaces.

The concept of *messaging* is also prevalent in the hardware world. It is through messaging that the loose coupling of components is achieved and the division of responsibility between the user and the supplier is defined and enforced.

The hardware industry has also achieved a high degree of reusability through the development of standards. There are standards for interconnection, power, and processing, for example. In contrast, in the software world standards for the syntax and semantics of only a few languages have been defined and adhered to across a range of hardware. There have also been many unsuccessful attempts to define standards for the implementation of software algorithms and applications (such as GOTO-less programming, no global data, loose coupling, tight binding, and data hiding, among others). Stressing strict static "type checking" as a standard helps solve the problems of integration and debugging but does not change the basic operator/operand concept embodied in most languages; it only moves it to a higher level of abstraction. To reuse modules developed using the operator/operand concept, you have to hope that the output of one module is compatible with the "type" of the input of the receiver, redefine the type of the operands in either the receiver or sender, or transform the operands. Because of the complexity, there has been little progress in the definition of standards for reusability in the operator/operand model. In contrast, useful standards for reusability are in use or being developed in organizations that have embraced the message/object paradigm.

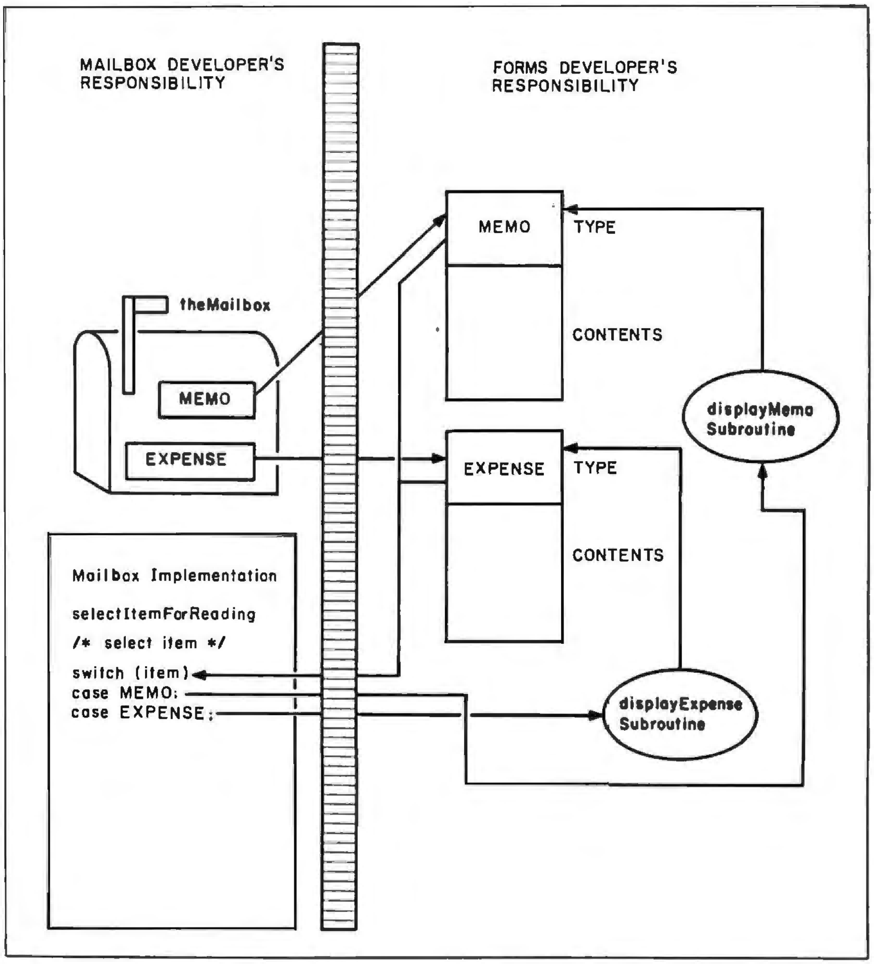

Figure 1: *Mailbox using the operator/operand model. The Mailbox developer must specify how to display the form by checking the form type and calling the correct subroutine. As a result, every form type must be enumerated and the implementation changed as form types are added or deleted.*

In the hardware world, the functions of standard components are well defined and identifiable. Given a knowledge of the functions available and a high level of standardization, hardware designers routinely integrate reusable hardware components into new systems. Standard functions are easy to identify because they map into the real-world model of hardware systems. In the software world, the definition of standard, identifiable functions is still a dream, even with our "standard" utility libraries. If software reusability is to become a reality, languages must support a more direct mapping from the model of the real-world functions to the implementation.

Hardware components are delivered in an unmodifiable form. That means that standard functions are protected. If Software-ICs are to become a reality, the languages and standards must support the delivery of components that operate as advertised and are immune to modification by the system builder. If the system builder wants different functions, he must go back to a Software-IC "foundry" for a new component.

Reusability can have several meanings in both the hardware and software worlds. A hardware designer would never think (as we do in software) of starting the design of a modification with a blank piece of paper or by looking at the design of all of the connecting components. A designer also doesn't worry about needing to modify the interfaces or components not affected by the change. Modified components "inherit" most of the previous implementation and contain only the changes necessary to provide the required new behavior. The inheritance of already-working methods by a new Software-IC has tremendous productivity implications.

Why Didn't Software-ICs Exist Before?

One of the main reasons Software-ICs didn't exist before is that the cost performance of hardware did not support the requirement that computer cycles must be used ("wasted") to enhance software reusability. The cycles were too expensive, and performance optimization was necessarily a primary goal. Strict implementations such as Smalltalk-80 consume orders of magnitude in performance. Less revolutionary implementations of the message/object paradigm, such as Objective-C, while paying some performance price, are viable for commercial systems and are in use today in companies building major software systems.

Most of us have been taught to think within the conceptual framework of operators and operands. That framework has led many to conclude that the complexity involved in reusing a software component far exceeds the possible benefits.

In order for Software-ICs to work, the manner in which systems evolve has to be fundamentally different. The concept of *inheritance*, discussed in detail later, is that fundamental difference. The concept of Software-ICs also demands a level of standardization in system implementation that has not been feasible until recently. Finally, the market for Software-ICs is a recent reality created by the recognition that what I call the Software Crisis can be solved only by fundamental changes in the way we build systems. It is no longer competitively viable to ignore the products of previous development efforts if there is any way to reuse or reapply those products.

Encapsulation is fundamental to success in software reusability.

Objects, Messages, and Encapsulation

The distinction between specifying what should be done as opposed to how it should be done is subtle and often misunderstood. It is, however, a crucial one because, as has been demonstrated in the hardware world, it is central to reusability.

By way of example, imagine a programmer building an electronic mailbox in an electronic office system, and focus on the mailbox developer's role as a user of services provided by his supplier, the developer of the forms being mailed. The mailbox developer must provide a way to implement the intention to display the selected item. If he does this using the conventional operator/operand model and specifying how, not what, as depicted in figure 1, the code given in listing 1a results.

Notice the separation of responsibilities. Because the mailbox developer is responsible for deciding how to implement the function that is called selectItemForReading, the code must enumerate every data type the forms developers might provide. This results in code that is inherently nonreusable; the case labels explicitly

(continued)

Listing 1: *Operator/operand versus message/object implementations. Listings 1a and 1b are, respectively, examples of portions of code that create an electronic Mailbox using conventional (operator/operand) and message/object models. Comparing the two illustrates the difference between the Mailbox developer specifying "how" versus "what."*

(1a)

```
selectItemForReading(theMailbox) {
	.
	.
	.
	/* Select an item in theMailbox and . . . */
	/* check the item type flag */
	switch(item->type)
	/* Now call the appropriate display subroutine */
	{
	case MEMO:     displayMemo(item); break;
	case EXPENSE: displayExpense(item); break;
	.
	.
	.
	default: error("unknown contents"); break;
	}
	.
	.
	.
}
```

(1b)

```
selectItemForReading(theMailbox) {
		. . .
		/* Select an item in theMailbox and. . . */
		[item display];     /* Send item a message to display itself */
		.
		.
		.
}
```

Listing 2: *Using Software-ICs. This message/object program counts the unique words in a file using preexisting Software-ICs from the Objective-C library:* Set *and* String.

```
// Reads words from stdin and counts unique ones main( ) {
	extern id String, Set;    // Specify object (instance) factory ids
	id uniqueWords, currentWord;    // Local object (instance) ids
	char buf[MAXBUF];        // Word buffer

	uniqueWords = [Set new];    // Create a new empty set instance
	while (nextWord(buf) != EOF) {    // forEachWord . . .
		currentWord = [String str:buf];  // Create a string instance for each word
		[uniqueWords filter:currentWord];// Store unique ones in set
	}
	printf("The number of unique words is %d \n", [uniqueWords size]);
}
```

state that this mailbox is useless except for memo and expense contents.

Now notice what happens in the rewritten code (listing 1b) using messages and objects as depicted in figure 2. The message expression, item display, commands the object, item, to display itself, thus specifying only what the object is to do. How the object is to do it is decided by the forms developers so the mailbox code becomes independent of its contents.

The technical term for this is *dynamic binding*. Dynamic binding and encapsulation are at the root of the reusability provided by this variety of message/object programming.

Some modern programming languages (Ada, Modula-2, and CLU, for example) provide a different form of encapsulation by binding statically at compile time. While this certainly is an improvement over traditional languages like C and Pascal, it provides no new help in solving the reusability problem. The mailbox example coded in any of these languages would still need the switch statement.

The notion of a Software-IC, in which reusable code is built and tested by a supplier and then delivered to consumers in binary form, is not possible without dynamic binding.

Using Software-ICs

We will demonstrate the use of Software-ICs by building a simple program that counts the unique words in a file. For the sake of comparison, we will discuss two different solutions based on reuse of existing software and then turn our attention to the Software-IC solution.

The subroutine-library solution would reuse library functions for managing files, printing results, and comparing strings. Custom software would be required for the word parser, hash function, hash table/collision handling, counting words in the hash table, and printing the formatted results. Much of the significant new development and debugging effort concerns algorithms that have been implemented in many previous applications. Once working, however, the implementation should be fairly efficient.

A UNIX-style solution would consist of small "tools" connected by pipes. The off-the-shelf utilities that could be reused include tr (translate characters), sort (sorting utility), and wc (word-count utility). The programmer would have to custom-build a script for assembling the utilities. This particular problem requires a good working knowledge of applicable UNIX utilities but no custom software. The implementation would be noticeably slower than both the subroutine library and Software-IC solutions.

The Software-IC solution involves assembling two prefabricated Software-ICs from a library of components. A String is used to hold words, and a Set can be used to hold the unique words. Both are standard components in the library released with Objective-C. The performance of the Software-IC solution would not be as good as the first solution, but it would certainly be acceptable and could be optimized by tuning. The full text for this solution, except for the small function nextWord(), which parses words from the input stream, is presented in listing 2.

The two external symbols Set and String identify a pair of *factory objects* whose function is to produce instances of their *classes* (Software-ICs). Each class defines behaviors and declares data for (a) its factory object and (b) its instances. The two local symbols uniqueWords and currentWord identify instances, which will be manufactured by Set and String at run time.

The notion of a Software-IC is not possible without dynamic binding.

In this example, String responds to a str: message by allocating enough space to hold the characters in the message argument buf. The next statement commands the set uniqueWords to perform the filter: function on currentWord.

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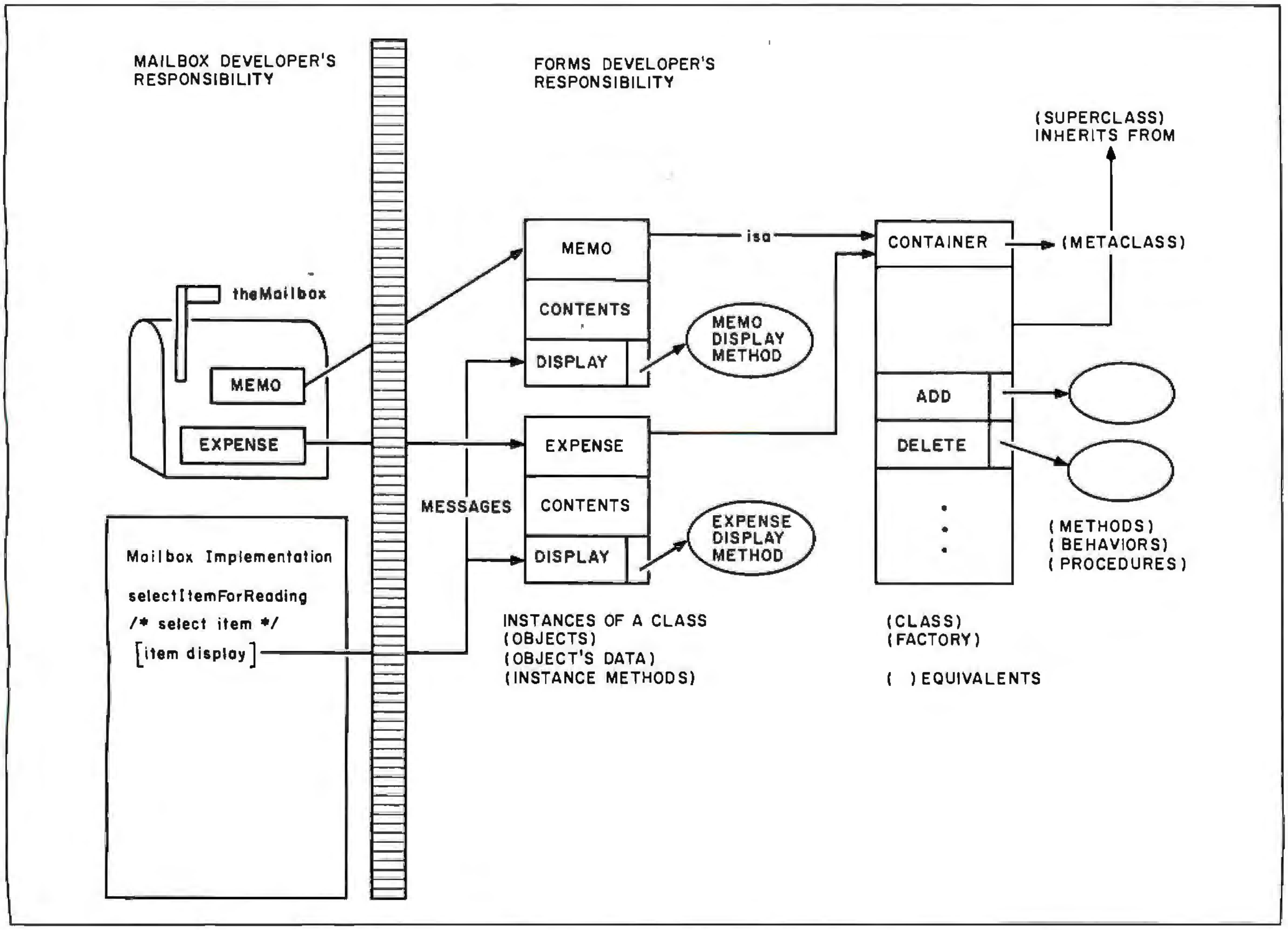


Figure 2: *Mailbox using the message/object model. The Mailbox developer specifies what the form should do by sending it a message to display itself. As a result, form types can be added or deleted without changing the Mailbox implementation.*

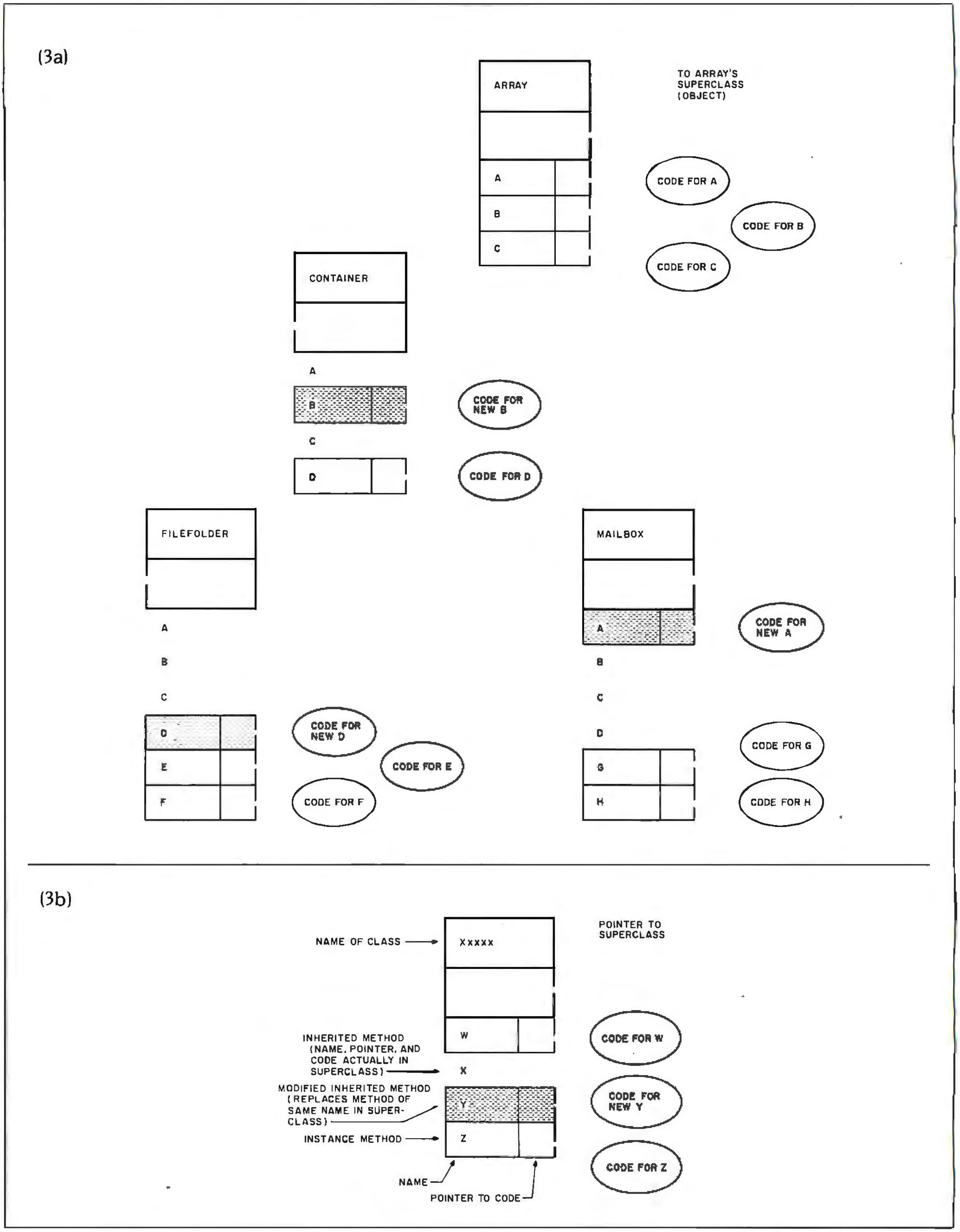


Figure 3: *Inheritance. New specialized classes can be, and almost always are, defined by inheriting the data and behaviors of older generic classes, then specifying only how the new ones differ. Figure 3a shows how the classes Container, FileFolder, and Mailbox are created; 3b explains the notation used. Note that, for example, the definition of Container includes only definitions for methods B and D. It inherits definitions for methods A and C from Array; these definitions do not need to be explicitly specified by the programmer, nor do they take any room in the definition of Container.*

How are reusable sets possible, since they must work properly with many different kinds of contents? For example, the same Set code may need to compare strings, points, symbols, and so on, often within the same application. The answer is that dynamic binding allows the Set to legitimately consider equality testing, for example, none of its business. Instead, it pushes that decision back onto its contents. When it needs to test the equality of two items, it merely commands one of them to report whether it isEqual: to the other.

The manner in which systems evolve has to be fundamentally different.

CLASSES, METHODS, AND INHERITANCE

So far we have focused primarily on encapsulation. This technology should be thought of as an aid to using the services in a system. It also provides some advantages for the suppliers (builders) of message/object systems as well. Consider the job facing the builders of three familiar components of an office-automation system: Mailbox, Envelope, and FileFolder.

At one level a Mailbox is very different from a FileFolder, but they are similar in that they are kinds of containers. Each will have some amount of code involved in managing collections of other objects.

Inheritance allows containment code to be built, stockpiled, and thereafter reused as often as needed. This is done by building a class named Container, whose methods support the operations we expect of containers: adding elements, removing them, expanding and shrinking their internal capacity as needed. Thereafter, specialized container classes like Mailbox, Envelope, and FileFolder are built by describing only how each subclass differs. They may differ by having additional private data fields or by having additional (or modified) behaviors. Figure 3 depicts a typical inheritance hierarchy.

To design a new capability, the programmer's thoughts turn immediately to "What do I already have that is most like the thing I need?" (see figure 4). For example, to develop an Envelope the programmer focuses on describing how Envelopes should differ from Containers. Envelopes differ from Containers by, for example, having additional data variables such as returnAddress, targetAddress, and stamp. Envelopes also differ by exhibiting additional behaviors (or methods), for example, mailTo:, open, and discard. Note that no methods

(continued)

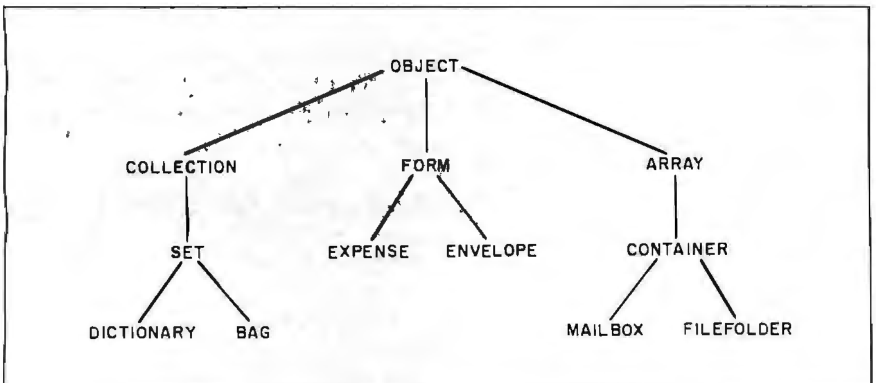


Figure 4: *Opportunities to reuse work emerge. As the design proceeds, similarities to previously developed Software-ICs become apparent, and a large degree of reuse results.*

OBJECTIVE-C

Objective-C, a PPI product (Productivity Products International Inc., 27 Glen Rd., Sandy Hook, CT 06482), is a hybrid language that combines the reusability, modeling power, and complexity-reducing attributes of Smalltalk-80 with the portability, efficiency, compatibility, and access to machine details of the C language. As shown in figure A, the Objective-C compiler transforms the Objective-C language into standard C statements. The message/object code examples use the Objective-C syntax.

While Smalltalk-80 attempts to revolutionize programming, Objective-C seeks to change it through evolution. Objective-C provides a thin layer of new structure over its C substrate by adding classes, objects, messages, encapsulation, and inheritance. No C-language capabilities are eliminated, and none are changed. The programmer can choose conventional C-language tools when efficiency and portability are paramount and message/object power tools when encapsulation, inheritance, and dynamic binding are needed to enhance reusability and reduce code bulk and complexity.

The hybrid approach of Objective-C does breach the purity of the message/object paradigm. This means that the design and implementation rules are not as clearly defined but must evolve through experience. The hybrid approach will also require more management diligence if the amount of reusable code is to be optimized. The criteria for choosing messages/objects or writing functions in C should be clearly defined and enforced. This will require standards and control.

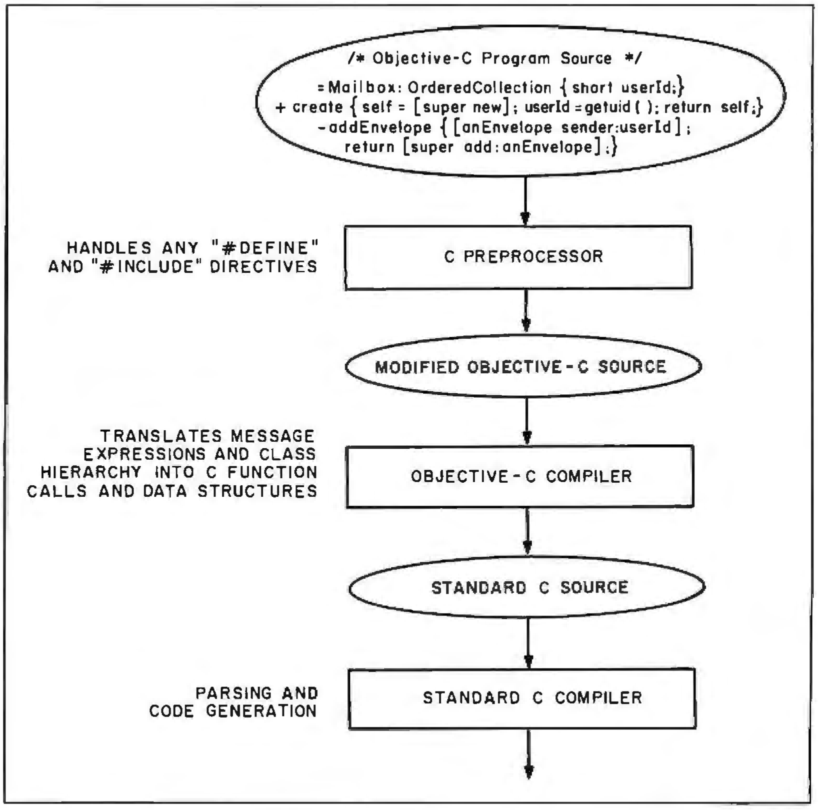


Figure A: *Objective-C—a superset of the C language. Objective-C is actually a hybrid language whose message/object syntax is changed to standard C syntax by the Objective-C compiler.*

Message/object programming allows a more direct representation of the real-world model in the code.

need be defined for adding and removing contents from envelopes because they, and the data variables that support them, are acquired automatically, or *inherited*, from Container.

FileFolders and Mailboxes will have their own distinctive implementations. However, only their differences from a Container need to be designed, coded, tested, documented, delivered, and maintained. Their containment abilities were developed once and thereafter reused. Containment is defined consistently, systemwide. You add a letter to a Mailbox in precisely the same manner as you add a letter to a FileFolder.

SYSTEM BUILDING WITH SOFTWARE-ICS

System requirements normally model data, data flow, and actions on data. In traditional system building, the system requirements must then be mapped into the operator/operand model in order to optimize the implementation on a computer. Message/object programming allows a more direct representation of the real-world model in the code. The result is that the normal radical transformation from system requirements (defined in users' terms) to system specifications (defined in computer terms) is greatly reduced.

Software-ICs directly support the concept of rapid prototyping (or, in hardware terms, *breadboarding*). The ability to demonstrate a subset of a system's final functionality (particularly the human interface) in a rapid pro-

(continued)

Table 1: *Software-IC specification sheets. This is a condensed version of the specification sheet for the* Point *Software-IC. The complete version contains 21 methods (versus the 9 shown).*

Point

Instance variables: { short xLoc, yLoc; }

Inherits: Object
Inherited by:
Referenced by: Point Rectangle
Refers to: Geometry Point Primitive _Object_Object_csav msg fprintf lmul sqrt

Discussion

Points are vectors (i.e., coordinates) on a two-dimensional plane. When displayed on a graphics terminal, the origin is at the top left; the horizontal axis increases to the right . . .

Instance Variables

xLoc A short integer specifying the value for the horizontal axis (e.g., column).
xLoc A short integer specifying the value for the vertical axis (e.g., row).

Instance Creation

+x:(int)xy=(int)y
Replies a new point at coordinates (x@y).
+fromUser
Prompts the user to specify the coordinates for a new point. The default implementation is . . .

Instance Variable Access

Unless otherwise specified, these methods reply to the receiver.
-(int)x Replies the x-coordinate of the receiver.
-(int)y Replies the y-coordinate of the receiver.
-X:(int)xy:(int)y
Sets the coordinates of the receiver to (x@y).

.
.
.

Conditionals

In the following, words like "isAbove" or "isLeft" are with respect to a screen-oriented point of reference, not the numerical magnitudes of the coordinates. For example, the point (0, 0) is above and to the left of all other positive coordinates.
-(BOOL)isBelow:aPoint
Replies YES of receiver is below aPoint.

.
.
.

Equality Testing

-(int)hash
Replies xLoc ^ yLoc.
-(BOOL)isEqual:aPoint
The receiver and someObject are equal if and only if they are both points and have equal coordinates.

Printing

-printOn:(IOD)anIOD
Prints the receiver as: fprintf(anIOD,")%d@%d)'', xLoc, yLoc);

(continued)

```
                    Declarations:Point.m
==Point:Object (Geometry, Primitive){
  short xLoc, yLoc;
}
+x:(int)xy:(int)y
+fromUser

-(int)x
 .
 .
 .
```

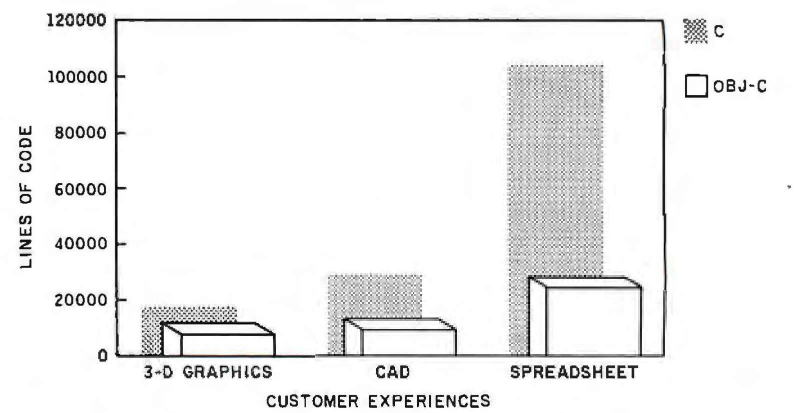


Figure 5: *Productivity experiences. Actual decreases in lines of code experienced by PPI customers using Objective-C in three different application areas.*

totype helps ensure that the system built is the system needed.

No matter how well the delivered system satisfies the requirements, people usually have an immediate desire to change/evolve the system. Fortunately, as we have seen, it is possible to build changeable systems.

System builders using Objective-C employ a combination of aids to enhance the reusability of their Software-ICs. The standard libraries, for example, are documented using a catalog composed of Software-IC specification sheets. Table 1 summarizes the specification sheet for a Software-IC called Point.

CONCLUSIONS

The tools exist today in the software world to build Software-ICs. They are in use in a number of major companies and have demonstrated (see figure 5) code bulk reductions of between 2.5-1 and 5-1.

As the use of Software-ICs spreads, productivity in the software world should improve much as hardware ICs improved productivity in the hardware world. The use of Software-ICs also will promote the evolution of optimized system-building methodologies and tools. Just as semiconductor foundries produce both standard and custom ICs, Software-IC foundries will do exactly the same in the software industry. ■

REFERENCES

1. Love, T. "Application Development in Smalltalk-80." Arlington, VA: *Proceedings of Softfair-83*.

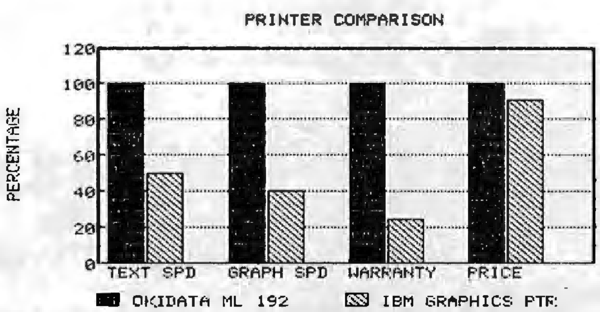
2. *Objective-C Reference Manual*, Version 3.0, Sandy Hook, CT: Productivity Products International, December 1984.

Got a minute?

The folks who make very modern personal computers would have you accept a very old fashioned idea. Namely that you should buy everything else from them, too.
Including their printers.

But IBM owners everywhere are finding that while the IBM PC may be the right tool for their business, the ideal tool for putting their business on paper is the all new Microline 192 from Okidata. And it isn't taking them long to find out.

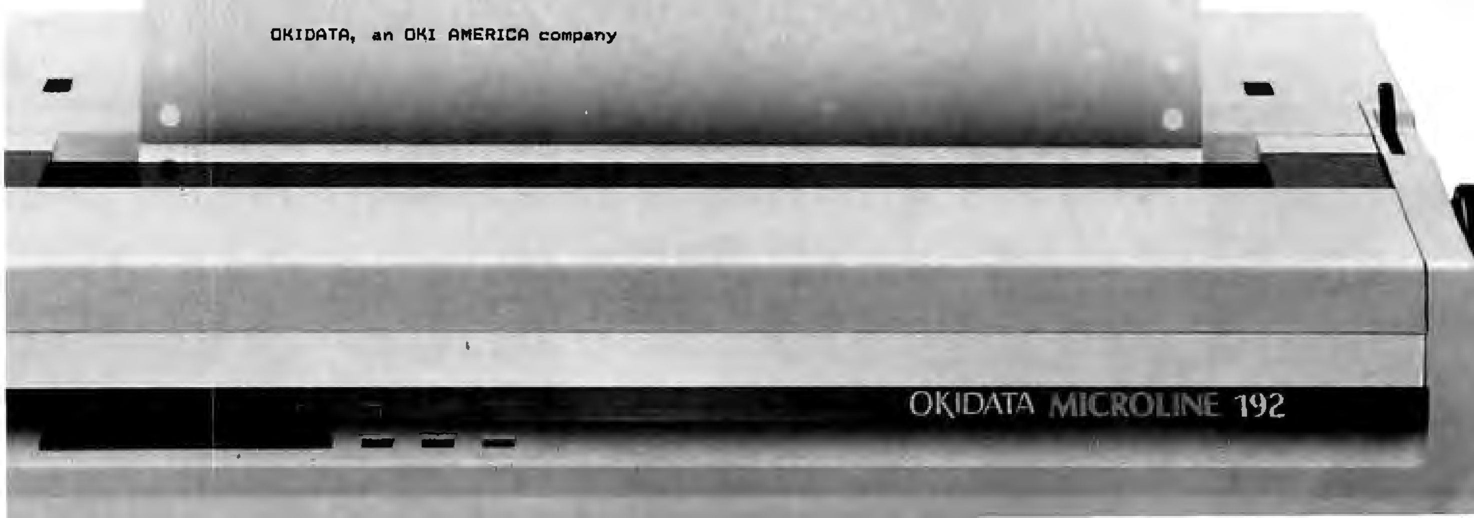
First there's speed. The Microline 192 is twice as fast as the IBM Graphics Printer. But IBM PC owners are finding some other very remarkable features about the Microline 192 that the Graphics Printer doesn't have.



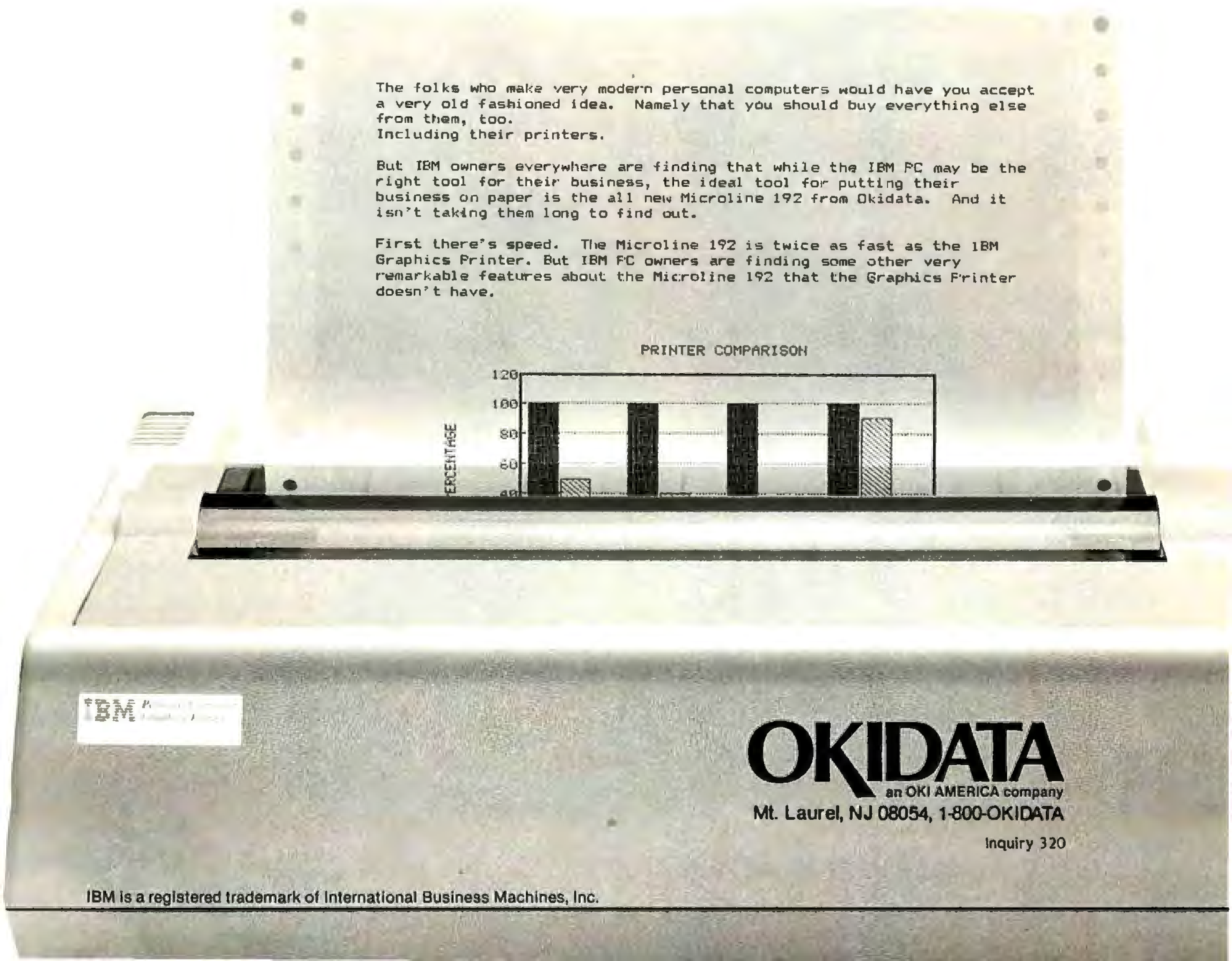
FEATURE	OKIDATA	IBM
SPEED	160 CPS	80 CPS
CORRESPONDENCE QUALITY	YES	NO
FREE FONT SOFTWARE	YES	NO
BIDIRECTIONAL GRAPHICS	YES	NO
MENU SELECT MODE	YES	NO
CUT SHEET FEEDER	OPTIONAL	NO
WIDE CARRIAGE MODEL	YES (ML-193 $699)	NO
WARRANTY	1 FULL YEAR	90 DAYS
WEIGHT	9 LBS	13 LBS
SUGGESTED LIST PRICE	$499	$449

Oh, one other comparison worth repeating. In the minute and ten seconds it took the Microline 192 to print what you've just read, the IBM Graphics Printer wouldn't have told half the story.

OKIDATA, an OKI AMERICA company



That's about all it takes to discover why Okidata's new printer beats the IBM® Graphics Printer.



Reviews

SOME ARTISTS SPEND A LIFETIME trying to get their work displayed in a major gallery. The designers of the Mindset Personal Computer hit the big time with their first effort: This aesthetically appealing machine is part of the design collection of the Museum of Modern Art in New York. Although the Mindset is not as popular as Apple or IBM machines, its graphics capabilities, inspired by CAD/CAM minicomputers, deserve attention. We first looked at this IBM PC work-alike in a product preview last year. Tom Wadlow now gives us an updated report.

Idea processors, tools for organizing text and thoughts, are growing in popularity. William Hershey examines an outline arranger (ThinkTank), two index-card systems (Executive Writer/Executive Filer and THOR), and a package that can handle outlines and index cards (Framework). As Mr. Hershey points out, these tools are applied in as many ways as there are users.

Another type of package that seems to be appearing frequently is the memory-resident software that lets you interrupt your program in progress to write notes, calculate, or execute DOS functions. Mark Welch compares some of this "convenience software": Borland's SideKick, Software Arts' Spotlight, and Bellsoft Inc.'s Pop-Ups.

Bruce D'Ambrosio poses the question: Would anyone of sound mind pay $12,500 for a software program? Before you assume the answer is no, read his review of M.1, a knowledge-engineering tool for the IBM PC from Teknowledge, a start-up company specializing in artificial intelligence.

Our two hardware reviews this month cover output devices. Our man in New York, Rich Malloy, plotted some graphs with Hewlett-Packard's HP 7475A and describes this six-pen graphics machine. Jon Edwards, one of our technical editors, reports on IBM's Quietwriter. Readers who think most letter-quality printers sound like chain saws might be glad to hear this unidirectional unit is neither loud nor slow. It's also not inexpensive.

Nothing can replace a good spelling teacher or proofreader, but according to George Sheldon, The Word Plus from Oasis Systems is the next best thing. This spelling-checker program includes a 45,000-word dictionary and runs on most CP/M and MS-DOS computers.

—*Glenn Hartwig, Dennis Barker, and Lynne Nadeau,* BYTE

Resource Technology — What's it all about?
IT'S ABOUT TIME!
...and Time is relative. In business, time is profitability!
80286
OPT. 80287
Z-80H
CCT-286Z
512K-6164 STATIC RAM
CCT-M512
Given enough time, an end result of the desired quality may be finally attained - (see natural examples). In business, however, the bottom line is directly proportionate to the quality of, and the time consumed by, the tools employed - (see digital examples).
CCT teams up with MACROTECH to bring these ultimate speed and power tools to the serious business/scientific market. State-of-the-art processors, with super high-speed/high-density memory boards, form the basis for CCT machines with bottom-line computing power PCs can't touch.
CCT Implements Tomorrow's Technology Today!
Join some of the serious CCT clientele: U.S. Dept. of State, Uniroyal, Miles Labs, Univ. of Massachusets, UCLA, Teledyne Semiconductor, UC Berkeley, U.S. EPA, Proctor & Gamble, MIT, Lockheed, Corps of Engineers, U.S. Navy, U.S. Coast Guard, Jet Propulsion Labs, Hallmark, McGraw-Edison, Sperry, International Paper, 3M, Beech Aircraft, LSI, Eastman-Kodak, Western Electric, Nat'l. Bureau of Standards, USC, Cornell University, British Cable and Wireless, USAF, and thousands more, worldwide.
For further details, see our technical ad on page 483 of this issue, or contact our technical staff at (602) 282-6299.
For system quotations and ordering only, call our sales building at (800) 222-8686.
CUSTOM COMPUTER TECHNOLOGY / 1 CCT PLAZA / SEDONA, AZ 86340
Photograph: Sedona's famous Red Rock Crossing, taken with Nikon FE-2 and Nikkor 35-105mm lens, at 40mm, at f11-1/60th, with special Kodak 5294 movie film-ASA 320.

R·E·V·I·E·W·E·R'S N·O·T·E·B·O·O·K

TeleSoft (10639 Roselle St., San Diego, CA 92121) recently dropped the price of its Ada subset compiler for the IBM Personal Computer (PC) from $3030 to $1200, prompting us to take a look at it. The fact that TeleSoft's Ada compiler for the 68000 has been validated made it seem possible that the company's IBM PC compiler would outperform other efforts. When it arrived, the inclusion of an 850-page manual also seemed promising.

The manual, however, carried on the theme of the 68000 to such an extent that much of the information it contained was specific to that processor. Inaccuracies and a cryptic style further inhibited understanding.

TeleSoft's Ada needs either an IBM PC XT with 320K bytes of memory or an IBM PC with dual floppy-disk drives and at least 576K bytes of memory, much of which it uses as a RAM (random-access read/write memory) disk for its many system files. A call to TeleSoft was required to create the two working disks needed to run the compiler (from the 10 floppy disks provided); the manual's instructions were mislabeled. Another call was needed to decode and correct the manual to learn to format and initialize a disk using ROS (real-time operating system), TeleSoft's proprietary operating system. You have to use TeleSoft's screen editor to enter programs since ROS can't read text files and disks created with PC-DOS editors.

Once the system was ready, two more calls to TeleSoft were needed to compile a program; the system really expects a hard disk and requires special, undocumented efforts to run on a floppy-disk system. To its credit, TeleSoft provided extensive phone support.

Summarizing: The product costs $1200, has cryptic and sometimes inappropriate references in its documentation, requires numerous long-distance telephone calls, makes you learn a proprietary operating system and a new screen editor, and generates intermediate code that you can interpret only from within the proprietary operating system.

A copy of SongPainter version 1.00 for the Apple Macintosh came from Rubicon Publishing (La Costa Centre, 6300 La Calma Dr., Austin, TX 78752) with copyrights crediting Starcor J.V., also of Austin; the Regents of the University of California; and Apple Computer Inc. Given that its asking price is $59.95, it has generated a lot of curiosity in most of those who've heard it.

SongPainter's promotional material says it's for experienced musicians or users with "virtually no knowledge of music." Basically, it lets you write a song by picking a note from a "tone window" and transferring it to one of four tracks in a "song window." Notes are labeled, and each is distinguished by its own visual pattern (dots, cross-hatching, stripes, in several varieties each). You can paint single notes or chords. You get a choice of 32 horns, woodwinds, strings, percussion instruments, keyboards, and synthesizer-type waveforms.

The documentation that came to us was a draft version, and the software itself was labeled "Not For Release" (although it is considered to be a full-fledged version 1.00). I certainly hope that the real documentation has an index.

When and if the manufacturer releases a production version of SongPainter, I hope it fixes a fairly obvious bug. Although you can copy SongPainter (at least version 1.00) onto a backup disk, trying to use the help function on the backup crashes the system.

I saw the Ericsson gas-plasma-screen laptop portable for the first time at the West Coast Computer Faire. I admit I was intrigued. Actually, it's a laptop transportable since it doesn't have batteries for truly independent operation. Still, it claims full IBM PC compatibility, weighs about 14 pounds, has 256K bytes RAM, uses 5¼-inch disks, has an 80-column by 25-line screen, and has a full-size, detachable keyboard. The whole package looks very nice except that it has only one disk drive. I'm looking forward to getting one for evaluation.

Another nice item that was demonstrated but wasn't ready for sale was a 2-megabyte Macintosh from Levco Enterprises in San Diego. At the time, Levco said it had all the bugs out and was just waiting for a reliable source of supply before setting a price and taking orders. However, the vendor was selling a Fat Mac upgrade kit for $235. It wasn't surprising that the Levco booth looked pretty busy for most of the show.

We've gotten a number of requests for the operating-system patch that gives the NEC APC III partial compatibility with the IBM PC. It works with some packages but not with others (for example, it works with Perfect Writer, Filer, and Speller version 1.0 but not with version 2.0). We've put the program listing for that patch on BYTEnet Listings, our electronic bulletin-board system. If you call (617) 861-9774, you can download the patch and try it out on as many packages as you like. An article detailing how the patch works is scheduled for an upcoming issue.

—Glenn Hartwig, Technical Editor, Reviews

S·Y·S·T·E·M R·E·V·I·E·W

The Mindset Personal Computer

A high-performance graphics machine that runs IBM PC software

BY TOM WADLOW

IBM Personal Computer work-alikes, often called "clones" by the industry, are designed to duplicate as many of the IBM PC's features as possible. The reason they can compete in the marketplace lies in their differences, however. Clones usually have a lower price, a faster processor, or a better keyboard than the IBM PC.

The Mindset Corporation has chosen to enhance a different feature. The Mindset Personal Computer system (see photo 1) differs from the IBM PC primarily in the quality and speed of its graphics display. The Mindset machine has the ability to do some graphics operations in hardware rather than software. This makes some sophisticated and otherwise time-consuming graphics procedures run briskly on the Mindset PC. [*Editor's note: Many IBM PC-compatible manufacturers, Mindset included, have recently had some financial trouble. However, the Mindset's extensive graphics capabilities deserve close examination.*]

THE SYSTEM

As outlined in a BYTE Product Preview (see "The Mindset Personal Computer" by Gregg Williams, April 1984 BYTE, page 270), the Mindset comes in five basic pieces: the system unit, the expansion unit (disk drives), the keyboard, a mouse, and the display. Of these, the expansion unit and the mouse are optional. A full system with two disk drives and a monochrome display has a list price of about $2900.

The system unit is the heart of the Mindset and contains the processor, 32K bytes of RAM (random-access read/write memory), two cartridge sockets, I/O (input/output) module sockets, and system indicator lights. The system unit also includes another 32K bytes of RAM specifically dedicated to the video display.

The Mindset uses the Intel 80186 microprocessor (with a 6-MHz clock speed), rather than the 8088 used by the IBM PC or the 8086 used by some of the other clone systems. Since the 80186 is upward-compatible with the 8088 (meaning that it has all the same instructions as the 8088 and a few more as well), quite a lot of IBM PC software runs on the Mindset.

The cartridge sockets were designed to hold preprogrammed memory cartridges but none are available from Mindset. However, a programmable 8K-byte cartridge that Mindset calls an NVRAM (nonvolatile random-access memory) is available. You can store information in the cartridge, and it will retain this information when you turn off the power or remove the cartridge from the machine. This cartridge consists of low-power memory with its own battery.

Mindset originally intended that it would be possible to use the cartridge system in the same way as you would a floppy-disk-based system. The Mindset's operations guide gives the example of a cartridge containing BASIC in one socket, with an NVRAM cartridge in the other. Unfortunately, the BASIC cartridge is not available.

The rear of the system unit contains the connectors for an external video monitor and audio speaker. In addition, the Mindset has space for several I/O modules at the back of the unit.

Mindset has covered all three display options. The system unit has connectors for composite (NTSC) video, for RF (radio frequency) video on a regular television set, or for an RGB (red-green-blue) monitor. The composite-video output is suitable for taping on a videocassette recorder. The RF output can be seen on television channels 3 or 4. And the RGB output is compatible with the IBM PC-type RGB monitor.

The Sync signal for the RGB is split into separate horizontal and vertical drives. It is not difficult to convert these signals to composite sync, which is required by many non-IBM RGB monitors. A single NOR gate is all that is required. I used a 74LS02 to interface my Sanyo DMC6113 RGB monitor to the Mindset. This is not necessary if you have an IBM PC-compatible monitor.

You can add various interfaces to the

Tom Wadlow is an engineer and freelance writer living in the San Francisco Bay area. He can be reached at POB 2755, Livermore, CA 94550.

Mindset by plugging special I/O modules into three slots on the system unit's rear panel. Two of the slots can accommodate one double-width I/O module or two single-width modules. Mindset sells modules for an RS-232C interface, printer interface, and stereo sound. Each costs $99. A 300-bps (bits per second) modem module takes up two slots and costs $199. The Mindset has no internal IBM-type slots for expansion boards. Most of the capabilities that those boards provide are handled by the I/O modules.

The Mindset has three indicator lights on the front of the system unit: a red light indicating that power is on, and yellow and green lights that can be accessed by software. Not many of the Mindset programs use these lights. The lights on my review unit were visible only when the room lighting was off.

Since Mindset does not offer any cartridges, most users will need the expansion unit. Adding the expansion unit will bring the total amount of RAM to either 128K bytes or 256K bytes. Also, the expansion unit contains one or two 360K-byte floppy-disk drives. On the back of the expansion unit are three more slots for I/O modules.

The expansion unit sits on top of the system unit. The two are coupled together by a special connector that extends down from the expansion unit into a receptacle on the system unit. Other than the friction fit from this connector, there is no mechanical connection between the two boxes, as you will find out if you are careless in picking up a Mindset.

The Mindset keyboard (see photo 2) plugs directly into the front of the system unit, unlike the IBM PC keyboard, which plugs into the rear. The jacks on either end of the connecting cord resemble those modular plugs used for telephone connections.

On the left and right sides of the keyboard are connectors for a mouse or some other type of pointing device. A joystick is available, and some software can use a bit pad. Only the mouse was available for review. Having two connectors for the mouse means that both left- and right-handed people will find the Mindset comfortable to use. The only people who will be inconvenienced are those who like to put the keyboard on their lap. Note that you cannot unplug the mouse and move it to the other port once a program (such as Lumena) has initialized it.

As is the case with any mouse, the Mindset mouse is useless unless a program knows how to access it. This means that the mouse may not be usable in many programs, such as spreadsheets or editors. Some mice for the IBM PC come with software patches that let you modify these programs so they can be used with a mouse. There is no reason why a similar approach could not be devised for the Mindset mouse, but Mindset does not provide such a patch.

The Mindset keyboard is slightly smaller than that of the IBM PC and somewhat lighter. The keys all have a solid feel to them

(continued)

Photo 1: *The Mindset Personal Computer with optional expansion unit, two disk drives, and mouse.*

with good tactile feedback. Though the Mindset is primarily a graphics machine, the keyboard is adequate for word processing or other applications that demand a lot of continuous typing.

A lot of thought went into the layout of this keyboard. Mindset did not make the mistake of duplicating the IBM PC's key layout that caused such an uproar among touch-typists. The keyboard has the same functionality as that of the IBM, retaining all the important keys. There is no numeric keypad, however, which may disturb some. In its place, Mindset has put an inverted-T cursor-control set and the IBM's special-purpose keys such as Ins, Del, PgUp, and PgDn. The 10 function keys are arranged across the top of the keyboard. Since there is no numeric keypad, the special Num Lock, plus, and minus keys on the IBM keyboard have not been duplicated on the Mindset. The scroll-lock and break functions, which share a single key on the IBM, are separate keys on the Mindset.

The Mindset power switch, by the way, is in an unusal place—the back of the keyboard. Certain parts of the Mindset are powered up as long as the unit is plugged into the wall. These include the on-board clock/calendar and the memory that holds the system-configuration information.

When you boot the system after it has been unplugged, a built-in configuration program is run. This program lets you reset the clock, specify the order in which the system checks the boot devices, inform the system of the particular display device you are using, and slightly modify the horizontal and vertical position of the screen display to compensate for your monitor. The program also displays the available amount of RAM and lets you turn the audible beeper on or off.

The configuration program is organized as a visible menu with currently selected options highlighted in color. Pressing the space bar cycles the current menu item through its possible settings. Pressing Return moves you to the next menu item. To finalize the configuration, you just reboot.

Although the Mindset has three different jacks for monitors, it has no way of determining which jack is in use. Some programs, such as Lumena, need to know whether composite video or RGB is in use, since certain color combinations do not work well on a composite monitor. Other video features, such as the limited anti-aliasing (blurring the jagged edges of a diagonal line so that it appears smoother) available on the Mindset, will not work on an RGB monitor. The configuration program lets you specify which monitor will be used.

I was using an RGB monitor but I noticed a little interference between the RF output and my television. A visible but fuzzy copy of the system screen was ghosted on top of the program on channel 3, about 20 feet from the computer. An RCA plug with the center pin clipped out and the ground shield soldered across the back cleared up this problem.

When you select the TV option (composite video or RF-modulated video), the Mindset will start up in 40-character by 16-line mode. The monitor (RGB) option starts up in 80-character by 25-line mode.

It was a pleasant surprise to find that Mindset has designed a new typeface rather than adopting the ugly one used by IBM on its color display. The Mindset font is similar, but many of the irregularities, such as the shape of the lowercase letters, are smoothed out. The new font is pleasant to look at.

The Mindset can boot from either of the cartridge slots or drive A. If the first device on the priority list does not contain bootable code, it tries the next device, then the third. You can set the priority of each device in the configuration program. If none of the devices will boot, a picture of the Mindset logo appears and begins to rotate. This looks impressive and beats an error message.

Photo 2: *The Mindset keyboard includes two connectors for a mouse or joystick. Note the inverted-T cursor-key arrangement. The Sys Config key calls up the Configuration program stored in* ROM.

SOFTWARE

The Mindset does not come with any software. The operating system, MS-DOS 2.0, is a $60 option. The Mindset version of MS-DOS is specially written for it. In fact, the machine will not boot an off-the-shelf copy of PC-DOS. Newer versions of MS-DOS must be obtained directly from Mindset or its distributors. The DOS manual claims that this customization is necessary to let the operating system take advantage of the Mindset's 80186 processor. Although the DOS is a custom product, it can read and write disks from PC-DOS or other MS-DOS systems, and it uses much of the same applications software.

(continued)

AT A GLANCE

Name
Mindset Personal Computer

Manufacturer
Mindset Corporation
617 North Mary
Sunnyvale, CA 94086
(408) 737-8555

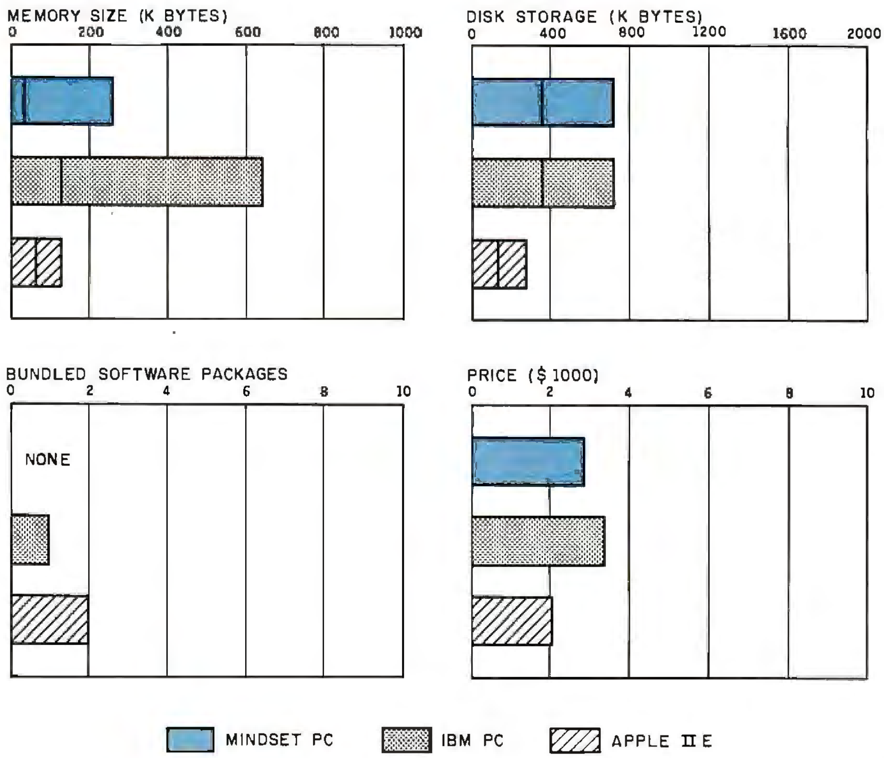
Size
(with expansion unit) 16 by 12.2 by 5.5 inches

Components
Display: Connects to RGB, composite, or TV monitors
Text: 80 by 25 or 40 by 16
Graphics: 640 by 400 pixels by 2 colors, 320 by 400 by 4, 640 by 200 by 4, 320 by 200 by 16, plus IBM PC graphics modes
Keyboard: Detached, 84 keys
Processor: 16-/16-bit 80186, 6-MHz clock speed
Memory: (with expansion unit) 128K or 256K bytes
Storage: (with expansion unit) One or two 360K-byte, 5¼-inch floppy-disk drives, MS-DOS format
Interfaces: Joystick or mouse, cartridge slots
Options: 8K RAM cartridge ($79), parallel port ($99), serial port ($99), 300-bps modem ($199), mouse ($149), joystick ($39), Genlock circuitry ($500)

Optional Software
MS-DOS ($60), GW-BASIC ($79), Lumena ($399)

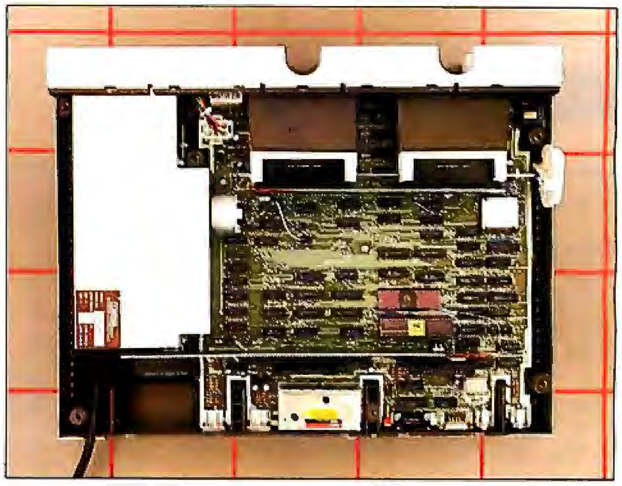
Price
With 256K, two drives, monochrome display, parallel and serial ports, MS-DOS, and GW-BASIC, $2885

Comments
Well-built solid machine with good keyboard; much better graphics performance than IBM PC; recommended for artists, graphics enthusiasts

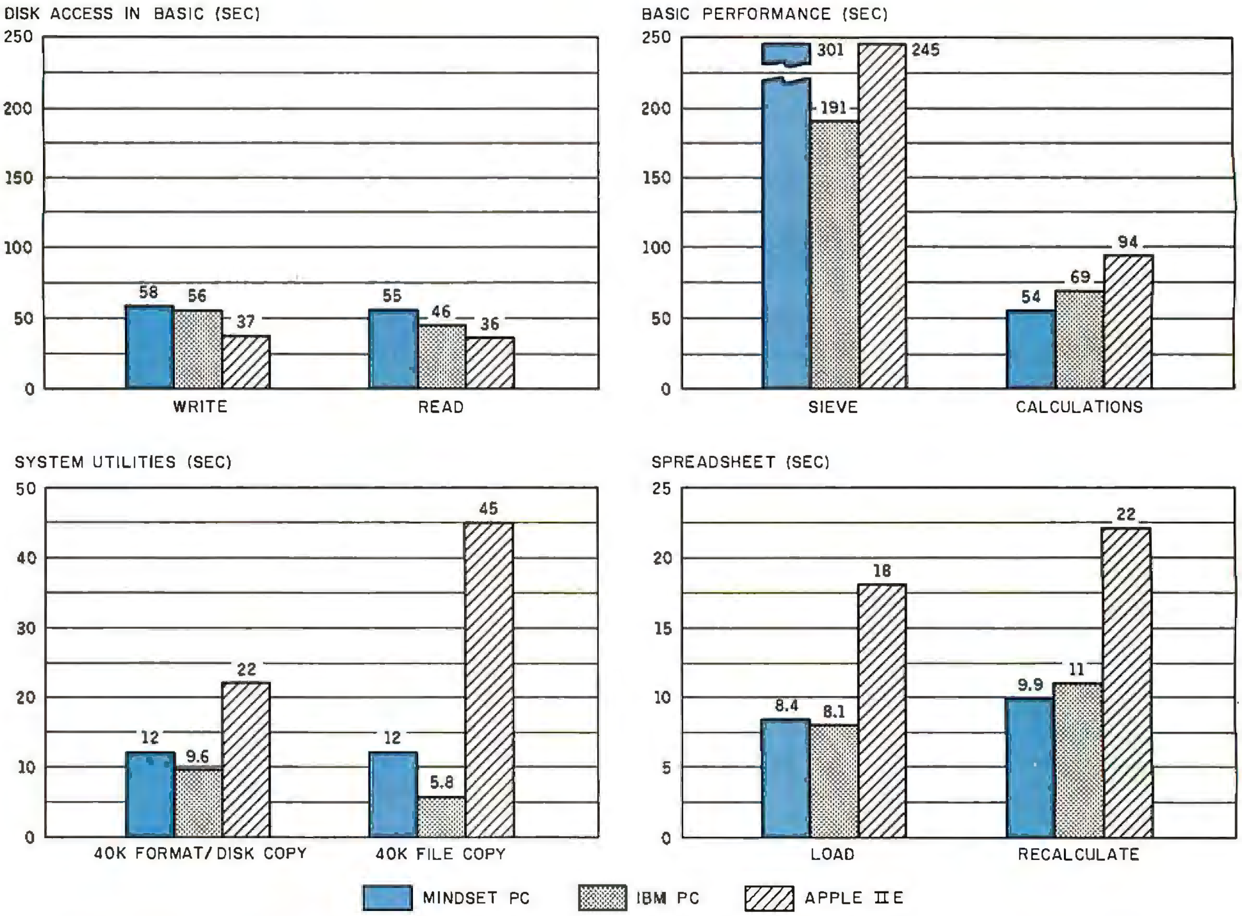


The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity for a single floppy-disk drive and the maximum standard capacity for each system. The Bundled Software Packages graph shows the number of software packages included with each system. The Price graph shows the list price of a system with two disk drives, a monochrome monitor, a printer port and a serial port, 256K bytes of memory (64K bytes for 8-bit systems), and the standard operating systems and BASIC interpreter for the computers under comparison.

The rear panel of the Mindset system unit and expansion unit. Note the three slots on each for I/O modules.



The inside of the Mindset Personal Computer.



The graph for Disk Access in BASIC shows how long it takes to write and to read a 64K-byte sequential text file to a blank formatted floppy disk. (For the program listings, see "The Chameleon Plus" by Rich Krajewski, June 1984 BYTE, page 327, and October 1984, page 33.) The Sieve column in the BASIC Performance graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations column shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. The System Utilities graph shows how long it takes to format and to copy a standard text file to disk (adjusted time for 40K bytes of disk data) and to copy a 40K-byte file using the system utility programs. The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell spreadsheet where each cell equals 1.001 times the cell to its left. Microsoft Multiplan was the spreadsheet used. The tests for the Mindset used Mindset DOS 2.0 and GW-BASIC. Tests for the Apple IIe used ProDOS (except for the spreadsheet test, which was done with DOS 3.3). The IBM PC was tested running under PC-DOS 2.0.

Although the primary purpose is color graphics, Mindset claims that its machine can run a large number of IBM PC software packages. I have successfully run Multiplan, The Final Word, dBASE II, PC/FORTH, Kermit, Turbo Pascal, and Starcross. However, I did not exhaustively test all these packages (especially the Starcross game, which I haven't solved yet). One unfortunate failure was the Microsoft Flight Simulator, which I particularly wanted to see on this machine.

LUMENA

Two software packages that drive the Mindset graphics particularly well are Lumena and the special Mindset version of GW-BASIC. Lumena is a paint program, similar in principle but not in appearance to MacPaint. GW-BASIC is the familiar Microsoft BASIC clone package with special additions to use Mindset's display capabilities.

Lumena apparently runs on a wide variety of graphics machines, of which the Mindset is on the lower end. It was written by Time Arts Inc. of Santa Rosa, California, and it is a real tool for artists and illustrators. Time Arts sells a range of products based around Lumena, including special workstations, animation tools, and digitizers. On the appropriate hardware, you can create some truly spectacular artwork with this package.

A typical Lumena system uses a graphics screen with 512- by 512-pixel resolution and a choice of 256 simultaneous colors. The workspace available on the Mindset is limited to 320 by 200 pixels and only 16 simultaneous colors. While it is not possible to duplicate the efforts of the professional system on the Mindset, some interesting and useful work can be done with the Mindset/Lumena combination (see photos 3 and 4).

Lumena (from now on, I refer to the Mindset version) uses the graphics screen as a frame buffer to store an image the artist can work on. Most of the time the artist sees just his or her design with the Lumena cursor, a small white cross, superimposed. By bringing the cursor to the bottom of the screen, you get the Lumena command menu on the bottom third of the screen over part of the image. Moving the cursor out of the command menu causes the menu to vanish, and the portion of the image that was covered reappears.

Lumena has a tree-structured menu

(continued)

Photo 3: *An example of graphics produced by the Mindset using Lumena software and an IBM PC-compatible RGB monitor. The photo shows the Lumena control panel. This display is overlaid on your drawing when the cursor is moved through the bottom of the screen. Moving the cursor out of the control panel restores the screen to its original condition.*

Photo 4: *Another example of Lumena on the Mindset. This picture is courtesy of Rebecca Wilson.*

interface. This means that some menu selections will bring up a submenu. You select an item by touching the appropriate menu entry with the cursor and clicking the left button on the Mindset mouse. The left button is consistently used to select or draw. The right button always repositions the cursor to the center of the screen.

Clicking a command such as Airbrush causes the cursor to act as such. Some commands, such as Shape, have many possible subcommands, such as Circle or Ellipse. Selecting these commands places you in a submenu. Selecting the Menu option (always the top left choice in each submenu) returns you to the next higher menu on the tree. Selecting the "<" option takes you to the most recently used submenu, so you need not go up to the main menu and back down the other side of the tree.

The basic drawing implements of Lumena are brushes and pens. The differences between these two are slight. You can draw freehand with round circles, squares, and airbrushes (like spray paint). You can also draw straight lines by specifying the end points, circles by specifying the center and radius, ellipses by a center and two points on the circumference, and so on. All of this is done graphically. You do not have to enter numbers for size or position. You point and click.

An Artist Reacts to the Mindset

BY CAROLYN KING

Having been trained in the traditional arts and crafts, I have always tended toward an appreciation of handcrafted artwork and an apprehension about things technological. Using a computer was something I had avoided for years.

My training is mainly as a printmaker and painter. I have always felt that the visceral side of art-making can be as important as the art itself. Manipulating media such as clay, fiber, and paint can somehow set up a bridge between our awareness of ourselves and an awareness of the history behind the art. Although this account might seem quite familiar to other users of mouse-based systems, it is my way of underscoring how surprised I was by the outcome of working on the Mindset with Lumena.

I was surprised at how little time it took to learn how to use the mouse as a drawing tool. In just a few hours, I felt relatively comfortable with the mouse and the mechanics of the Lumena program.

I enjoyed the blend of sculpture and graphic arts used to create images. Bringing the image into view by "sculpting" the negative space (i.e., using black or the background color to nibble away at the picture) is a wonderful addition to the usual technique of painting color on background.

I was surprised and relieved to find that, although the computer is not a "plastic" medium to the senses in the way that paint and clay are, I was able to slip into that "altered state" in which the images flow from me to the medium. This was an important discovery for me and eliminated most of my misgivings about the computer as an art tool.

Finally, as far as the mechanics of this particular unit go, the screen doesn't have good enough resolution, so the artist is limited in the ability to refine the image beyond a certain point.

On the whole, I have been convinced that the computer can be a tool the artist can use like any other. Working with a computer is full of a lot more surprises, however. I went into this with a lot of resistance and preconceived notions. I came away with a much wider view of the computer as a tool for the artist and the stirrings of a serious addiction to the mouse.

With the exception of the Escape key, which is used to abort a command in progress, the keyboard remains untouched during a Lumena session.

In addition to pens and brushes, Lumena provides a wide selection of transformations that you can apply to a portion of the image. You can easily select a part of the display and enlarge, shrink, move, copy, make a mirror image in either direction, rotate, taper, or render it in perspective. You can even take a rectangular piece of the screen and use that as a paintbrush. The special graphics hardware in the Mindset makes these operations happen fast. You can use the mouse to select half the screen and move it around superimposed on the rest of the picture. Lumena can overlay an image using several logical operations, such as AND, OR, XOR, or their complements.

Like the Macintosh's MacPaint program, Lumena's command interface encourages playful exploration. It is easy to try out a function just to see what it does. This feature is the most addictive in the program. Even if you are not an artist, you can have hours of fun doodling on the screen. It is a very malleable medium and an easy one in which to correct your mistakes.

Having no artistic training myself, it seemed prudent to get an artist's opinion. I asked graphic artist Carolyn King to try the system. She was reluctant, having managed to avoid computers up to this point. After a brief introduction to Lumena, I left Carolyn alone with the machine. In an hour I returned to find her using sophisticated commands that she learned by playing with Lumena. After minimal training and an hour of experience, she was making real pictures without resorting to the manual. She could even correct some of my mistakes. That is the mark of a well-designed user interface (see the text box "An Artist Reacts to the Mindset" at left).

BASIC

A strong point of the Mindset version of GW-BASIC is animation. GW-BASIC

(continued)

lets you define "objects" and move them around the screen. During their journey, they may vary their appearance using up to eight different views. They may collide with other objects or perform a specific action upon arriving at a destination. Objects can also be clipped, which means that they can pass through a "window" on the screen, becoming partially, then fully visible as they move into view, and then gradually vanishing as they pass back out of view, much like a car moving past a window.

A simple yet impressive demonstration of the animation facilities comes with GW-BASIC. Across a background of words, a picture of a Saturn-like ringed planet slowly tumbles across the screen. As it hits the edge, it bounces off toward another part of the display. The power of this system becomes evident when you run this program in high-speed mode. Saturn becomes a streak, still bouncing and spinning but whipping across the screen faster than an IBM PC user would think possible.

As for non-graphics capabilities, GW-BASIC performs in the same ballpark as the IBM PC. Mindset's GW-BASIC, together with some special video interfaces Mindset has designed, might provide the basis for some impressive video-production systems (see the text box "Update on Mindset" below).

PROBLEMS

Every system has some flaws, and the Mindset is no exception. One particular annoyance is the insistence of the operating system to look for its Command program (COMMAND.COM) only in the current drive. For example, if you are running Multiplan on drive B and you quit, the system will check only drive B for COMMAND.COM, never A. Fortunately, many applications will be unaffected by this, since they leave the resident copy of COMMAND.COM in memory while they are running.

A slight but annoying feature involves the mouse's design. The mouse cord is very thick, as big as the power cord for the system unit. The placement of the mouse connector on the side of the keyboard, combined with this monstrous cable, means that you constantly readjust the cord to get it out of the way. A thin mouse cord with a connector on the system unit would have been appreciated.

A major problem with this system has to do with copy protection. Both Lumena and the disk-based version of GW-BASIC are copy-protected. You can copy each disk, but neither will run unless the original disk is in the default drive. I would be very hesitant about buying software that does not permit at least one working backup copy.

Lumena appears to have a bug in the way it writes to the disk. The Lumena manual says that the correct way to run the program is to keep the master disk in drive A with the working disk in drive B. Then you set B as the default drive and you enter A:LUMENA. Thus, you are running the program from drive A but writing by default to drive B. This does work and it is the only way that it works. Reversing the disks or running from drive A and using the Lumena command to change the current disk cause big problems. In particular, saving a file to drive B will eat up all the available space on that disk and Lumena will die. The disk can be fixed with the Recover program.

Lumena also seems prone to "Zero Divide" errors. These happen occasionally for no apparent reason. They cause Lumena to crash and return to DOS. Luckily, the Mindset frame buffer is not cleared on each invocation of Lumena, so it is sometimes possible to reenter the program and find your work retained in the graphics memory. Still, I would prefer to avoid the need for such error recovery.

CONCLUSIONS

All in all, the Mindset is a pleasant alternative to the IBM PC. If you have no need for graphics, you have no compelling reason to select this machine over many of the other IBM compatibles on the market. But if your application requires fast, easy-to-use, medium-resolution color graphics, and particularly if you want animation capability, the Mindset/Lumena combination is hard to beat. ■

UPDATE ON MINDSET

BY RICH MALLOY

Mindset has recently been aiming its machine away from the general consumer market and toward professional graphics designers. This is evidenced by the fact that consumer-oriented software such as games has not been developed for the machine, despite the fact that the Mindset's graphics hardware seems well suited for such applications. Instead, Mindset has made available some special video-related products that might be more at home in professional video studios.

A special version of the system unit includes Genlock circuitry to let it interact better with video equipment. There is also an external video-production module that lets you mix the Mindset's computer-developed graphics with signals from standard cameras and recorders. According to Mindset, these options let you superimpose Mindset graphics on video images. In addition, you can fade graphics in and out. The special Genlock circuitry costs an additional $500; the video-production module is $799.

I have not tested this equipment, but Mindset claims that its system is already being used for graphics in a new television game show entitled "Catch Phrase," which should debut this fall.

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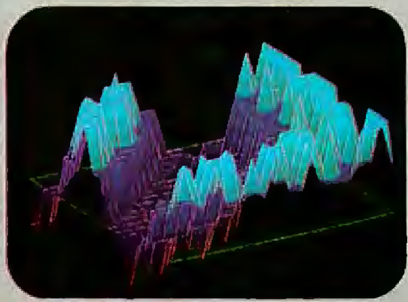

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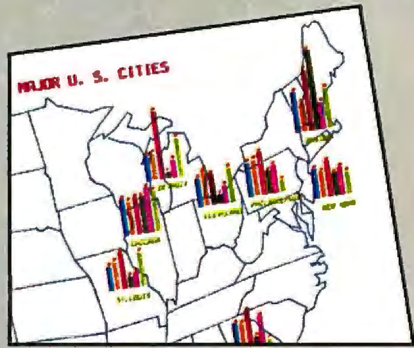

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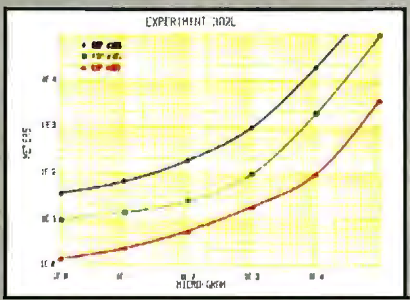

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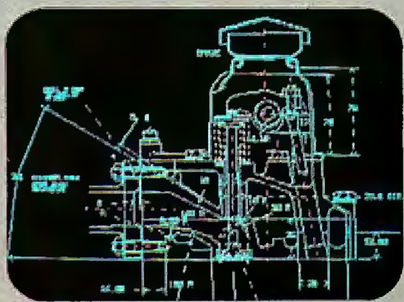

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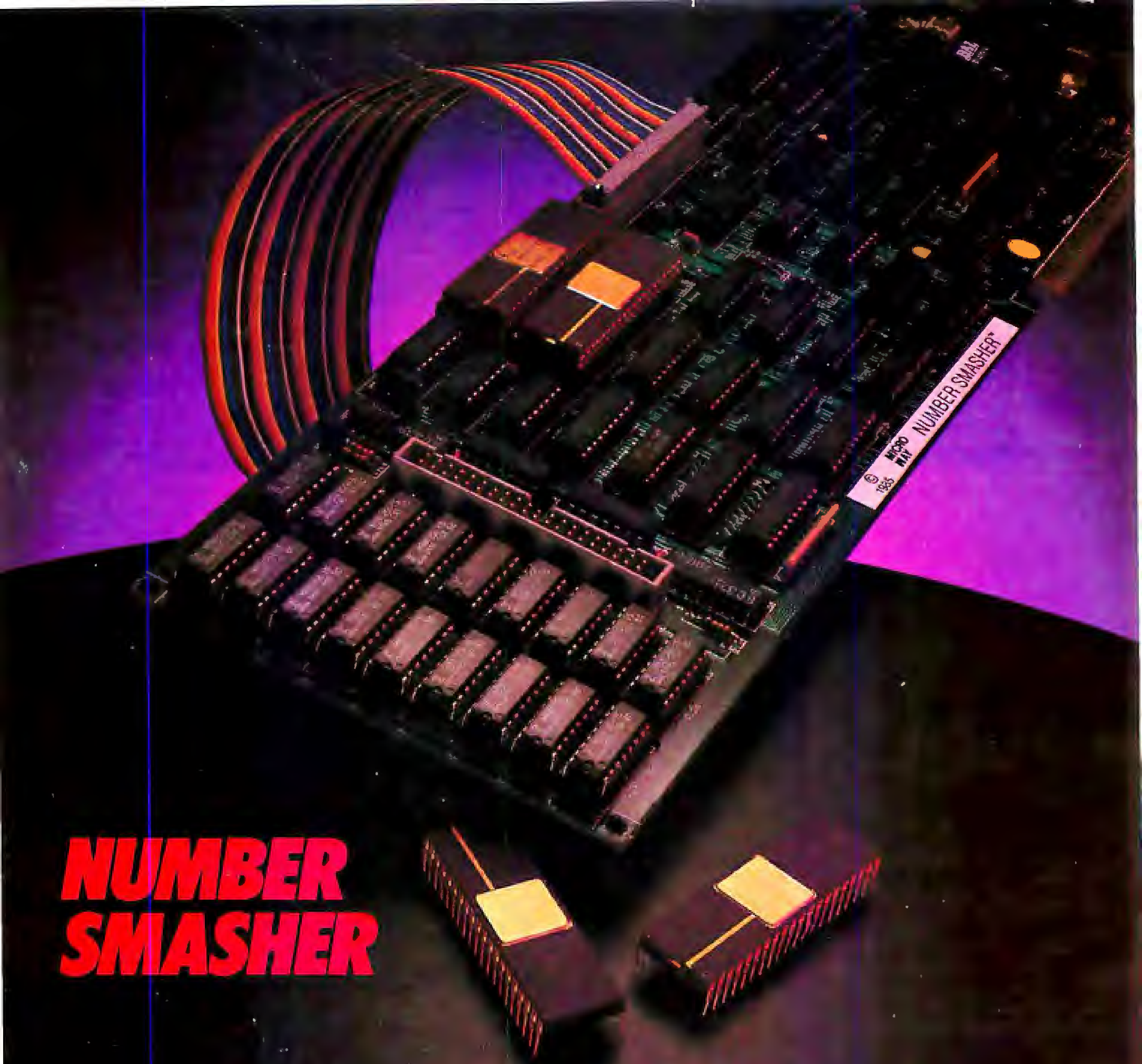

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Idea Processors

ThinkTank

Executive Writer/

Executive Filer

THOR

Framework

BY WILLIAM HERSHEY

An idea processor is a tool for organizing blocks of text. Because text is a critical part of the final product, idea processors incorporate some type of text editor, even a full-blown word processor in some cases. So far the products that call themselves idea processors seem to fall into two classes: outline organizers and computerized index-card retrieval systems.

Like spreadsheets, these tools are applied in as many ways as there are users. I prefer outline processors to index-card systems. They are better at giving you a top-down view of things, which is supposed to be the best way to think. If you have a large amount of textual reference material to manage, an index-card system might better meet your needs. But keep in mind that it is easy to structure an outline to work like a deck of cards.

Idea processors are growing in popularity, and their range of capabilities varies widely. This review examines four. One program is an outline processor, two are index-card systems, and the fourth can be used both ways. All four packages are available for the IBM Personal Computer (PC) and compatibles; ThinkTank is also available for the Macintosh. I tested the IBM versions on a Compaq with 640K bytes of RAM (random-access read/write memory) and two floppy-disk drives.

THINKTANK

Billed by Living Videotext as the first idea processor, ThinkTank is a versatile outlining tool with a decent text editor. Since the program's introduction on the Apple II and III, reincarnations with varying capabilities have arrived for the Macintosh and the IBM PC. The command tree in the PC version is complex. But once you discover the shortcuts, you won't have any trouble using it. The version for the 128K-byte Macintosh, called ThinkTank 128, is like a sports car. It won't hold much, but it's fun to drive and gets you where you're going fast.

I first used and reviewed ThinkTank (on an Apple III) more than a year ago (see my review "ThinkTank" in the May 1984 BTYE, page 189). Now that the IBM PC and Macintosh versions have been on the market for a while, that review deserves an update. The IBM version is much improved over the first Apple versions. Disk accesses are reduced, paragraph capacity is dramatically increased, and editing is easier. But the commands for the PC version could confuse novices. The initial Macintosh version has limitations and design problems, but its simplicity and speed make it effective.

ThinkTank outlines have just a few key elements. You can enter headlines as long as 77 characters. Each headline can have any number of subheadings beneath it and, with the IBM PC version, a "paragraph" of up to 20,000 characters of text. You can break up ThinkTank's paragraphs into your own smaller paragraphs by inserting "hard" carriage returns. The subheadings can have more subheadings and paragraphs beneath them, up to as many as 10,000 levels.

A bar cursor highlights each headline as you scroll through the outline. You can "expand" a headline (using the plus-sign key on the PC's numeric keypad) to see the subheadings and paragraphs beneath it, or you can "collapse" it (using the minus-sign key) to hide all the subordinate levels. ThinkTank automatically precedes each headline with a plus or minus sign. A plus means that the headline has subordinate levels or paragraphs. A minus means that no deeper levels exist.

The ability to collapse or expand an outline at any headline level gives you many ways of viewing the ideas that make up your outline. This, combined with the ability to move headlines and insert new ones at any point, is the essence of idea processing, ThinkTank-style. ThinkTank 128 does not let you enter paragraphs under the headlines. That's a serious drawback, but the benefit is speed. With your whole outline in mem-

(continued)

William Hershey (MITRE Corp., 1820 Dolley Madison Blvd., McLean, VA 22102) is a systems engineer with a B.S. in engineering from Princeton and an M.A. in computer and communication sciences from the University of Michigan. He is also an instructor in computer literacy at the University of Maryland's University College.

Except for the lack of paragraphs, ThinkTank 128's biggest flaw is its unconventional user interface.

ory and the mouse to guide you through the commands, the program is a joy to use. (ThinkTank 512, with enhanced capabilities that include paragraph and image handling, should be on sale by the time you read this but was not available for this review.)

In converting the program from the Apple III to the PC, Living Videotext made some commands easier to use by assigning them to the PC's function keys and the keys on the numeric keypad. Unfortunately, the company left all the old commands intact and mixed function keys, the Insert and Delete keys, and single-letter commands in the same main command menu. This could make the command structure seem very complex to a first-time user. In some cases, there are as many as three paths to travel to perform a given operation. Once you have learned the program, of course, you avoid the long detours and take the express route. Replacing the old menu commands with function-key definitions at the bottom of the screen might simplify the process.

The editor works well. You can move through a paragraph quickly and easily by using the numeric keypad. Moving and copying text between paragraphs, however, is tedious. Once you leave a paragraph and go to another one beneath a different headline, you are effectively editing a different document. Selected blocks can't go with you. Whole paragraphs can be merged, but only if their parent headlines are adjacent.

Using ThinkTank 128 is quite easy because of the Mac's pull-down menus and the use of the mouse. You control the position of an arrow on the screen with the mouse. When you click the mouse button, a box appears around the nearest headline. Double-clicking makes a headline's subordinate levels expand or collapse. Finer control with the mouse lets you put a vertical bar inside the boxed headline to set an insertion point for editing. Holding down the mouse button changes the sharp box around the headline to a fuzzy one, and you can then drag it along with all of its subheadings to a different spot in the outline (see photo 1). Here the Macintosh really outshines the PC. You can also move headlines the old way, using the keyboard. The keyboard commands are most useful for inserting new headlines.

The Macintosh Clipboard works as expected for some cut-and-paste operations, including sending all or part of your outline to another application like MacWrite. But drag selection for cutting and copying does not work within a headline; the Backspace key is your only deletion tool there. In fact, drag selection is not implemented anywhere in ThinkTank 128. Consequently, you cannot select groups of headlines for deleting, moving, or copying unless they all fall under a high-level headline.

Sorting of subheadings and searching for strings of text are available in another pull-down menu. They are easier to use here than in the PC version, which has them buried deep in the menu tree. Unfortunately, however, ThinkTank 128 has no Undo command as do many Mac programs. When you delete part of your outline or sort a set of subheadings in a way you don't like, you have no way to restore things to their previous condition.

Except for the lack of paragraphs, ThinkTank 128's biggest flaw is its unconventional user interface. Scrolling is one example. Instead of using the predefined "scroll bars" from the Macintosh's built-in routines, the Living Videotext programmers invented their own "hot" border surrounding the text window. It's the same gray

Photo 1: *In the Macintosh version of ThinkTank, moving headlines and their subheadings is much easier than in the IBM PC version. When you hold the mouse button down, a fuzzy box appears around the headline and everything subordinate to it. You can then drag it where you want it.*

AT A GLANCE

Name	ThinkTank	Executive Writer/ Executive Filer	THOR	Framework
Type	Idea processor	Idea processor	Idea processor	Integrated package
Manufacturer	Living Videotext 2432 Charleston Rd. Mountain View, CA 94043 (415) 964-6300	Paperback Software International 2612 Eighth St. Berkeley, CA 94710 (415) 644-2116	Fastware 200 Freeway Dr. East East Orange, NJ 07018 (800) 372-2345	Ashton-Tate 10150 West Jefferson Blvd. Culver City, CA 90230 (213) 204-5570
Computer	256K IBM PC, 128K and 512K Macintosh, 64K Apple II family, 96K Apple III, 384K Data General/One	192K IBM PC, 256K PCjr	128K IBM PC	384K IBM PC
Features	Outlining, text editing, formatting	Index-card retrieval and word processing	Index-card retrieval and text editing	Integrated outlining, word processor, database, spreadsheet, graphics, telecommunications
Documentation	User's manual	User's manual	User's manual	Tutorial, reference manual
Price	IBM PC, $195; 128K Macintosh, $145; 512K Macintosh, $245; Apple II family, $150; Apple III, $150; Data General/One, $195	Executive Writer, $69.95; Executive Filer, $49.95	$295	$700

pattern as the normal Mac desktop background. A press of the mouse button when the arrow is on one of the four borders causes the text to scroll away from that border. Clicking on the corners causes diagonal scrolling.

It sounds easy and it is. But Mac users are used to seeing scroll bars with arrows and a "thumb" that can be dragged to a relative position in the document. Giving them a nonstandard alternative to what they already know is contrary to Apple's philosophy of keeping the Macintosh user interface consistent from one program to another. This is one of the few features I had to find in the manual before I could make full use of ThinkTank 128.

ThinkTank's diagonal scrolling is not available with standard Macintosh scroll bars. But how many times have you wished for diagonal scrolling? Another shortcoming is that you cannot drag or size the ThinkTank 128 outline window (at least not in the version I tried).

Even the IBM PC version of ThinkTank does not claim to be a word processor. Although it lacks advanced editing and formatting features, it does a decent job of putting an outline on paper. For some features, the paragraph editor in the IBM PC version of ThinkTank is easier to use than Executive Writer (reviewed later), which does claim to be a full word processor. Neither program formats text on the screen as it will appear on paper, but at least ThinkTank reformats paragraphs automatically to end lines at word boundaries. Executive Writer requires the press of a function key for that.

ThinkTank lets you format output as DOS (disk operating system) text files (with hard carriage returns after each line) for polishing with your favorite word processor. WordStar users will appreciate the option that inserts WordStar formatting codes into the output file. ThinkTank's 17 format options include outline-specific information, such as the number of spaces for indentation of the various levels and the depth for printing headlines, paragraphs, and section numbers. ThinkTank will print a table of contents to the level you specify and automatically insert the page number where each section heading will appear. The version for the 128K-byte Macintosh, however, severely limits printing capabilities. You highlight a headline, and the program will print out that headline; all others become subordinate to it. You have no control over outline depth and no table of contents.

The IBM PC version comes with two manuals. The well-written user's manual combines a tutorial approach with a full account of how things work. The last 10 pages are reproduced as a separate quick-reference guide to help you keep track of commands. ThinkTank 128's documentation is of similar quality but takes a different approach. It has a tutorial section and two reference sections, covering the specific and the general. ThinkTank's simplicity on the Macintosh eliminates the need for a Mac quick-reference guide.

Both versions come with one disk that contains the program and sample outlines. Unlike the Apple III version that I reviewed earlier, the IBM

(continued)

and Macintosh disks are copy-protected. With the IBM version you can copy the program to your own disk (including hard disk) and execute it from there, but you must have the master disk in drive A when you start the program.

EXECUTIVE WRITER/ EXECUTIVE FILER

[Editor's note: Prior to January, Executive Writer and Executive Filer were marketed as one package, called The Idea Processor. The developer, Idea Ware, split the package and sold the two programs to Adam Osborne's Paperback Software International (PSI) for distribution. In its new incarnation, the product has been upgraded to version 2.0 and repackaged as Executive Writer and Executive Filer. Each package consists of a manual with a software disk inside the back cover. The packages sell for $69.95 and $49.95, respectively. Version 2.0's reported improvements include on-screen formatting, horizontal scrolling, and enhanced speed. Steve Cook of PSI said that version 2.0 provides on-screen help, printing from within the editor, and many WordStar-like control-key sequences. Cook explained that the package is offered as separate modules because PSI wanted a word processor and felt that The Idea Processor's was a good one. Buyers who purchase both modules integrate them by using a routine provided by PSI that needs to be invoked only once. PSI provides all support for both packages.

Mr. Hershey initially reviewed The Idea Processor but has added material to reflect the capabilities of the new packages.]

Executive Writer and Executive Filer combine a flexible word processor with an indexed "cardfile" system that lets you search for cards by keywords. You can shuttle blocks of text quickly between the cardfile and your document. Features include keyboard macros and the ability to store and recall graphics images for insertion into your text.

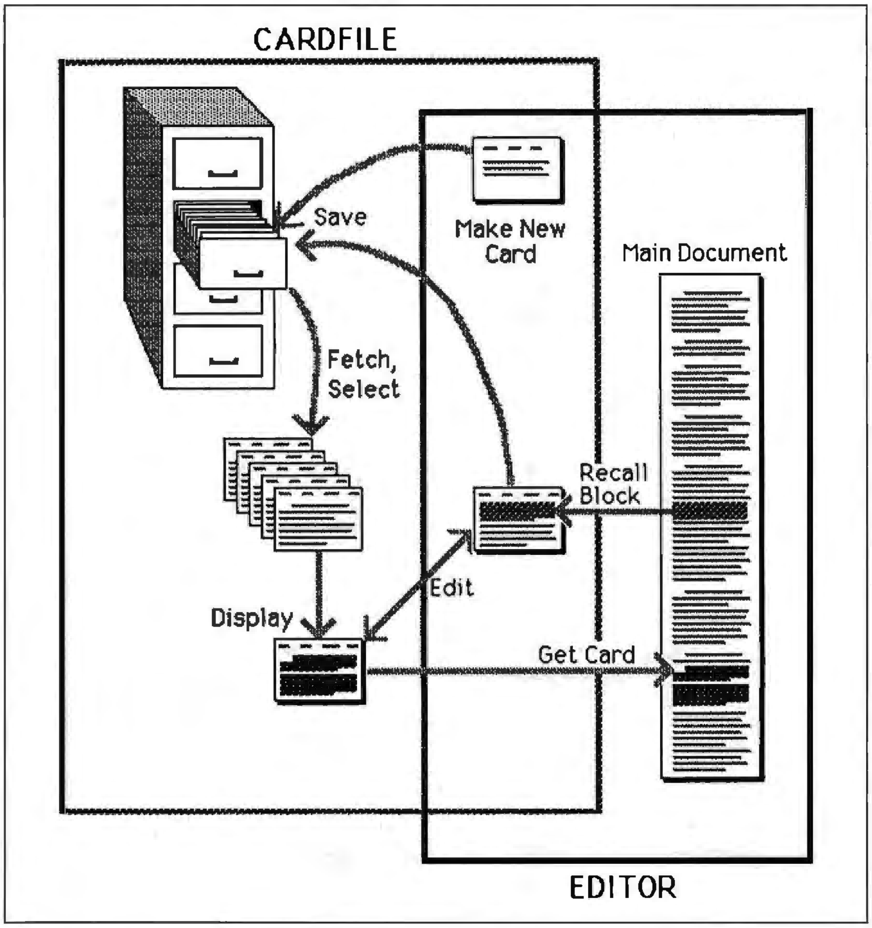

Figure 1: *With Executive Writer and Executive Filer you can create and organize blocks of text on "cards." You can move text back and forth between the cardfile and a document in the editor.*

In The Idea Processor, as well as in Executive Writer and Executive Filer, the word processor and cardfile are integrated. The cardfile resides in a hierarchical system of "drawers" and "cabinets," making it easy to relate to the real world. Figure 1 shows an overview of the system's operation.

Unlike ThinkTank, Executive Writer and Executive Filer do not help you visualize the big picture. Your document consists of straight text, just as it would in any word processor. You have no tools to experiment with the overall structure of your work. The value of Executive Filer lies in finding blocks of text by keyword. Especially if you keep a large amount of reference material on disk, this retrieval feature could save you time.

Even if you don't need the cardfile, Executive Writer might meet your word-processing needs. It has many features and is relatively easy to learn and use. When used with the Ctrl key, the cursor keys on the numeric keypad and the Insert, Delete, Backspace, and Tab keys position the cursor to the beginning or end of a line, to the top or bottom of the screen, or to the next or previous word. A status line near the bottom of the screen shows whether the insert, wordwrap, boldface, and underline features are on or off.

Function keys handle most of the other word-processing commands. An information line at the bottom of the screen labels them. They work alone or in combination with the Ctrl, Alt, and Shift keys to invoke 40 different operations. I found using the function keys cumbersome in some cases. Block operations, for example, use Ctrl with the function keys. Copying a block of text requires pressing Ctrl-F3 to begin the block, moving the cursor to extend it, Ctrl-F4 to end it, moving the cursor again to indicate where you want the copy, Ctrl-F7 to put it there, and Ctrl-F5 to make the highlight on the original block disappear. Deleting and moving blocks requires similar finger contortions. Fortunately, shortcuts with the Ctrl, Alt, Backspace, End, and Delete keys make it easy to delete individual words or all or part of a line, eliminating the need to select a block for deletion.

Executive Writer's search and replace capabilities are flexible. The function keys work with the Shift key to activate them. You can define up to 10 keyboard macros with as many as 100 keystrokes each. They disappeared when you left The Idea Processor, but in Executive Writer you can save them along with margin and tab settings. You assign each a number from 0 to 9 and call them by pressing Ctrl and the appropriate number. You can nest macros within each other as long as you don't ask a macro to call itself. Macros work with the cardfile's editor, too.

Besides the minor complaints already noted, The Idea Processor's biggest shortcoming was the editor's inability to format text on the screen as it will appear on paper. Some format features like boldface and underlined text did appear on the screen, and Executive Writer adds on-screen margin control to these. Page breaks are still left to your imagination. Another annoyance that remains in Executive Writer is the need to press F2 periodically to reformat the current paragraph.

Each format command is a two-letter code. Pressing F6 generates a special "feather" symbol that precedes the code. There are 24 of them, giving you the usual formatting capabilities plus special features like even/odd logic in headings and footings, automatic numbering of footnotes, automatic counters anywhere in the text (for section numbers, etc.), and insertion of graphics images into text. A separate Print program prints your document. If your printer is not one of the standard ones supported, PSI supplies a utility to help you create the necessary printer-configuration file.

The Idea Processor lacked a graphics editor, and so does Executive Writer, but the manual tells how to save screen images from other programs. Idea Ware publishes one called The Graphics Idea, which includes the SlideShow facility. The manual provides examples of others such as Lotus 1-2-3, VisiPlot, and dGRAPH II. The file format is the same used by the BSAVE command in BASIC. A SAVESCREEN utility lets you save the graphics images for access from the editor or cardfile. File operations, invoked with Alt and the function keys, let you save all or part of a document. After saving a document, The Idea Processor required you to leave the editor and reload the document to resume work on it. Executive Writer has an Update feature that avoids this extra step. Once a document is loaded, you can insert text from other files and from cards in the cardfile.

In the cardfile, provided by Executive Filer, you can peruse your indexed ideas for just the right one to insert in your document. Or you can take a highlighted block of text from the main document to store on a card for later use. You won't have a split screen or windows to keep your document in view while you examine cards, but switching between editor and cardfile screens is nearly instantaneous.

Instead of function keys the cardfile uses menus to help you organize cards. The first thing you do when accessing the cardfile is make or unlock a cabinet. Each cabinet holds up to eight drawers, which in turn hold thousands of cards (depending on the space available on your disk). Each card in the cardfile holds up to 8000 characters. You edit the card with the full set of commands used to edit

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Inquiry 161

documents in Executive Writer. After creating the card, you specify which drawer it's to be stored in and enter a list of keywords to use in retrieval.

You can fetch a card or set of cards by specifying a keyword or pressing the tilde (~) as a wild card to fetch them all. Then you can browse through them one at a time. Once a card is displayed, you can modify the selection criteria by specifying Boolean operators (AND, OR, NOT) that combine the current list of keywords with others. With only these search mechanisms, Executive Filer lacks power as a database manager. But the keyword retrieval scheme is effective and simple and should meet most people's needs.

In addition to Executive Filer's obvious text-classification uses, the package can be useful to programmers. With wordwrap off and no boldface or underlined characters, files are standard ASCII (American Standard Code for Information Interchange) text files that can be read by compilers and interpreters. You can use the cards to organize and store subroutines.

The two extensive demonstration disks that came with The Idea Processor are not included with Executive Writer/Executive Filer. The new version does have a file illustrating a simple application. The new manuals have "quick courses" to get you started, and the Executive Filer manual has an "expert" section with tips on various ways to use the package. The new software requires you to have the master disk inserted when you start the program. After you register, you can get an unprotected copy for $10.

Although it lacks ThinkTank's outlining and sorting capabilities, Executive Writer is a better word processor. Executive Filer's retrieval features are also more flexible than ThinkTank's, though limited in comparison with most database managers. It appears well suited to large writing projects that require the assembling and indexing of much information. The program would also be useful to reporters or authors who want to keep a disk library of material for reference.

THOR

If you want a program that puts commands on the screen in color and gives you total control over the color and intensity of your text as you type, this one from Fastware is for you. THOR stands for "thought organizer." According to the manual, it "combines the free format facility of a word processor with the power of a database manager." Unfortunately, it doesn't perform either function very well. Commands are inconsistent with common sense, and the text editor is awkward to use.

For retrieval of text blocks, THOR works more like a conventional file-management program than Executive Filer, which provides search capability on up to 10 keywords for each record. THOR stores a block of text, which it calls a "thought," with up to 5 categories or fields plus the date you entered the information. The total number of categories in a database of thoughts can be as many as 255, but any given thought can use only 5 of them.

Retrieval by category can occur at two levels. You can search your thoughts to find the ones that merely *have* a category or a set of categories. Or you can be more specific and search the contents of those categories. You can thus mix several types of records in the same database and still find what you want.

Two other selection criteria are available. You can search for thoughts created within a specified range of dates, and you can search for thoughts containing any of three specified strings of text. If you want to use combinations of the three

(continued)

types of selection criteria, they are automatically connected with AND operators—that is, a thought must meet all the criteria specified in order to be selected. Selection of thoughts is thus rather inflexible.

If I seem to be dwelling on the database aspects of this program, it is because the program authors have dwelled on them. The tutorial does not show how to classify and organize blocks of amorphous text, brimming with intertwining ideas. A real "thought organizer" should do that. Rather, the tutorial illustrates in detail how to work with a database of restaurants in New York City and select the French ones in midtown that serve duck (see photo 2).

The most annoying feature of THOR is not its limited capability but its terminology. As I've noted, a block of text is called a thought. This leads to the terms "thought maintenance," which you and I know as text editing; "thought categorization," which entails entering database fields and their values; and "thought review," which we normally call record selection. And it goes downhill from there.

Let's turn now to thought maintenance (text editing). There are two editors—a "field editor" for fields and a "screen editor" for larger blocks of text. They work differently. The field editor works only with capital letters. No matter how you type them in, they appear as capitals. I suppose this is to facilitate "BRAINscanning" (retrieving records). The Delete key erases an entire field, not a single character as it does in the screen editor. However, fields are limited to 12 characters, so you won't have much to retype.

In the screen editor, the up and down arrows take you to the previous or next line. In the field editor, it all depends. If you have not made any changes to the field yet, these arrows take you to the previous or next field, respectively. Be careful using the up arrow, however; the manual warns, "Sometimes to insure data integrity, THOR will not allow you to do this and will tell you so with a beep." Using the down arrow in this situation, the manual states, "is similar to using the RETURN key except on some screens the down arrow key will jump over a group of subsequent fields." If you have made changes to the field, pressing either the up or the down arrow—or the Esc key—replaces the changes with the original default value and moves the cursor to the beginning of the field.

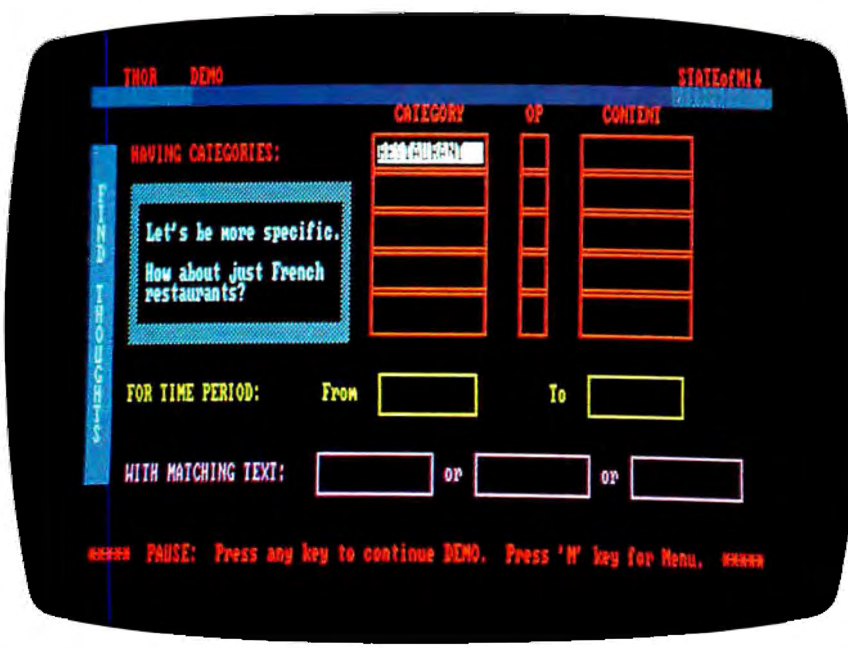

Photo 2: THOR *is pretty and colorful, but it lacks power in both its file-management and text-editing operations.*

Now that you have mastered the field editor, we can move to the screen editor. Unlike Executive Writer/Executive Filer, THOR does not focus on a single main document that can be assembled by the screen editor from smaller blocks of text. The only unit of organization for a THOR database is the thought. THOR's thoughts, however, can hold more than Executive Filer's cards. Fastware claims that thoughts can be as large as 40,000 characters, depending on your machine's amount of RAM.

THOR's screen editor has cut-and-paste commands, but they're not like the ones in most word processors. Cut breaks the current line into two lines at the cursor position. Paste reformats a paragraph from the cursor position, like Ctrl-B in WordStar or F2 in Executive Writer. There are no block move or copy commands, but you can save a block of text to a file and load it in again. The screen editor does not have a destructive backspace, but it has a typeover mode, called Edit mode.

Although I am not fond of this editor, it does have a feature not found in most word processors. In the upper right corner of the screen is the current attribute character, which shows the color, intensity, and other characteristics (like underlining, flashing, and reverse video) of the characters to be typed. By pressing the Alt key in combination with others, you can affect the way each character in your block of text will be displayed. The graphics attributes work only within THOR and cannot be saved with text files for use in other programs.

THOR provides limited on-screen formatting in the form of margin and tab settings. Print-formatting commands must be inserted into text and are confined primarily to page-length settings. The INCLUDE formatting command lets you string thoughts together as they are printed.

Like Executive Writer/Executive

Filer, THOR can save and load straight ASCII text files. The jobs that THOR claims to handle best are some of the same ones cited by PSI for Executive Filer. THOR's manual was 44 pages of poorly written dot-matrix printout in a loose-leaf binder. Fastware claims to have improved the documentation. It still has no index.

FRAMEWORK

The real champion of idea processing is Framework. The top level is an outline organizer in the manner of ThinkTank but with more power and flexibility. It also offers screen-formatted word processing, a database manager that you can use as a cardfile, spreadsheets, graphics, and telecommunications with Macintosh-like pull-down menus and consistent, easy-to-use commands. Naturally, it's the most expensive offering, and it requires lots of memory (256K bytes minimum).

Framework's applications and capabilities extend far beyond those of the other programs in this review. The outline is the web that ties together all applications. As tempting as it is to dig into all of Framework's features, I will focus here only on the parts of Framework that are similar to other idea processors. (For more information, see the product preview of Framework in the August 1984 BYTE, page 121.)

Just as ThinkTank can create headlines with subordinate subheadings and paragraphs, Framework can create an outline with many levels. Commands for expanding and collapsing work on any part of the outline in much the same way they do in ThinkTank. Each line in the outline represents a "frame." A frame can remain empty or contain text, a database, a spreadsheet, a graph, or other frames.

To understand what Framework can do to help you process ideas, it is first important to understand how frames work. A frame is a box that you can resize and relocate anywhere on the screen. Frames overlay each other as you use them, but you can put them away at any time. The only limit to the number of active frames is the amount of memory in your IBM PC.

There are five types of frames. Your title for each one goes into its border at the upper left. You can have a "container frame" that merely holds other frames. Each application also has its own type of frame: word processing, spreadsheet, database, and presentation graphics. The manual claims that a sixth type is the outline frame, but that's not quite right. Outlines are merely container frames displayed in "outline view."

When you decide to make an "empty/word" frame into a container frame, you can put only other frames into it. You cannot use it to store blocks of text unless they are inside other frames.

If the screen weren't green, you'd swear that Framework was running on a Macintosh. The pull-down menus appear quickly. The function keys have a single set of actions and operate consistently throughout all applications.

The top of the screen has a line of nine menus. You will need most of them for idea processing. The Disk menu loads and saves files and gives you access to DOS and other programs. (When you are done, you return to Framework with a frame full of whatever DOS put on the screen. I even ran ThinkTank from within Framework to compare some features of the two programs.)

The Create menu makes empty frames. Creating an outline frame is the logical first step in beginning a project. The resulting container frame has empty section headings (each representing a frame) in a predetermined format. After you learn Framework, you'll probably prefer to create your own container frame with your desired outline format. The Edit

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Framework outlines have a triangle in front of frames with subframes.

menu lets you choose Insert or Typeover mode and has an Undo command. The Locate command is for searching and replacing strings; it also has ascending and descending sort commands that sort sections in an outline as well as fields and columns in databases and spreadsheets.

The Frames menu has a number of commands unique to Framework (see photo 3). Normally when you add frames to an outline, the program puts one below another in "column" format. An alternative in the Frames menu is referred to as "Allow Free Dragging." A better term would be "allow vertical dragging" because you can always move frames horizontally on the screen. Only when you have allowed free dragging can you drag frames vertically.

Free dragging can come in handy when polishing writing. If you have two alternative paragraphs you need to compare for the best wording of an idea, you can put them in frames and put the frames side by side. They will appear on the printed page in that arrangement until you decide which one to delete. This is also a great way to print multiple columns of text on a single page or print blocks of text scattered haphazardly over the page.

Although ThinkTank numbers the sections of your document and generates a table of contents with page numbers, these features are available only on the printed output. Framework lets you view them on the screen as you work. When you add a new frame to your outline, the section numbers are automatically adjusted to accommodate it. Both programs use a hierarchical numbering scheme (for example, 1, 1.3, 2.4.1, etc.).

Framework outlines have a triangle in front of frames with subframes. You have the option to "Reveal Type" for each frame. Frame types are empty/container, word, database, spreadsheet, and graph.

If you are writing a document with a block of text in each subframe of your outline, it is easy to see how well you are progressing. Just check the number of frames marked (W), for word frame, against the ones still marked (E), for empty/container frame.

Two especially useful keys with Framework are F9 (Zoom) and F10 (View). When used with a typical document consisting of an outline and word frames, they can provide four different ways of looking at the document. The use of these keys can be confusing at first because where they take you depends on where you've been. I tend to stick with F9 most of the time to zoom back and forth between outline and full-screen views of text. The view accessible via F10 shows a nested set of frames with part of the text visible inside each one.

For linear narrative, in which one idea flows logically to the next, you may find the frames view unnecessary; the outline provides a better overview, with the full-document view providing the detail. The frames view lets you be very creative in using Framework's display to show logical or dependent relationships between frames of text. Framework can be a two-dimensional tool for writers, just as spreadsheet programs are for number crunchers.

Framework uses margin settings within frames so you can see roughly how your text will appear on paper. You can scroll horizontally to 255 columns, and paragraph reformatting is automatic when you insert new text into the middle of a paragraph. The Words menu at the top of the screen has a few key attributes to control margin, justification, and tab settings. It also has switches for boldface, underline, and italic attributes. You can also select combinations of these styles, and the type on the screen reflects your choice. For other formatting features, however, Framework uses formulas that you load into the frame border. These control paging, headers, footers, and the like.

The biggest formatting deficiency is the lack of page-break lines on the screen. Because a finished document is likely to be produced from a series

(continued)

Photo 3: *Framework's pull-down menus are fast and easy to use.*


PAGE: 7 KNIGHT-RIDDER MoneyCenter 15-Feb-85 05:24P
MoneyCenter
ACTIVE TREASURIES
Issue Maty Price Change
3-MO 5-16 8.19-15 +.02
6-MO 8-15 8.27-23 +.02
11 1/4 2/15 99.01-04 -1.4
Symbol Last Change High Low
B-POUND 1.1030 +0.0120 1.1045 1.0960
D-MARK 0.3073 +0.0030 0.3075 0.3059
SW-FRNC 0.7305 +0.0144 0.7320 0.7200
YEN 3913 +65 3916 3892
T Amer Telephone & Telegraph
SPH TICK CHART 04:22P
HI=183.65 LO=181.20 181.85St -1.00
LA: 21 3/8 CG: +0 1/8
PV: 21 1/4 VL: -0
O1: 21 1/8 C1: -0
CH: -0 CL: -0
182.00
181.60
181.20
100 150 200 250 300
5616 05:19P Economist advises near-term caution in fixed-income markets
5612 05:18P Kessler sees FOMC holding to a relatively accommodative mode
T LA: 21 3/8 CG: +0 1/8 OP: 0 PV: 21 1/4
MoneyCenter
Monitor colors simulated
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of frames, page-break lines would be understandably hard to implement. You can, however, use the "widow orphan tolerance" parameter in Framework's configuration file to set the minimum number of lines allowed stranded as a widow or orphan when a paragraph is broken. You also can preview a document before printing by saving the formatted version into a DOS text file and then loading that file as a new frame. Your printer-control codes will show up as IBM screen-graphics characters, which can be a big help in debugging printer-formatting problems. The spooling feature is nice, too. When you print your document, Framework writes it to a temporary disk file and prints it from there, so you can get back to work right away.

Photo 4: *You can look at a Framework database in "forms view," which lets you set up a database as a cardfile system to manage blocks of text. Every field in every record is a frame.*

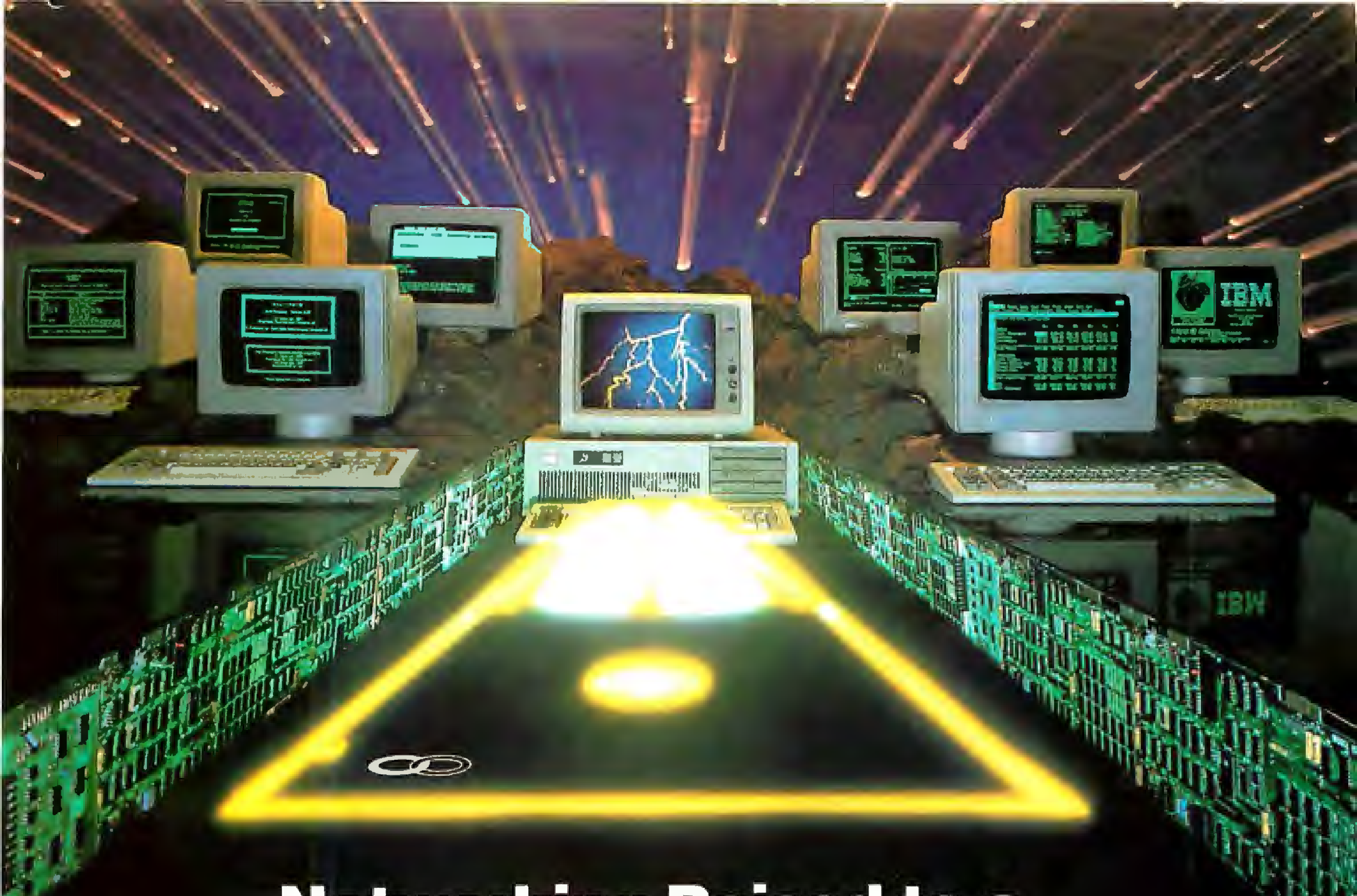
Photo 5: *An alternate view of the Framework cardfile database in photo 4 shows the first several words in each field and lets you scan through and sort your cards.*

Framework far surpasses all the other idea processors for straight word processing. Cursor movements are clean, flexible, and fast. Selection of blocks for moving, copying, and deleting is simple and consistent with those operations in other Framework applications. When compared with other full-service word processors it stands up very well, and at the time of this writing it is the only one with outlining and other organizational capabilities.

As I stated earlier, Framework can help you organize text in the form of an outline much as ThinkTank does. But it can also be used as a cardfile system. The key lies in Framework's database capabilities. Each field in each record of a Framework database is a frame. This means, of course, that you can fill it with as much text as you like (up to the 32,000-character frame limit). The forms view of a database displays all field values of a given record inside their frames (see photo 4). You can arrange them on the screen however you like.

By constructing a database with fields for categories (like title, author, and keywords), plus a large frame for text, you can have a cardfile system with powerful retrieval capabilities. You can readily copy text from the text frames of your cards into larger documents that reside in non-database frames. You can also view a database in a table format that shows one line for each record. Here, you can see the keyword fields plus the first few words of each text block (see photo 5). (THOR provides a similar feature, but Executive Filer does not.) You can

(continued)



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quickly sort all your cards or a subset of them on any category and scroll through them to get ideas.

Framework comes with well-written tutorial and reference manuals and was easy to learn despite all its power. It also has five disks, two of which are needed to start the program and run it. (The second drive remains free for a data disk.) There is a backup copy of disk 1, the only one with copy protection. The two remaining disks contain a tutorial and utilities. As with ThinkTank, you can copy the program files onto your own disks. But you must have a system disk 1 in any drive for the program to start. A new copy-protection scheme should be shipping with Framework by the time you read this. It will enable PC XT owners to install Framework on their hard disks and boot the program without the floppy system disk.

Framework's critics point out the program's thirst for memory. You must have 256K bytes, and 384K bytes if you install the telecommunications package. You will probably want more. Spreadsheets, especially, take a lot of RAM. And everything you do has to reside in memory. Framework has no automatic spooling of memory contents to disk files as WordStar and dBASE do. As a Framework document, the original manuscript of this review occupied about 95K bytes. As a straight ASCII text file, it reduced to about 56K bytes.

CONCLUSIONS

If you need a tool to organize blocks of text, whether for a doctoral dissertation or a collection of subroutines, one of the idea processors presented here could help you. Framework is by far the most capable; it gets my vote for most valuable program. It does everything the other three programs can do and more.

ThinkTank and Executive Writer/Executive Filer offer slightly different solutions to the problem of managing textual information. As an outline processor, ThinkTank presents a better way of organizing ideas into a structure for writing. Executive Filer has with its cardfile a more flexible retrieval system for large volumes of information, and Executive Writer is a more powerful word processor.

THOR offers some capabilities for organizing blocks of text, but its limitations and awkward implementation should eliminate it from serious consideration.

We obviously have not heard the end from developers of idea processors. As information continues to overwhelm us, we will have to use more tools like these to keep it all straight. ThinkTank, like VisiCalc, may have really started something by coming up with an easy way to do something for which pencil and paper are inadequate. ■

Now Showing In Black And White

If you own an IBM-PC or PC work-alike, Roland's new MB-142 monitor lets you show off your text and graphics in today's hottest colors—black and white. That's right! The MB-142 gives you black characters on a paper-white background—just like people have been reading for centuries. You can also have white characters on a black background with just the touch of a button.

Both of these black and white display formats are easier on the eyes and less fatiguing than the green or amber phosphor used in standard monochrome monitors. The MB-142's large 14-inch screen, combined with its ultra-high 720 x 350 resolution, can display characters that are larger and more legible than what you can get with ordinary monochrome monitors. Another great plus is that the MB-142 plugs directly into the monochrome board of your IBM or compatible—just like your present monochrome monitor, with nothing more to buy.

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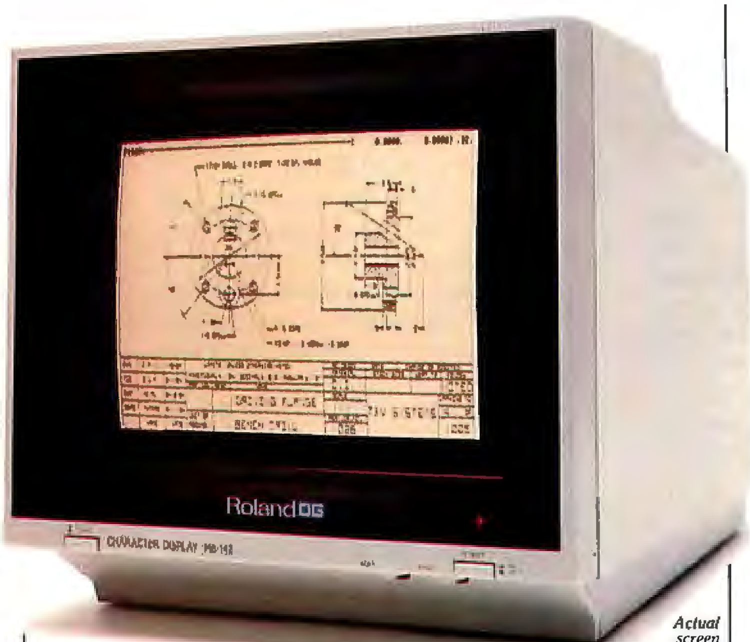

Actual screen image

MODEL
MB-142

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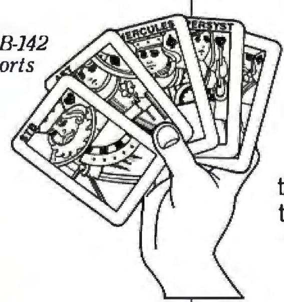

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Convenience Software

The latest in pop-up programs

BY MARK J. WELCH

Editor's note: Bellsoft claims that Pop-Up and Pop-Ups are trademarks of Bellsoft Inc. In this article the author uses the lowercase term pop-up to refer to any memory-resident program that can be invoked at any time, including Spotlight and SideKick. Pop-Up refers to Bellsoft's specific programs.

Until recently, microcomputers usually handled spreadsheets, word processors, and database programs one at a time. Now that memory is relatively inexpensive, a number of programmers have developed software that lets the computer run more than one program concurrently or switch activities instantly. Some integrated software packages and operating systems let you load and run two or more standard applications at once. However, integrated programs are generally expensive in terms of money and memory.

Lately, several companies have introduced relatively inexpensive memory-resident pop-up programs that let you interrupt your current program to calculate, write notes, check an appointment calendar, look up a phone number and dial it, or execute DOS (disk operating system) functions.

Borland International's SideKick includes a programmer's calculator, a WordStar-compatible notepad, an appointment calendar, an auto-dialer, and an ASCII (American Standard Code for Information Interchange) table.

Software Arts, creator of the VisiCalc spreadsheet program, has introduced Spotlight, which includes an appointment book/alarm, a DOS filer utility, a phone book, a notepad, a calculator, and an index-card file.

Bellsoft's Pop-Ups are 10 programs in eight packages, including an alarm clock, an appointment calendar, a calculator, a clipboard, a notepad, a DOS filer, an auto-dialer, a computer-use log, and a telecommunications program. Because the programs are sold separately, they are individually less expensive than SideKick or Spotlight and reserve less memory.

No two people have the same needs or preferences. In microcomputing, this has led to a wide variety of word processors, spreadsheets, and operating systems. The same applies to memory-resident pop-up programs. I began looking at the programs because I needed a pop-up phone directory. You might find a pop-up notepad more important. Others might think that no pop-up program is useful unless it includes a spreadsheet, a feature I haven't yet found.

I'll try to identify my personal preferences and distinguish them from more general performance problems. I'll also suggest what uses might be best for each program module. Rather than review each program separately, I'll give an overview of each, summarize major issues, and compare similar modules of each package.

SIDEKICK

SideKick is the oldest and, in my opinion, the simplest of the programs. SideKick costs $50, which is less than comparable programs. It appears to be designed for programmers. The manual is good and includes an index and a "Quick Starter" chapter.

SideKick's ASCII table is a programming feature that isn't included in any other pop-up program. It is valuable for programming, but it isn't helpful in any other application.

SPOTLIGHT

Spotlight is easily the slickest, best-packaged program, and it features the best—and least necessary—manual. I found Spotlight to be the most intuitive program to use and the most attractive on screen. Its phone book and index-card file can each handle up to 36 directories with up to 500 entries each (disk space permitting).

Spotlight costs $150, but it includes features SideKick doesn't have.

POP-UPS

Bellsoft chose not to bundle its programs together and instead sells eight separate

(continued)

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Pop-Up packages for $19.95 to $149.95 each. (Pop-Up Alarm Clock is available for $5 shipping and handling and is bundled with each of the other programs.)

PopDOS ($39.95) is a DOS utility. Pop-Up Notepad ($39.95) includes separate notepad and clipboard programs (see photo 1). Pop-Up Tele-Comm ($79.95) includes Modem, a telecommunications program, and Voice, an auto-dialer. Pop-Up Calendar ($19.95) and Pop-Up Calculator ($39.95) are separate packages.

While SideKick and Spotlight feature professional, typeset manuals, the Pop-Up programs include shorter, typescript manuals. Also included with each program is a quick-reference card that duplicates its on-line help function. All three programs had fairly good on-line help.

Table 1: *Memory allocation for pop-up programs.*

Product	Programs	Memory Requirements
Spotlight	Full system	75K bytes (minimum) Users can reserve more (128K bytes is enough to have all applications on screen)
SideKick	Full system	60K bytes
	No calendar	51K bytes
	No notepad	40K bytes
	Only calendar and ASCII table	23K bytes
Pop-Ups	DeskSet Plus	155K bytes
	Notepad	20K bytes
	Clipboard	15K bytes
	Calendar	24K bytes
	Calculator	18K bytes
	Alarm Clock	13K bytes
	Modem	28K bytes
	Voice	15K bytes
	PopDOS	23K bytes

Photo 1: *Bellsoft's Pop-Up programs are typical of the convenience software available.*

MEMORY USAGE

Money isn't the only price you pay for pop-up programs. You must also sacrifice part of your RAM (random-access read/write memory). If you use a 64K-byte IBM PC or compatible, beware: Few of the pop-up programs will function with another program running. While the programs can run in a 128K-byte machine, few applications will run simultaneously unless you have 192K or 256K bytes of RAM. A few programs might have problems even then. I used a 256K-byte IBM PC with two floppy-disk drives.

You can use more or less memory with each program, depending on your needs and available memory. Spotlight lets you reserve from 75K to 128K bytes; 75K bytes is the minimum necessary to run the program and with 128K bytes you can load all the Spotlight windows on screen simultaneously.

You can load SideKick in one of four versions: the full system (60K bytes), everything except the notepad (51K bytes), everything except the calculator (40K bytes), or just the calculator and ASCII table (23K bytes).

You load the Pop-Up programs separately. Each one uses up from 13K to 28K bytes. If you load all of them at once, 155K bytes are reserved (see table 1 for each program's memory allocation).

OTHER FACTORS

All three systems are designed for the IBM PC but will run on some compatibles. I tested all the software on my Seequa Chameleon and all the programs ran. However, Spotlight's copy-installation program didn't work, and scrolling fuzzy lines appeared whenever I invoked a Spotlight window. Software Arts says it is developing versions that will work properly on compatibles.

SideKick is copy-protected. To make backup copies or to install it on a hard disk, you must buy the unprotected version for $79.95. Spotlight is also copy-protected, but the program lets

AT A GLANCE

Name	Pop-Up Programs	SideKick	Spotlight
Manufacturer	Bellsoft Inc. 2820 Northup Way Bellevue, WA 98004 (206) 828-7282 (800) 862-6262	Borland International 4113 Scotts Valley Dr. Scotts Valley, CA 95066 (408) 438-8400 (800) 255-8008	Software Arts 27 Mica Lane Wellesley, MA 02181 (617) 431-6500
Features	Programs available separately	Calculator, notepad, auto-dialer, ASCII table, appointment calendar	Appointment book, DOS filer utility, phone book, notepad, index-card file, calculator
Computer	IBM PC or compatible with 64K bytes of memory, monitor, and one disk drive	IBM PC or compatible with 128K bytes of memory, one disk drive, and monitor; IBM PCjr, Seequa Chameleon, and BytecComterm Hyperion owners must buy unprotected version	IBM PC or compatible with 128K bytes of memory, one disk drive, and monitor
Price	Pop-Up Alarm Clock $5 (or bundled with all programs) Pop-Up Calendar $19.95 Pop-Up PopDOS $39.95 Pop-Up Notepad $39.95 (includes Pop-Up Clipboard) Pop-Up Calculator $39.95 Pop-Up TeleComm $79.95 (includes PopModem, PopVoice, Simplicity Modem, and Simplicity Voice) TaxLog plus Pop-Up Calendar $39.95 Pop-Up DeskSet $59.95 (includes Calendar, Notepad, Calculator, PopDOS, and Alarm Clock) Pop-Up DeskSet Plus $129.95 (includes all of above plus TeleComm)	Copy-protected version $49.95 Unprotected version $79.95	$150

you make up to three working copies from the master on either floppy or hard disks. Spotlight also lets you "uninstall" in case you want to reformat a hard disk or add a hard disk to a machine. The Pop-Up programs from Bellsoft are not copy-protected.

CALCULATORS

All three packages are supplied with standard four-function memory calculators. I found Bellsoft's Pop-Up Calculator to be the best for office work because it features a scrolling "paper tape" that you can echo to the printer. It also includes a 10-number memory; SideKick and Spotlight have a standard 1-number memory. Pop-Up Calculator also has a dollar mode; if you enter 4567 in this mode, the screen displays $45.67.

For programmers, SideKick's calculator includes decimal, binary, and hexadecimal modes and can perform conversions and logical functions (XOR, AND, OR). It also lets you use parentheses to specify the order of calculations. SideKick's calculator keys are located all over the keyboard. For example, the C key clears all entries, E clears the last entry, and the bottom six function keys (F5 to F10) are for hexadecimal numbers A through F (the keyboard letters A through F won't work as hexadecimal numbers).

Spotlight and Pop-Up Calculator let you paste (or feed) numbers into an application program. SideKick is a bit more obscure; it lets you program keys that insert the calculated value when hit. With SideKick's method, you can reposition the cursor and program multiple keys with values, but a key is unusable until deprogrammed.

ALARM CLOCK/ APPOINTMENT BOOK

The price of the Pop-Up Alarm Clock is certainly the best; it's available for

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$5 shipping and handling from Bellsoft, as a sort of "free sample." The program is quite limited; it only lets you program alarms for one day at a time. It's also not easy to figure out; even with the on-line help, I had to refer to the manual. Two problems: The alarm message is too short, and it is erased after the alarm rings and the window is put away.

Bellsoft also sells a separate Calendar program that lets you enter appointment information. The Calendar program is extremely difficult to understand and use. I quickly abandoned it because it has such limited message space per day. The separation of the daily alarm and the long-term calendar also reduced each program's usefulness.

The Alarm Clock includes an option to feed the current date and time to an application. It can also generate a "timed feed," which passes a series of keystrokes to an application at a certain time.

SideKick's calendar is much better; you can list appointments for each half hour. However, the message line is very short, and the daily calendar runs only from 8 a.m. to 8:30 p.m. The program does not have an alarm feature.

Spotlight's appointment book is my favorite. It contains an alarm option so Spotlight beeps 10 minutes before an appointment. It lets you set appointments far in advance. A weekly event (a staff meeting, for example) only needs to be programmed once. You can set the calendar to display appointments only or to show all appointments and every hour, half hour, or quarter hour. A vertical bar shows how long an appointment will last; bars also graphically show when more than one appointment is scheduled for the same time.

When a Spotlight alarm occurs, the program generates a unique tone (not too irritating) but doesn't display the appointment information. You have to invoke the appointment window to find out what caused the alarm. If an alarm sounds when you're not around, everyone else in the office

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must suffer through the noise without knowing where it's coming from. When Bellsoft's Pop-Up Alarm Clock sounds, it also pops up its window and highlights the current alarm, an approach I much prefer.

TELEPHONE OPTIONS

I must confess a bias; I can't live without Spotlight's phone directory. To find a number, I can locate a card alphabetically or search all cards for specific information (Joe Smith or (212) 555-1212), so I don't have to admit to callers that I don't remember them. The phone cards are the size and shape of Rolodex cards; I wish they were larger, perhaps even a full page. It would also be nice to have distinct fields so searching would be faster.

SideKick's auto-dialer is similar but it's designed with a very small single-line format, and you can edit information in the directory only by using the separate notepad. Of course, SideKick can auto-dial the number as well, something Spotlight can't do. SideKick's notepad lets you sort entries so the auto-dialer phone list can be in order. I prefer Spotlight's automatic alphabetizing and editing from within the phone book.

SideKick can include pauses in numbers. This is useful if you have a PBX or long-distance service and have to wait for a dial tone before continuing to dial. SideKick also required that I reset my modem DIP (dual in-line package) switches. More irritating, I had to "install" a modem on SideKick. This involves selecting the COM1: or COM2: ports. I think SideKick should use COM1: as the default port for a modem.

SideKick's documentation indicates that when you invoke the auto-dialer it reads a phone number at the cursor and can auto-dial it. I could not get this function to work.

Bellsoft's PopVoice, included in the Pop-Up TeleComm package, is a limited auto-dialer. When invoked, it dials a phone number located at the cursor; it also stores three most frequently dialed numbers. The limit of only

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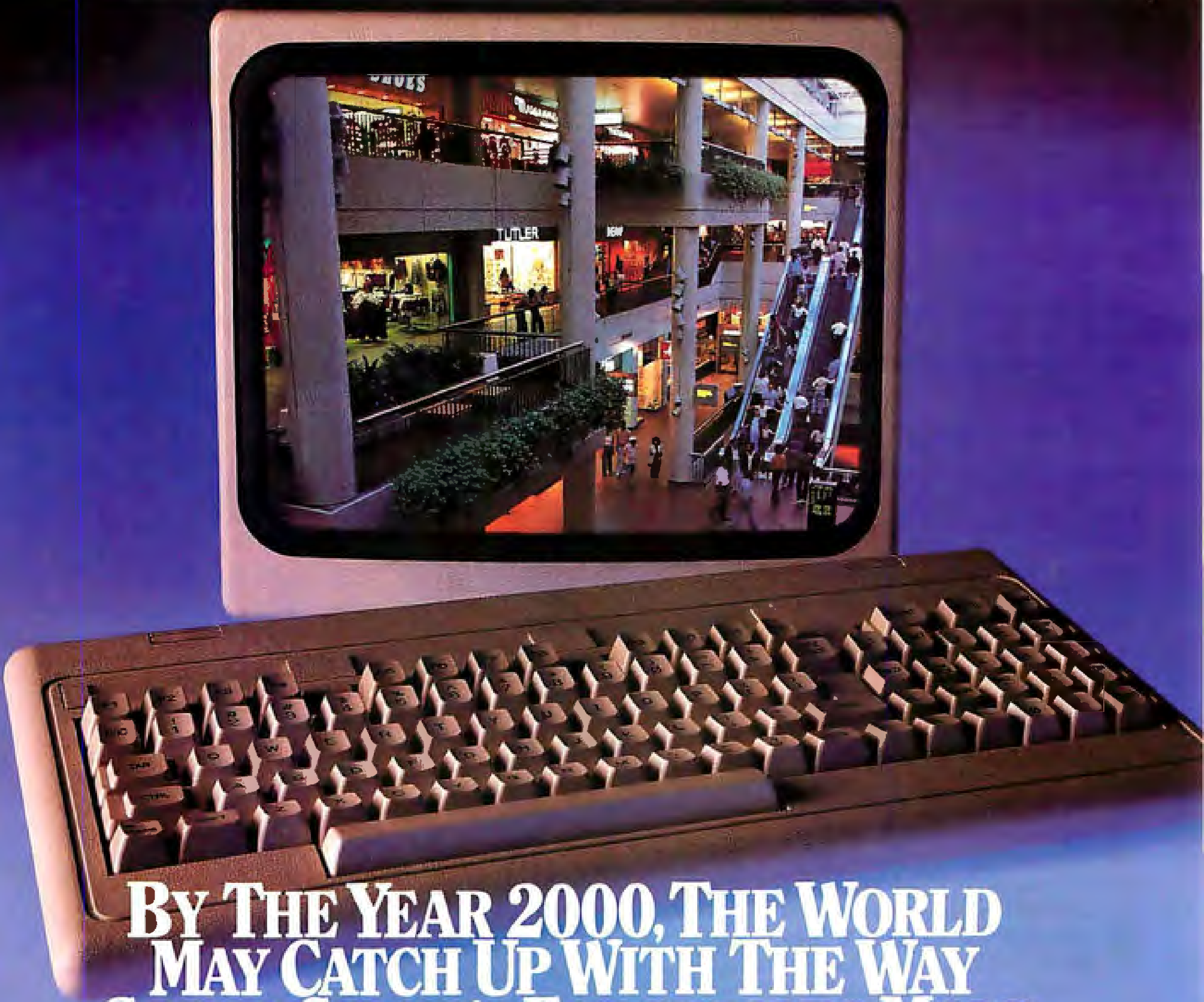

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A pop-up notepad lets me save my ideas and continue without losing my train of thought.

three numbers is intolerable. Also included with TeleComm is Simplicity Voice, a stand-alone auto-dialer. It allows longer phone lists, but it isn't a pop-up program.

PopModem, also part of the TeleComm package, is a pop-up telecommunications program. It has one problem: Normally the Escape key stops PopModem's dialing, but not if other keys are stored in the keyboard buffer. Also, when PopModem gets no answer, it hangs up without any screen message.

I can't anticipate needing telecommunications from within another task, given the amount of time most on-line sessions take. Usually I find myself wanting a notepad when I'm on line, not the other way around.

Spotlight also includes an index-card program that is identical to the phone directory. I used it to keep a second address list from the Spotlight phone book. While you can select any of 26 separate lists for each of the two programs, I prefer to use the default file.

NOTEPAD/CLIPBOARD

When I'm using an application program such as a word processor, ideas often pop into my head completely unrelated to what I'm doing. A pop-up notepad lets me save my ideas and continue without losing my train of thought. In a similar vein, when telecomputing I often want to save something I see. I can use features in my telecommunications software to capture incoming text, or I can use a pop-up clipboard feature to "clip" information from a screen.

(continued)

Spotlight features a simple eight-page notepad. I find the page size too small but still use it fairly regularly, even from within a word processor. Spotlight can print or save either one page or the entire notepad. It doesn't have any way to paste or feed information into an application or to capture it from a screen.

Bellsoft's Pop-Up Notepad is quite similar. It doesn't break its contents into pages; instead, it scrolls through a hundred 35-character lines. It can also print or save the information, though not a page at a time.

Also included in the Pop-Up Notepad package is Pop-Up Clipboard, which I find quite useful. Clipboard can capture any part of a text screen for editing and paste it back into an application. Clipboard can't save the text to disk or print it out, but the program can paste information into the Notepad to be saved or printed. The flaw in this approach is the 35-character line length in the notepad.

If you're including a list of numbers in a document, you can even use the Clipboard to feed the numbers into the Calculator, using plus signs to end each line, and then feed the Calculator's result back into the word processor. One problem with the Clipboard is that it can feed information to another application very quickly so it overloaded my word processor. However, when you load Clipboard, you can select the feed rate.

SideKick's notepad can also capture information from a screen, but it can't paste or feed information into an application. It can save information, but it has no print feature, which is quite frustrating. You can vary SideKick's notepad size to fill the whole screen or any part of it. SideKick's is more powerful than the notepads in Spotlight or Pop-Up Notepad, and it includes many WordStar features. It uses the WordStar command structure, which would be helpful to WordStar (or Turbo Pascal) users.

DOS Filer/Utility Window

Spotlight includes a DOS filer that you can use to view text files or sorted

(continued)

A problem might be the location of a pop-up window on your screen.

directories; to erase, copy, or rename files; to format a disk; or to change the current directory. It can also paste a selected filename, with drive and path information, into an application. I found the filer useful in checking files before uploading them and deleting files to make room on a disk during word processing.

PopDOS performs most of the same functions. When displaying a file, Spotlight pauses as the window fills each time; PopDOS requires that you use Control-S to pause. PopDOS adds the ability to print a file, a time-saving feature I used several times. You can also use PopDOS to send control codes to the printer. If you have an IBM graphics printer, the program can select the typeface.

SideKick doesn't include a DOS utility, but it can view directories from within the notepad.

SOME CONSIDERATIONS

The pop-up programs must be user-invoked. Spotlight uses Shift-Alternate and a mnemonic key command. The Pop-Up programs use Alternate and a key. SideKick uses Control-Alternate to invoke its main menu. If for some reason your program is looking for these keystrokes (and I don't know of any that do), the invocation won't work.

Bellsoft's Pop-Ups use an Alternate-key combination (Alternate-N for Notepad, for example). This can create problems, so Bellsoft lets you type the Alternate-key sequence twice. Then the Pop-Up program feeds the Alternate-key to the application program.

SideKick normally requires a two-step process to invoke a program. First, you must press Control-Alternate to bring up the SideKick menu. Pressing a particular letter key brings up a program, and the Escape key puts the program away. If you use one program a great deal, you can put it away with the Control-Alternate sequence; when you next type Control-Alternate, SideKick immediately restores the pop-up program you last used.

Another problem might be the location of a pop-up window on your screen. All the programs let you move the windows around the screen, but you can locate Bellsoft's Pop-Ups only

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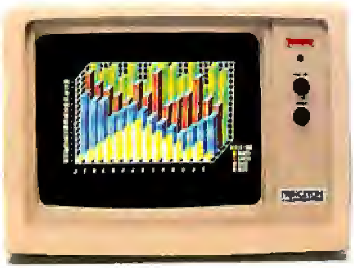

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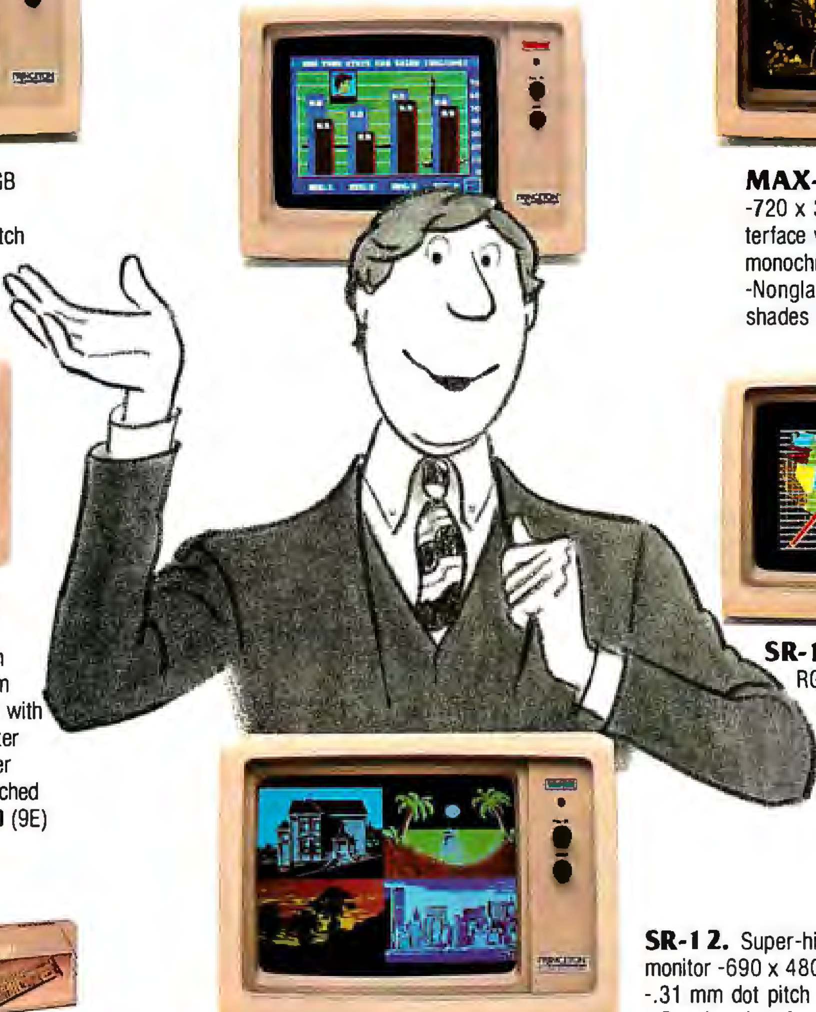

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in a limited number of locations. Spotlight loses track of your preferred location when you put a window away; the next time you invoke it, it appears in its original place.

Spotlight's disk must be present in the system at all times, since its programs and some data are stored on disk. SideKick also accesses the disk for data files. The Pop-Up programs never access the disk once loaded except to load or save a file at your request. The Pop-Up programs also pop up or go away more quickly. Spotlight can be installed on a hard-disk system, as can the Pop-Up programs; however, hard-disk users need to buy an unprotected version of SideKick.

In my opinion, Spotlight's programs use the best mnemonics, since each matches an abbreviation. SideKick includes both a calculator and a calendar; rather than calling the calendar an "appointment book" as Spotlight does, SideKick uses the letter L (caLendar). Bellsoft chose the letter B for clipBoard, but I often tried Alternate-C and got the Calculator. Bellsoft calls its Calendar a Dates program, so the command is Alternate-D.

You might decide you like some features of one program and other features of a different program. It is possible to have Spotlight, SideKick, and some Pop-Up programs resident at the same time. However, Spotlight can be interrupted by SideKick, but not by some Pop-Up programs. SideKick permits either Spotlight or a Pop-Up to interrupt it. The Pop-Up programs won't permit any other program to interrupt them. It was impossible to install all the pop-up programs simultaneously in a 256K-byte machine—they won't fit.

NEW VERSIONS

Since BYTE originally received the software covered in this review, new products and improved versions of older products have appeared. Here's the latest information I have as this review was written.

POP-UPS

Bellsoft has combined all its programs into the Pop-Up DeskSet and the DeskSet Plus (see the "At a Glance" page for a list of all the programs included). Another new package is TaxLog plus Pop-Up Calendar. The TaxLog program, resident on your work disk but not in RAM, lets you keep a daily log of your computer use.

SPOTLIGHT 1.1

Software Arts has released version 1.1 of Spotlight. Its major enhancement is the addition of an auto-dialer to the phone-book accessory program. Other changes include user-selectable colors for each accessory and support for MS-DOS 3.0 (including formatting IBM PC AT 1.2-megabyte disks) from the filer accessory. The company said it would send a free copy of the new program to every registered user of Spotlight 1.0. I had not yet received Spotlight 1.1 when I wrote this review.

PCWINDOW

PCwindow is a less sophisticated memory-resident program, but its price makes it quite attractive: it's free. Its authors are distributing it using the "user-supported software" approach. You can copy the program freely, and the authors only ask that users send them a check for what they think PCwindow is worth ($10 is suggested). Going a step beyond the usual user-supported software approach, the program's authors also offer a copy of the source code for $30.

PCwindow is less sophisticated than the other programs reviewed. It has three components: a one-page notepad, an ASCII (American Standard Code for Information Interchange) table, and a clock/timer/alarm. The notepad lets you edit messages on a single 78-character by 12-line page. You can read notes from or save them to disk files (you print by "saving" to the MS-DOS file/device prn). The clock/timer/alarm includes an alarm that rings once at the designated time and a timer accurate to one second (if your PC keeps poor time, so will this program).

By the time you read this, PCwindow should be available through many users groups and other sources of public-domain and user-supported software. You can also get a copy of the program by sending a self-addressed, stamped, disk-mailing envelope and a formatted 5¼-inch disk to Creative Freeware Unlimited, POB 10047, Columbia, MO 65205.

SUMMARY

Each of these programs has good features (for an update, see the text box "New Versions" at left). A programmer looking for an ASCII table or a calculator with hexadecimal and binary capabilities will want SideKick. If you want to keep track of your calculations, you'll prefer the Pop-Up Calculator's tape feature.

If you want a sophisticated phone directory, you will probably find Spotlight the most helpful of the three programs.

Users who need to be able to cut information from an application won't consider Spotlight. If they also need to paste the information back, they'll forget about SideKick in favor of Pop-Up Clipboard. I wish one pop-up program combined the Pop-Up Clipboard features with the ability to print and save to disk.

I've settled on a combination of Spotlight and Pop-Up Clipboard. My preference for Spotlight is based solely on its phone-book feature, which I need for work. At home, I prefer the Pop-Ups and SideKick, since I do programming in addition to activities where the Clipboard would come in handy.

Someone suggested to me that some of these programs shouldn't be necessary. The DOS utilities, for example, merely compensate for programs that can't take advantage of MS-DOS features. The calculator shouldn't be necessary within a word processor, since word processors would be better if they included a calculator option. But since everyone can't afford to own ideal software—even if it exists—it's good to be able to pop up a compromise. ■

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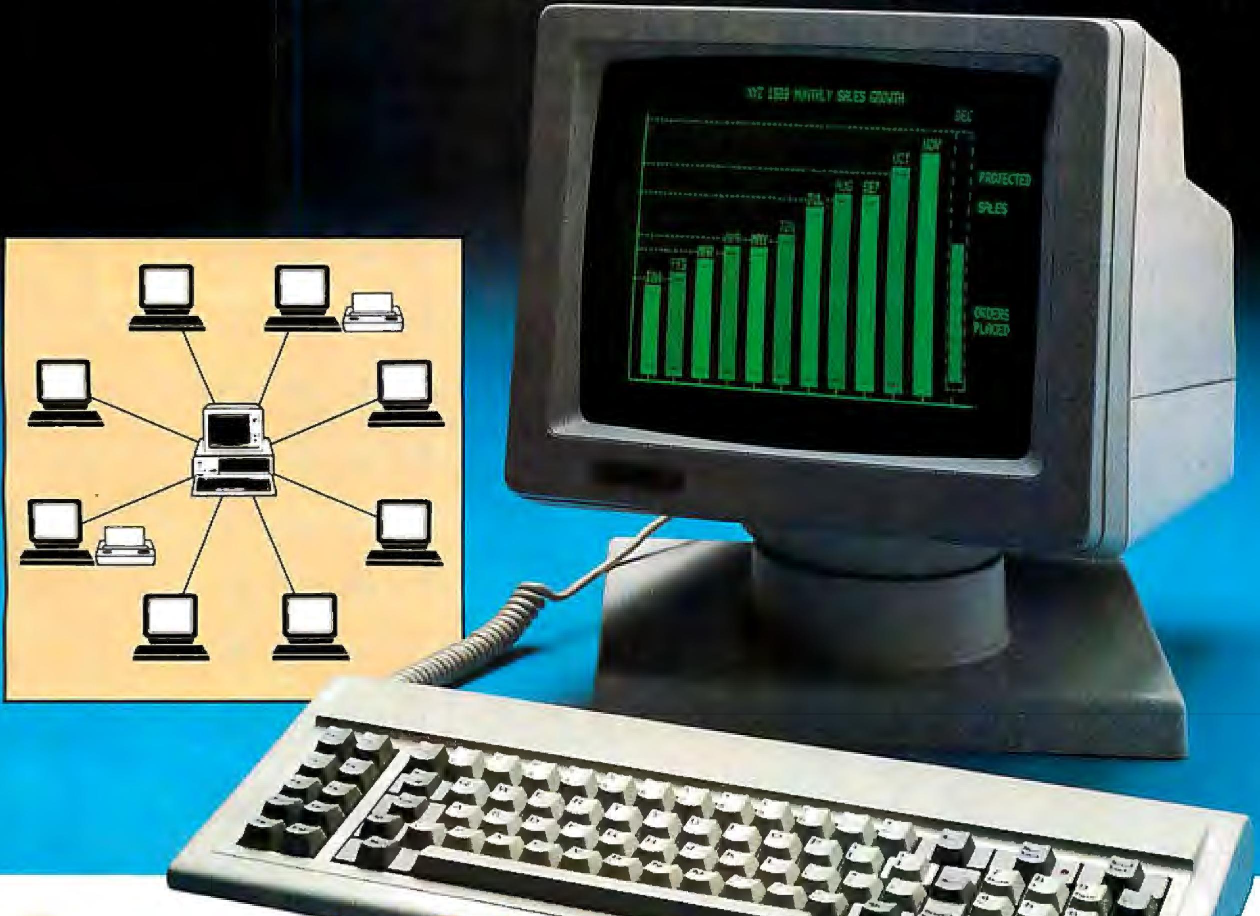

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Building Expert Systems with M.1

A knowledge-engineering tool for the IBM PC

BY BRUCE D'AMBROSIO

Would anyone of sound mind and body pay $12,500 for an IBM Personal Computer (PC) program? An individual, no—but a company, maybe. If the program helped to design and build expert systems, *maybe* becomes *might*. If the program also included a training course in knowledge engineering, *might* becomes *probably*. Teknowledge, a start-up artificial-intelligence (AI) company boasting that its founders constitute "one-third of the entire world's knowledge engineering expertise," hopes to convince companies anxious to explore knowledge engineering that its new product, called M.1, is worth such a hefty investment.

M.1 is *not* just a program but a carefully crafted product that provides companies with a moderately priced alternative (compared to hiring an AI professional and buying a LISP machine) for exploring knowledge engineering. It consists of a one-week training course, an extensive set of training materials, and the M.1 program itself. No one of these three items can be considered in isolation because the strength of the product comes from the design and integration of the entire package.

M.1 clearly shows Teknowledge's expertise in all aspects of both knowledge engineering and the technology-transfer problem. At the same time, there are some disturbing flaws in the execution of the product, flaws that would be understandable in a $200–$300 package but are as out of place here as a door that won't close on a new Rolls Royce.

M.1—THE CONCEPT

Knowledge engineering is an outgrowth of a technology developed in AI labs in the late 1970s known as "expert systems." This technology's basic goal is to free the expert for other tasks or to transfer an expert's problem-solving skill to a computer-based knowledge system for easy application when the expert is unavailable. One problem with this approach is that building expert systems requires an extensive time commitment from an expert, typically six months to two full years.

The Teknowledge approach recommends that rather than attempt to build expert systems, knowledge engineers concentrate on "knowledge systems," systems that contain less rare, but no less useful, knowledge.

M.1 is intended for what Teknowledge describes as a "structured selection" problem, one of the best-understood problems in AI. The signs of a structured selection problem, as described in the M.1 course, are that it can be solved in a 20-minute phone consultation with an expert, it does not involve the use of diagrams or plans (such as circuit schematics), and the recommended solution is chosen from a small number of options (a few dozen at most). A goal of the course is to bring the knowledge-engineer trainee to the point where he understands this characterization of M.1's intended applicability well enough to recognize problems within his own company that meet these criteria. In this the course succeeds well. Indeed, the course is at its best when discussing the subtle issues of problem selection and design, and it shows Teknowledge's broad experience in this area.

But is this enough? Or is this so limited an area of applicability as to render M.1 useful only for trivial problems? Here, Teknowledge's ambiguity regarding M.1 is apparent. When asked directly whether or not M.1 is capable of supporting knowledge systems complex enough to be worth fielding, the official Teknowledge answer seems to be "Yes, sort of, well, maybe. . . ." Teknowledge can't really seem to decide whether M.1 is a demonstration system intended for training and evaluation of the technology or a really useful tool in itself.

M.1 is designed for the junior to mid-level technical professional, typically with at least one or two years of programming experience. There is another aspect to the ideal

(continued)

Bruce D'Ambrosio (555 Tulsa St., San Lorenzo, CA 94580) is studying for his Ph.D. in computer science at the University of California at Berkeley.

AT A GLANCE

Name
M.1

Type
Expert-system toolkit

Manufacturer
Teknowledge Inc.
525 University Ave.
Palo Alto, CA 94301

Format
4½-day course, three documentation volumes, one 5¼-inch floppy disk

Computer
IBM PC, PC XT, and PC AT or compatible

Features
Inference engine, debugging tools, and sample knowledge bases

Documentation
Reference manual, training manual, descriptions of sample knowledge systems

Price
$10,000 for M.1 software and materials plus $2500 for course

Audience
Companies interested in exploring expert-systems technology and rapid prototyping of expert systems

M.1 trainee. M.1 can be thought of as a programming language, but with reservations. In programming-language terms, M.1 supports a *non-procedural* language. Teknowledge emphasizes that M.1 knowledge bases have declarative, as well as procedural, semantics and must be consistent from both perspectives. Each statement must make sense by itself and express some "fact" that you could say to someone when teaching that person about the problem area. What all this means in terms of choosing candidates for the M.1 training is that an extensive but narrow data-processing background may in fact be an impediment to learning some of the concepts embodied in M.1. A good, solid exposure to computer programming and computer science concepts, together with a general "liberal education," would be better. In particular, some exposure to the basics of mathematical reasoning and logic would be beneficial. M.1 shows the best preparation for the future may *not* be a crash course in the current technology (for example, the "computer literacy" craze) but rather a sound education in the old-fashioned "basics."

M.1—The Course

The course I attended (I actually attended only for a total of 12 hours) ran from Monday to Friday. It was about half lecture and half "hands-on" laboratory experience, with the lecture portion a mix of knowledge-engineering principles and M.1 mechanics. The pacing was quite relaxed, and I rarely felt that I had less time than needed to complete the laboratory sections of the course. There were three trainers for the six attendees; the architect of M.1, Steve Hardy of Teknowledge, was the primary lecturer, and the two main programmers on the M.1 development team served as laboratory assistants, guiding us through the exercises and answering any questions. Hardy has all the attributes to make a superb lecturer: flair for teaching, enthusiasm for his subject, and absolute command of his subject matter, both M.1 in particular and knowledge engineering in general. It was not clear that he would continue teaching the course (the session I attended was only the second time the course had been given), and I think it would be a loss should he delegate that task to others.

Each attendee had exclusive use of an IBM PC for the laboratory exercises. The course starts with a general discussion of M.1, what it is and what it can do, and then proceeds along two interwoven tracks. Lectures and exercises introduce increasingly complex features of M.1, and the remainder of the course covers various aspects of knowledge engineering, both theoretical fundamentals and practical wisdom. Both parts of the course are excellent.

The instructional component of the M.1 product is by far its strongest. The material is organized and presented superbly, and there are many gems of wisdom scattered through every lecture. Anyone attending this course should take careful notes, or perhaps use a tape recorder (Teknowledge permitting), because the documentation for M.1 does not meet these same standards.

The course clearly communicates the essence of knowledge engineering in a way I have seen no book do.

M.1—The Documentation

The M.1 documentation comes in three 3-ring binders. The first contains the transparencies used during the lectures (about 250 slides) plus some discussion material. The second contains listings of five sample knowledge bases that are part of the M.1 package. The third is the M.1 reference manual. While the volumes are nicely bound, reproduction quality is poor (but not bad enough to seriously threaten the readability of the text).

The volume containing the slides serves as an outline to organize your notes around. It also provides a way to effectively reduce the cost of M.1. Once a trainee has completed the three-month training program, he can in turn train others. The slides provide a detailed record of topics and the order in which they were covered, and the text of the exercises does a good job not only in describing each assignment but also in making clear what the student is supposed to be getting out of it.

The volume containing the five increasingly complex sample knowledge bases is also well done. This volume includes text describing each of the laboratory exercises done using the sample systems as well as a complete listing of each sample knowledge base.

The first is called Wine and is a simple wine advisor, criticized in prior reviews of M.1. The point of this system, however, is not sophistication but simplicity. It is the simplest possible system that could be written in M.1 to serve as an introduction. Two variations of Wine follow, Vine and Cwine. They differ from Wine solely in their use of increasingly sophisticated features of M.1; they encode more or less the same knowledge about wine.

Next is a knowledge base called Banker. Banker represents the level of complexity the trainee is expected to be competent at upon completion of the three-month M.1 program. It contains about 150 rules and facts and advises clients on banking services. At the end of a consultation, Banker recommends a combination of accounts most suitable for the particular client (for example, regular checking plus money-market savings).

The final sample system is an excerpt from Sacon, an early, landmark expert system. The most complicated of the sample systems, it serves as a benchmark demonstrating use of the most complex features of M.1.

These samples are crucial for understanding knowledge engineering and M.1, and they should be studied carefully. Effective utilization of M.1 relies on the user developing an intuitive feel for proper style; some of the issues remain unclear until you actually encounter them in attempting to construct a system of your own. At that time it is invaluable to have a set of samples to refer to.

The M.1 reference manual is adequate. One reason I suggest careful note-taking is that not all features described in the course are clearly documented in the manual. Were M.1 a $500 product, I would praise the manual as quite adequate. However, as the price rises, so do expectations, and this manual does not meet them.

M.1—THE SOFTWARE

The software, while only one component of the total M.1 product, is the most crucial. [*Editor's note: A second version of* M.1, *called* M.1a, *costs* $2000 *and is a scaled-down version of the program; it's suitable for developing prototype* M.1 *applications.* M.1a *cannot interface to other software and is not suitable for developing complex systems.*] Overall, the software is solid in concept. Again and again this product demonstrates Teknowledge's clear understanding of practical knowledge engineering. However, its execution has many minor flaws, as I will explain. In concept, it clearly owes much to EMYCIN, developed by the Heuristic Programming Project at Stanford University and the first "productized" knowledge-engineering system. However, M.1 incorporates many differences, and it certainly is not merely a straightforward implementation of EMYCIN for the IBM PC.

The major architectural components of M.1 are a knowledge base, an inference engine, and a cache (see figure 1). The knowledge base is built by the knowledge engineer and contains the facts and rules needed for the specific application. The inference engine is the software that "reasons" using the facts and rules provided in the knowledge base. The cache is a memory-resident database in which conclusions are stored as they occur.

The knowledge representation (language for expressing rules and facts) in M.1 is based on a subset of predicate logic. While this is hidden from the knowledge engineer by an easy-to-understand syntax, there are several consequences nonetheless.

(continued)

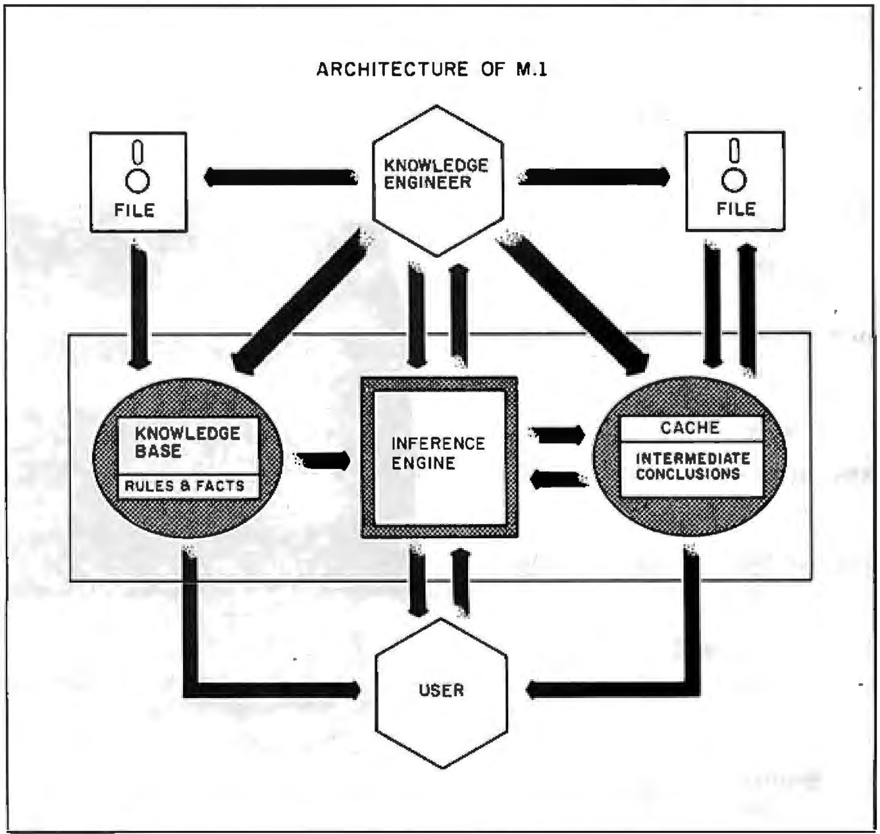

Figure 1: *Block diagram of the components of* M.1.

Logic-based representations are known for completeness and rapid prototyping rather than speed of execution. M.1, true to this tradition, is slow: It can evaluate about one logical inference every 2 seconds (by my very crude estimates). But this is adequate for a typical consultation-style system; in the sample systems, I spent much more time thinking about answers to questions than I did waiting for program execution.

Another consequence of the logic basis of M.1 is that knowledge structure is implicit rather than explicit. While this is a rather technical point, an important result is limitation of the system's ability to provide any knowledge-base construction tools to aid the knowledge engineer. This does not seem to concern Teknowledge, however. The company has made no attempt to provide construction tools of any kind (as I'll explain).

A very interesting feature of M.1 is that the rule language has been extended to be a complete symbolic programming language. You never have to use any other language in building a knowledge base with M.1. Most rule-based systems (EMYCIN, for example) provide "hooks" to the underlying language (LISP in the case of EMYCIN) so that you can code directly in that language any functions and tests that cannot be easily expressed in the rule language. This is unnecessary in M.1. Any internal computation that can be expressed in any programming language can be expressed directly in M.1's rule language.

M.1's rule language provides certainty factors using a modification of the "bounded sum" evidence-combination technique used in EMYCIN. Certainty factors are a standard technique for representing partial information within an expert system. (Here's an example. I usually prefer sweet wines, but I sometimes prefer a medium-dry wine. This could be expressed in M.1 as: Sweet CF 75, Medium CF 30). One distinction between rule-based systems and more traditional methodologies, such as decision trees, is this ability to reason with partial or uncertain information. M.1's implementation of certainty-factor calculations is fairly straightforward and intuitive. One potential problem is the handling of negation (if the client does not like sweet wine, then . . .). Negation is handled in a

Photo 1: *The windowed screen display of* M.1.

way that generates discontinuous results and is likely to produce conclusions unexpected by the knowledge engineer.

M.1 has a set of debugging tools including an "instrument panel," a set of four windows that appears at the top of the screen (see photo 1) and displays the current activity of the system. One window shows the goal the system is currently trying to achieve, a second shows the rule currently being considered, a third shows the conclusions the system has reached, and a fourth shows the legal responses that can be made to the current question. The instrument panel is a wonderful idea, but it's somewhat limited in its utility by the small size of the windows. Teknowledge strongly recommends use of a color display, and the panels do look nice in color, but they also work perfectly well on the monochrome screen of my Corona PC. In addition to the instrument panel, a set of inquiry commands is available once a rule base is loaded into M.1. The WHY command displays the rules leading to a conclusion, the SHOW command interrogates the cache (the place where conclusions are stored), the USES command displays all rules that reference a particular fact, and the LIST command lists entries in the rule base. There are some minor inconsistencies in the arguments these commands take and when they can be used, but nonetheless they are quite handy. Also, you can save the current state of a consultation on disk and retrieve it later, helpful in interrupted debugging sessions as well as in saving test cases.

You can make small changes to the rule base using a simple add/delete/replace facility within M.1. However, the utility of this facility is limited by two things. First, only entire rules can be added, deleted, or replaced. M.1 sample systems contain many rules of 5 to 15 lines in length, an awkward amount to key in simply to make a minor change. But even worse, these changes are made only to the copy of the rule base in memory. The only way to update the file copy of a rule base is to exit from M.1, start up your text editor, and edit the file. In defense of M.1, it would be almost impossible to write a knowledge-base editor that more than two people would like. Nevertheless, the lack of effort in this area seems to be a major weakness of M.1.

Another deficiency I find in M.1 is not being able to add any documentation that can appear during a consultation. Rules are displayed in the form in which they were entered by the knowledge engineer. Teknowledge claims the rule syntax is so flexible that self-documenting rules can be written. (The same claim was once made for COBOL.) Similarly, you can ask *why* a question is being asked (and see the rule that is being considered), but there is no mechanism for providing you with more information about *what* is being asked. (For example, M.1 asks for the client's preference in wine "body." What if the client doesn't know what body is?)

[*Editor's note: The latest version of* M.1 *provides an* OPTIONS *command that prompts the user with a list of acceptable answers to a question. This version also provides a method to call* M.1 *from high-level languages like* C *so that knowledge bases can be integrated with existing applications to add intelligence to databases or spreadsheets.* M.1*'s most recent version also can generate executable knowledge systems for distribution.*]

CONCLUSION

M.1 is a fascinating product. The course, the sample systems, and the software combine to form an excellent introduction to the capabilities of rule-based systems. For those with the money to spend, M.1 provides guidance to ensure that the knowledge-engineer trainee does not spend months or even years in a blind alley due to a misunderstanding of the nature or purpose of rule-based systems. Nonetheless, serious deficiencies in the current software lead me to conclude that M.1, at least in its present state, is best considered an evaluation and training tool and not a product for developing knowledge-based systems that can be put in the hands of naive users. ■


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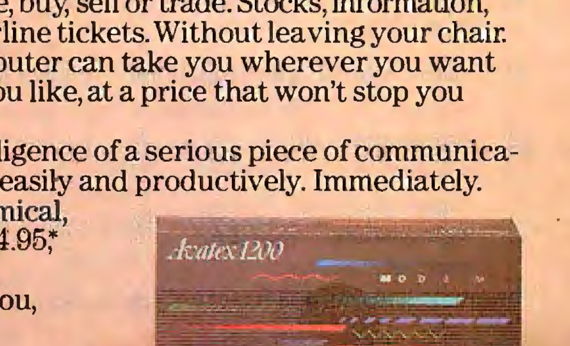

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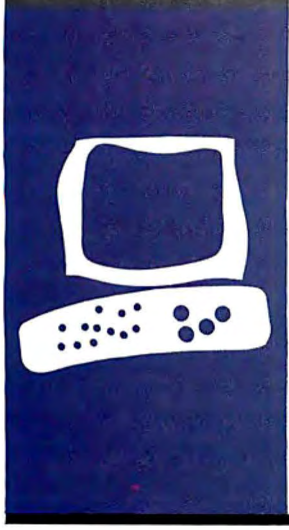


H·A·R·D·W·A·R·E R·E·V·I·E·W

Hewlett-Packard's HP 7475A Plotter

An accurate and versatile graphics machine

BY RICH MALLOY

Hewlett-Packard's six-pen plotter, the HP 7475A, can plot not only on the familiar 8½- by 11-inch paper but also on 11- by 17-inch paper. The 7475A has a suggested list price of $1895 (the original price of its two-pen predecessor, the HP 7470A, which now has a suggested price of $1095). It's about the same size as a wide-carriage dot-matrix printer and is somewhat lighter. Paper is driven in and out of the plotter by special rollers having a high-friction surface. This paper movement in and out of the plotter forms one dimension of pen movement. Moving the pen across a track above the paper surface forms the second dimension.

The plotter is available with either of two interfaces. The one we received has an RS-232C serial interface with a DB-25 connector that's very easy to reach. Right next to the connector is a group of eight tiny switches used to control the serial parameters and some of the plotter defaults. The HP 7475A is also available with a connector for the HP Interface Bus (HP-IB) for direct connection to other HP computers and devices. The model with this connector costs the same as the serial version.

On the right side of the plotter is a series of push buttons to control the plotter. Several of these buttons are used to move the pen position. Others change paper size and move the pen up or down manually. Two indicator lights signal error conditions. On the left side of the plotter is the *pen carousel*, a spool-like unit that has slots for six pens, which are loaded in much the same way as bullets into an old Colt .45 revolver. The carousel gets its name because it rotates to place a new pen into the moving pen holder.

Each pen slot has a rubber pen cover to keep the ink from drying out. You can easily remove the carousel to make quick pen changes. And you can buy extra carousels and load them up with pens of other colors.

Speaking of pens, Hewlett-Packard sent us two types. Both types had felt tips. One kind was fairly fine (0.4 mm) and came in a variety of colors (black, red, green, blue, violet, etc.). The other kind was broader (0.7 mm) and came only in black.

PLOTTING

The HP 7475A is controlled by a series of commands in the Hewlett-Packard Graphics Language (HP-GL). All HP plotters use this control language, although the low-end units may not be able to execute all of the commands.

An HP-GL command consists of a two-letter verb usually followed by a numeric argument or two. For example, the sequence

```
PA 100,300
PD
PA 400,700
PU
```

draws a line from point 100,300 to point 400,700. PA stands for "move to absolute point," and PD and PU mean "pen down" and "pen up," respectively.

The coordinate system is very large and easy to use. On an 8½- by 11-inch page, you can access any point within a 10,080 by 7520 matrix. In addition, you can scale these points to match your requirements. For example, instead of a coordinate system of 10,080 by 7520, you can set up a matrix of 640 by 200 to match your computer's video screen. Also, you can use relative coordinates.

The HP-GL commands can be generated fairly easily on your computer with simple BASIC commands. After a little experimentation, you can draw circles, arcs, dotted lines, and boxes filled with various textures (see figure 1).

PERFORMANCE

Watching the HP 7475A draw a picture is just short of fascinating. The pen is fast, and

(continued)

Rich Malloy is a senior technical editor for BYTE. He can be contacted at BYTE, 43rd Floor, 1221 Avenue of the Americas, New York, NY 10020.

AT A GLANCE

Name
HP 7475A Plotter

Manufacturer
Hewlett-Packard
9606 Aero Dr.
San Diego, CA 92123
(619) 279-3200

Size
5 by 22.4 by 14.5 inches; 16 pounds

Price
$1895

Computer Needed
Any computer with serial or HP-IB interface

Features
Six pens, fast pen speed, high-quality character set

Paper Sizes
8½ by 11 inches; 11 by 17 inches

pen changes are made quickly and accurately. A moderately complex graph takes about 1 to 3 minutes.

There are a few things I would improve on the HP 7475A, however. It can be quite noisy even when it's not doing anything. Also, I would like a key for aborting a bad plot. For example, suppose you forgot to put the right color pens in the carousel; you could probably stop your graphics software, but the plotter would continue until it emptied its input data buffer.

TEXT

With a plotter, of course, you can draw any text character you want, but this requires a bit of programming. To make things easy, most low-cost plotters (including the two-pen HP 7470A) are programmed to be able to produce the standard ASCII (American Standard Code for Information Interchange) characters. Unfortunately, to save memory space, most of these characters look fairly crude; for example, the numeral 0 may look like an octagon.

One of the nice features of the HP 7475A is its high-quality character set (see figure 1). These characters can be drawn at any height, width, or intercharacter spacing.

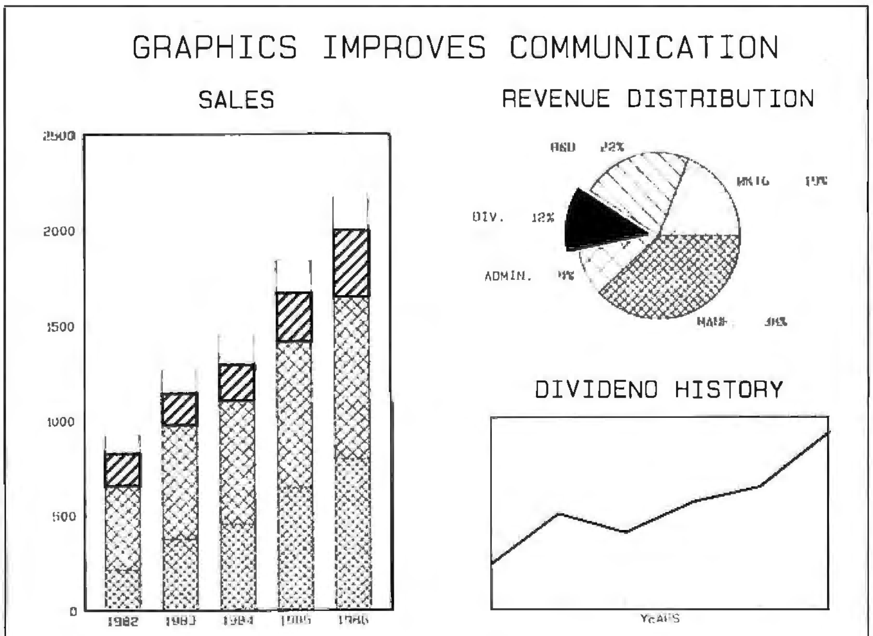


Figure 1: *Graphs and text produced by the* HP 7475A. *This test plot is automatically produced by a* ROM *(read-only memory) chip in the plotter.*

If I had more time with this plotter I would write a BASIC program that prints text characters in a flowing script font. This would let me print a handwritten note—or a close facsimile thereof. Well, I didn't have enough time to program all the characters in a script font, but I did create a short program using the preprogrammed characters. This program, in effect, turned the plotter into one of the slowest printers around (about 3 characters per second). But the quality of the characters was very close to that of a daisy-wheel printer, and I could print them any size I wanted.

COMPATIBLE SOFTWARE

In the very likely event that you do not have enough time to write your own software, you need not despair. A large amount of software should be available to drive the HP 7475A. Because of the popularity of the older HP 7470A plotter, almost every graphics program written for microcomputers comes with a driver for it. Since the 7475A is compatible with the 7470A, it too can use this software (of course, this software cannot take advantage of the 7475A's extra capabilities). Hewlett-Packard, however, has been very successful in getting the major graphics-software houses to write drivers especially for the 7475A.

OTHER FEATURES

Although I did not get to try this, the HP 7475A can be used as a digitizer of sorts. Instead of holding a pen, the pen holder can grip a set of cross hairs equipped with a magnifier. You can then insert a map, for example, into the plotter and, using the arrow keys on the control panel of the plotter, move the pen holder to a specific point of interest. If you have your computer set up to give the plotter a certain command, it will respond with the coordinates of that point.

Another feature I have not tried is the ability to use a wide variety of pens. The HP felt-tip pens are fairly

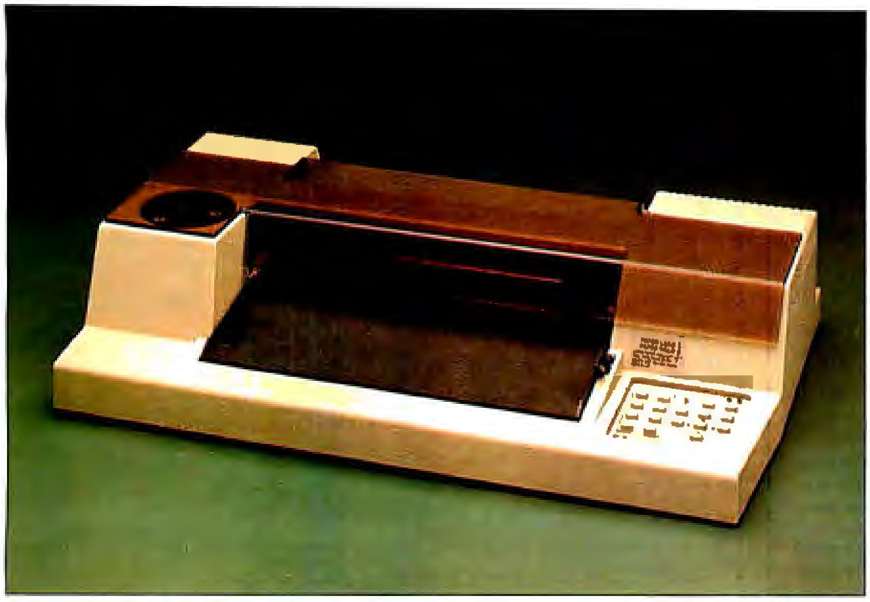


Photo 1: *Hewlett-Packard's six-pen plotter, the* HP 7475A.

good, but they do not produce a line of sufficient quality to be used in a magazine, for example. HP claims, however, that certain art stores sell adapters that enable you to attach technical pens to the pen holder. These pens are the same as those used by graphic artists, and when used at a slow speed on the plotter, they should produce high-quality lines.

INTERFACING

The HP 7475A comes in two versions: one with an RS-232C serial interface and one with an HP-IB daisy-chain-type interface. I didn't use the HP-IB version of the plotter, but I tested the serial version with the IBM Personal Computer and the Tandy Model 100. It worked fairly well with both systems. For the IBM, there's a special null modem cable that switches pins 2 and 3 and 6 and 20. The plotter uses pin 6 to signal when its input buffer is full (which happens very quickly).

Unfortunately, the Model 100 doesn't read pin 6 or 20 and keeps right on sending information to the plotter even when the buffer is full, causing some strange-looking plots. The only way I could get the plot to come out right was to slow down my homegrown graphics program with frequent pauses. According to the plotter's documentation, it can use the XON/XOFF protocol to signal when its buffer is full, but I couldn't get this to work.

DOCUMENTATION

By computer standards, the HP 7475A's documentation is good. It covers all aspects of the plotter, its organization is coherent and logical, and the presentation is professional. My only complaint has to do with the chapters on interfacing. A few more examples and some simplified phrasing would have helped immensely.

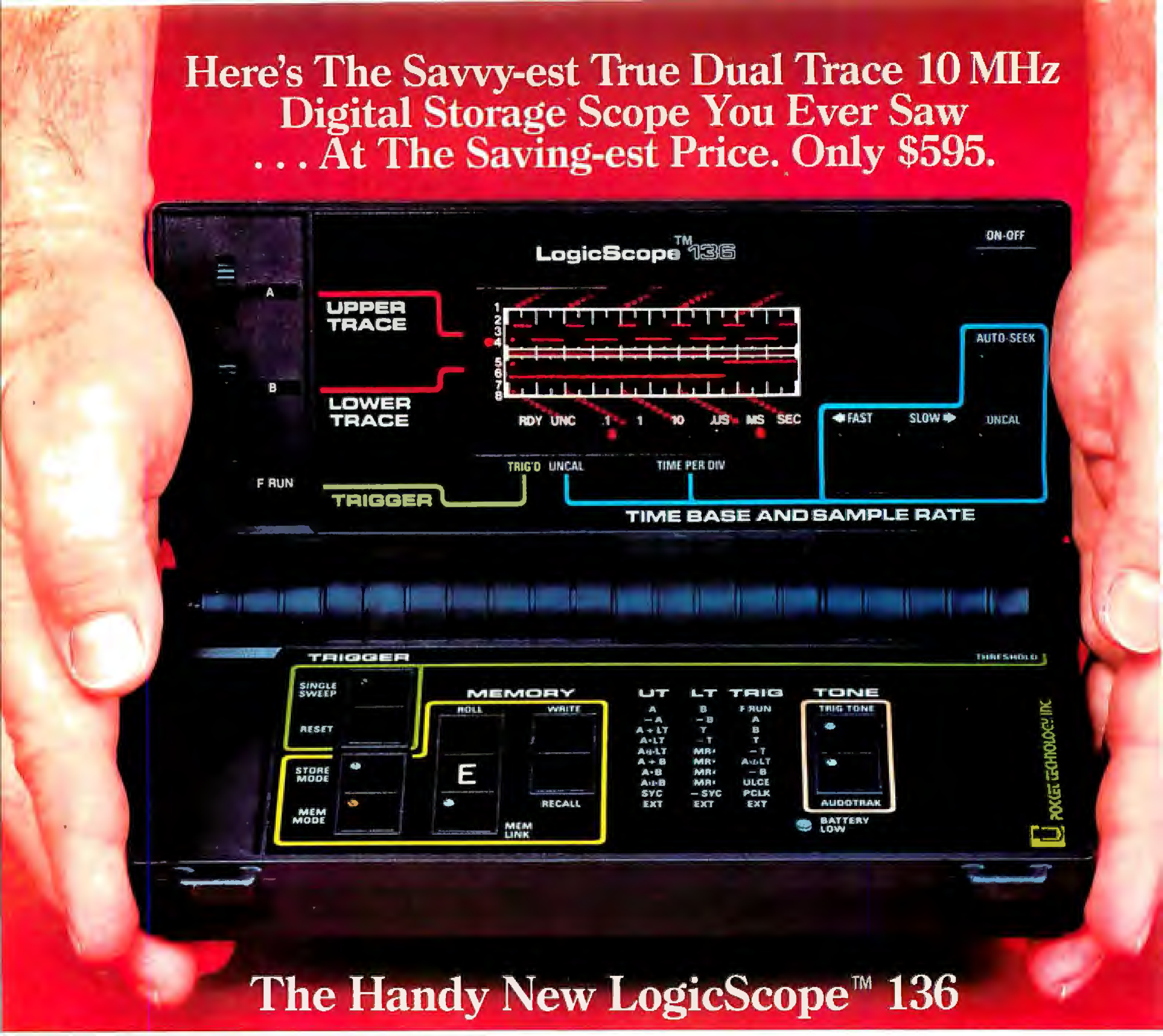
The documentation includes instructions for interfacing the plotter with all the major personal computers (except the Tandy Model 100).

CONCLUSIONS

The HP 7475A six-pen plotter is a powerful, accurate, versatile, and affordable graphics machine. It is well designed and well built. Its performance is practically flawless, and it seems to be expandable.

I wish the plotter had a key for aborting a bad plot. Another nice addition would be an automatic paper feeder—but for that you'll have to buy the new HP 7550A plotter for a significantly higher price, about $3900. ■

Inquiry 322



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Inquiry 329

H·A·R·D·W·A·R·E R·E·V·I·E·W

The IBM Quietwriter Printer

Quietly elegant output

BY JON R. EDWARDS

Most letter-quality printers I have used are slow, loud, and expensive. IBM's new Quietwriter printer (see photo 1) is not inexpensive at $1395, but it is neither slow nor loud.

The unidirectional printer uses an innovative thermal-transfer process to simulate letter-quality printing while maintaining excellent font flexibility, acceptable speed, and a conspicuously quiet performance that justifies its name. For some users, the printer's most important feature will be the cartridge-based fonts, each of which can generate letter-quality output of the entire IBM character set.

DESCRIPTION

The IBM Quietwriter is large, solid, and well constructed. It measures 21 by 6 by 14½ inches and weighs 22 pounds without the optional pinwheel form feeder. The housing is an off-white, high-impact plastic. The front of the unit includes five membrane keys, five LEDs (light-emitting diodes) to indicate the status of the printer, and 10-, 12-, and 15-character-per-inch (cpi) rulers. The on/off lever is on the top left. To the right are the paper-release lever and the paper bail.

The Quietwriter, which comes with a standard Centronics-compatible parallel interface, uses unidirectional printing with friction paper feed and a special IBM Quiet noncorrecting ribbon. The maximum printing width is 13 inches. The Quietwriter has no option for a serial interface.

Unlike other thermal-transfer printers with print heads that apply heat to the ribbon, the Quietwriter applies an electrical current to the ribbon, which heats internally. The technique, which IBM calls a resistive-ribbon thermal transfer, apparently speeds the printing because the print head does not need to cool between characters.

The print head contains 40 vertical circuits that form characters in a dense matrix as the carrier assembly moves across the page (see photo 2). In 10 pitch, the matrix is 36 by 40; in 12 pitch, it is 30 by 40; and in 15 pitch, it is 24 by 40. The print head presses against the ribbon, selectively forcing the four-layer ribbon to release ink in response to pinpoints of current. A polymer material heats up in the pinpointed areas. A metallic conducting layer then melts a third layer (another polymer), which releases the fourth layer, the film of ink. The technology allows for correcting ribbons, although the age of word processing does not require them.

The printing process is amazingly quiet. Carriage returns are the loudest part of the operation, save for the three warning beeps that occur when the printer runs out of ribbon, runs out of paper, or cannot sense the font. The beeps effectively gain the user's attention, but I'd prefer a quieter warning more in keeping with the printer's name.

The five membrane keys on the front of the printer are easy to read and use. The Stop and Start buttons control on-line and off-line status. The other front buttons (Paper Up, Paper Down, and Form Feed) function when the printer is off line. Also, when the printer is off line, the Stop button becomes a Code button that provides a second, related function when used in conjunction with the other buttons; Paper Up and Paper Down work incrementally (rather than continuously), and Form Feed becomes Form Feed Set.

All the keys work properly and easily. However, the only way to clear the buffer, which holds about a page of text, is to turn the printer off and then on again.

Technically, the Quietwriter is a dot-matrix printer but its characters appear as clear and clean as most letter-quality output (see figure 1). All the characters are well formed; the dense matrix permits pleasant fonts with impressive curved detail on many characters.

Currently, IBM offers four fonts for the Quietwriter: Prestige (15-cpi), Prestige Elite (12-cpi), Courier (10-cpi), and Boldface (12-cpi), which provides proportional

(continued)

Jon R. Edwards is a technical editor for BYTE. He can be contacted at POB 372, Hancock, NH 03449.

spacing. It's simple to insert the fonts, which come in matchbox-size cartridge form, and you can switch between two installed fonts with a command from the computer. The printer has two font holders; even when not in use, the second font holder provides handy storage. The printer gives visual and audible warnings if fonts are improperly installed.

Printing speed depends upon the font. Benchmark tests, which involved printing 4000 characters (50 lines of 80 As each; see "The Art of Benchmarking Printers" by Sergio Mello-Grand, February 1984 BYTE, page 193), gave results of 25.2 characters per second (cps) for the 10-pitch font, 29.4 cps for the 12-pitch font, and 33.7 cps for the 15-pitch font. The times are well below press announcements of 40 to 60 cps, but the speeds are acceptable.

When you need to change the ribbon or if there are problems in the ribbon mechanism, the printer again gives audiovisual warnings, goes off line, and gives you a chance to change or fix the ribbon. The $12 ribbons are encased in sturdy plastic.

At first I had some small problems with the ribbon, which tended to form a crease at the top and occasionally cut off the tops of letters. I quickly became proficient in loading the ribbon properly and keeping it taut during installation, but I noted that the creased ribbon did not activate the ribbon warning. Changing the ribbon, at first a chore, now is quick and simple.

The paper bail rolls the paper into the printer quickly and easily, but I miss having a roller knob to give me more direct control over the platen. The addition of the optional pinwheel form feeder would obviate the need to load paper before every use.

```
This is the COURIER font (10 pitch)
This is the PRESTIGE ELITE font (12 pitch)
This is the PRESTIGE font (15 pitch)
This is the BOLDFACE font (12 pitch)
```

Figure 1: *Samples of printout from the* IBM *Quietwriter using the four available cartridge fonts.*

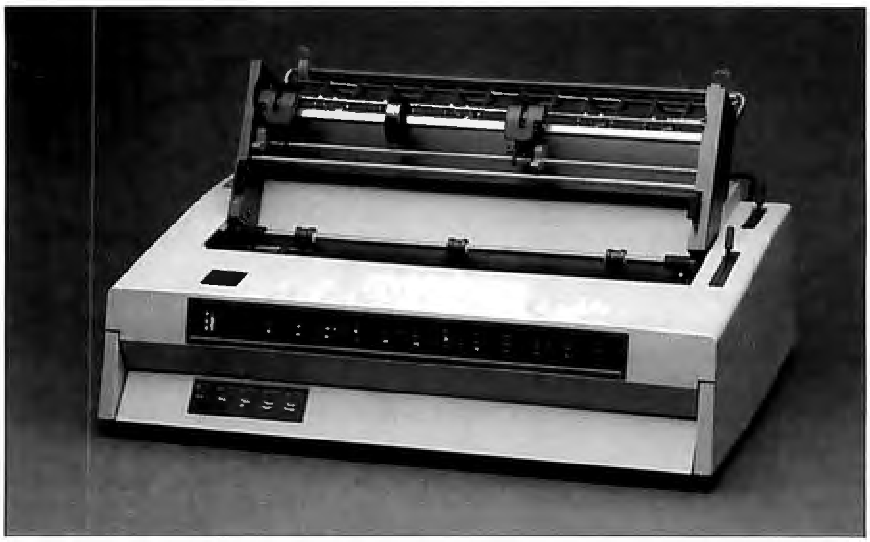


Photo 1: *The* IBM *Quietwriter with the optional pinwheel form feeder attached.*

The printer offers a contrast control switch with three settings to allow for changes in paper, ribbons, or climate (see photo 3). I got the best results with the contrast control set in the highest position. In the lower positions, using standard white printer paper, characters were unevenly thin or thick, and parts of some characters occasionally did not print. In the highest setting, I experienced the same problems but quite rarely. The final output was always very good. Note that different contrast settings have no effect on the benchmark times for each font.

IBM claims that print-head life is optimized on the lower contrast settings, and that the higher position causes the print head to wear out sooner. The latter might be the price users have to pay for acceptable printer output. New print heads cost $20. IBM recommends using its Quiet cleaning cartridge to preserve the head's life, which IBM rates in excess of 4,000,000 impressions.

Through the use of printer control codes, the printer allows switching between fonts, superscripting and subscripting, setting and clearing of horizontal and vertical margins and tab stops, and variable line feeding. I had no difficulty subscripting, superscripting, or underlining using PC-Write. To print in boldface, you have to use the appropriate control code to switch to the separate boldface font (available only in 12 pitch).

Without the optional pinwheel form feeder, printing multipage documents is likely to require the auto-stop function, which stops the printing at the end of every page. You only order the function once; it remains active until the computer resets the printer or you turn it off.

OPTIONS

Serious office use will require the Quietwriter's optional pinwheel form feeder ($75), which supports forms with widths between 3 and 15 inches. The form feeder is easy to install and use. It locks directly onto the platen shaft and has a cable that plugs into

(continued)

AT A GLANCE

Name
IBM Quietwriter printer

Manufacturer
IBM National Distribution Division
1000 Westchester Ave.
White Plains, NY 10604
(800) 426-2468

Type
Dot-matrix printer with letter-quality output

Size
21 by 6 by 14½ inches

Weight
22 pounds

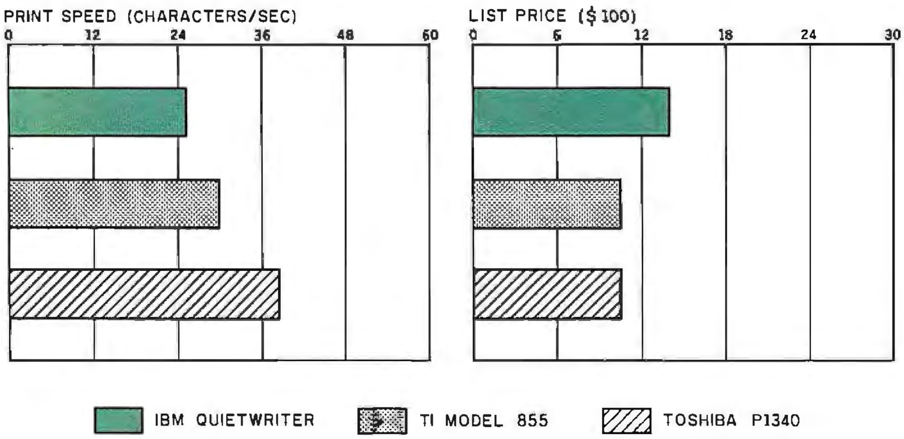
Computer
IBM Personal Computer or compatible with a Centronics-type parallel interface

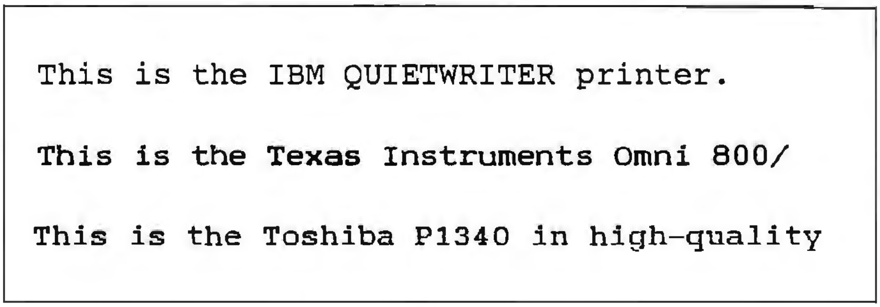
Features
The printer buffer holds 1800 characters. All four cartridge fonts, including Courier (10 pitch), Prestige Elite (12 pitch), Prestige (15 pitch), and Boldface (12 pitch) print the entire IBM character set. Ribbons have an approximate capacity of 160,000 characters depending on pitch used. Supports underlining, subscripting, and superscripting

Documentation
120-page guide to operations

Price
$1395

Options
Pinwheel form feeder $75
Additional fonts $50 each
Additional ribbons $12 each
Additional print heads $20 each





A comparison of the Quietwriter printer with the Texas Instruments Omni 800/Model 855 printer (see January BYTE, page 345 for review) and the Toshiba P1340 printer, both in letter-quality mode. The pitch for all the printers is 10 characters per inch. The print speeds were determined by timing how long it took the printers to print 50 lines of 80 *A*s each. The prices shown are list prices. The price for the Quietwriter does not include the optional pin-wheel form feeder.

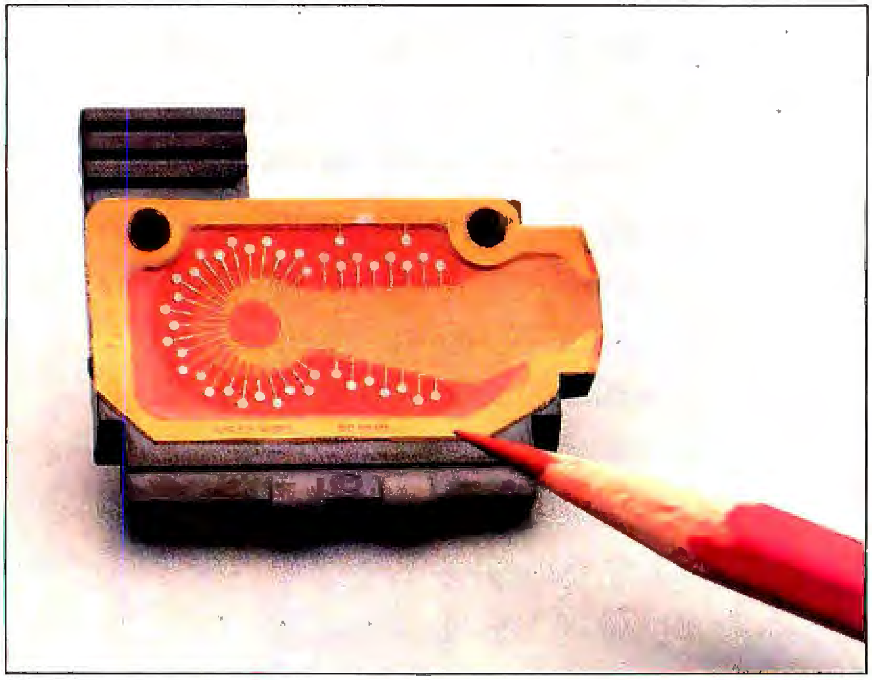


Photo 2: A *close-up of the* IBM *Quietwriter print head;* 40 *circuits press against the ribbon to form a dense matrix as the carrier assembly moves across the page.*

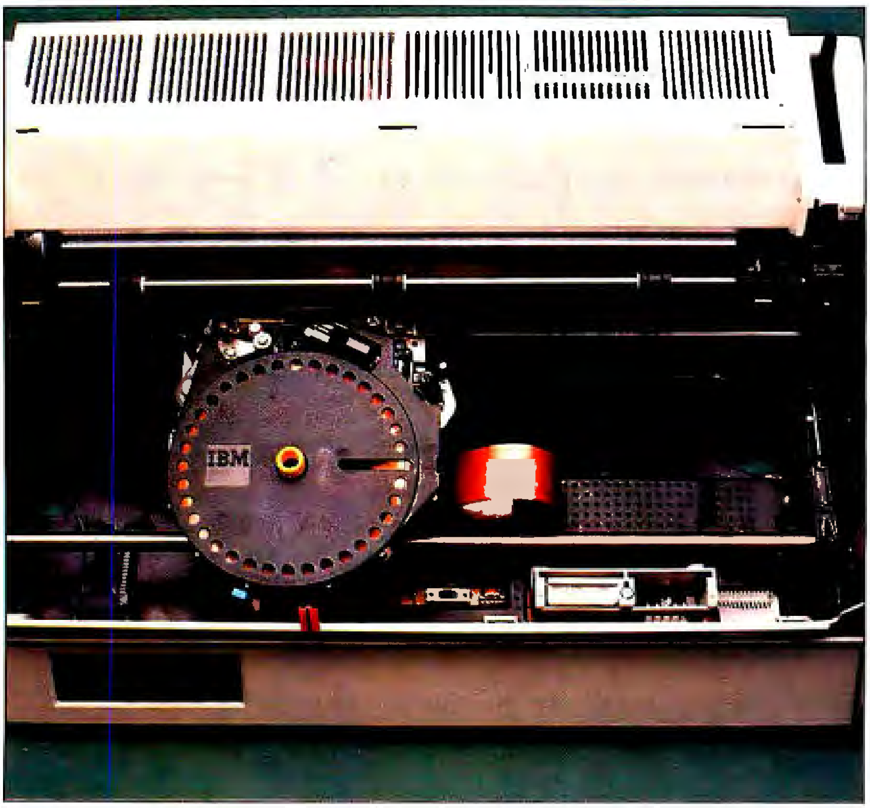


Photo 3: *The inside of the* IBM *Quietwriter. The fonts are at the lower right. The contrast control and* DIP *switches are in the middle.*

a connector on the rear of the printer.

You must use the Paper Up key and not the paper bail to move paper with the form feeder, but there are easy-to-follow instructions for inserting paper. It is important to follow the instructions carefully. For example, if the paper-release bail remains shut, paper will gradually pull and tear off of the pinwheels. The manual, however, contains proper cautions. IBM says it will provide a cut-sheet feeder for the printer in the second quarter of 1985. Its estimated cost is $350.

With the optional pinwheel form feeder attached, a light warning comes on when the printer senses the end of continuous form paper. The printer beeps loudly, goes off line, and waits for more paper.

The documentation is adequate, with simple, well-illustrated instructions for unpacking and assembling the printer. There are adequate sections on most aspects of printer operation. A "Problem Determination Procedures" section helps you diagnose problems. An appendix lists all the printer control codes, the escape codes used by word processors to engage the printer's functions. To engage these functions from a BASIC program, use LPRINT with the required escape character codes.

There are easy instructions for changing the DIP-switch settings to accommodate, for example, paper length and width. The switches are conspicuously located left of the font holders, but I would prefer a larger switch to regulate paper width. The printer's self-test, in addition to printing the entire font, prints out the DIP-switch settings—a useful feature.

CONCLUSIONS

The Quietwriter's main strength is its combination of acceptable letter-quality print, reasonable speed, and merciful quiet. Undoubtedly, many offices could not sacrifice one of the three. Others might welcome letter-quality output of the entire IBM character set. Those who require letter-quality printouts of program listings might find an answer in the IBM Quietwriter. ■

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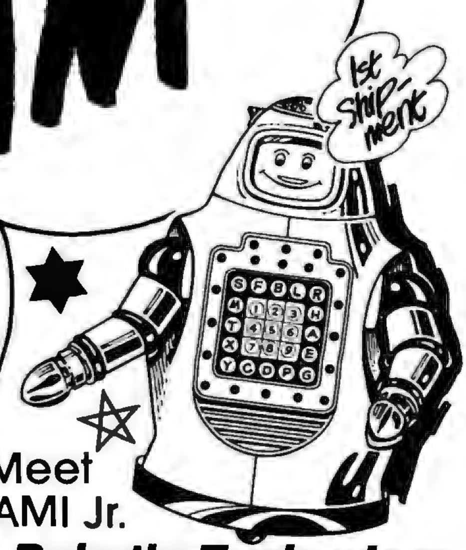

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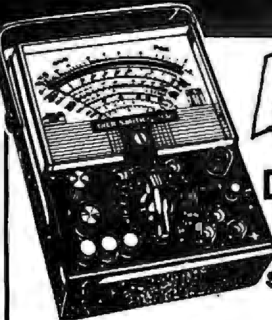

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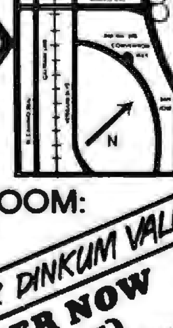

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Inquiry 119

The Word Plus

An easy-to-use spelling checker

BY GEORGE SHELDON

A spelling-checker program cannot replace a stern spelling teacher. But The Word Plus, from Oasis Systems, is the next best thing. This program, which sells for $150, contains a 45,000-word dictionary. It is one of the older spelling checkers on the market. The Word Plus is available for most CP/M, CP/M-86, and MS-DOS computers in both 5¼-inch and 8-inch disk formats, and it is compatible with WordStar and most other major word processors. For this review I used it on my Kaypro 2.

The very idea of a spelling checker may seem to some people to be an unnecessary option. Most people who use a word processor are satisfied enough with the formatted text and easy editing their chosen software offers. For them, adding an electronic dictionary is like extra icing on a cake.

But owning a word processor and not using a spelling checker is like buying a brand new automobile without shock absorbers: You can use the car to get where you want to go, but getting there could be a whole lot smoother.

Two Types of Spelling Errors

All electronic dictionaries, including the one incorporated in The Word Plus, have their limitations. This is caused by the fact that there are two types of spelling errors.

First, a word is simply misspelled because either the writer did not know how to correctly spell the word or the word was mistyped. With the determination of a bloodhound on a fox hunt, The Word Plus will search out and locate these kinds of errors.

Second, a word may be misused. This occurs with words like *there* and *their*. Both are spelled correctly but are misspelled when used in the wrong context. Unfortunately, a spelling checker cannot help with these types of errors. The reason is obvious: The word, according to the electronic dictionary, is spelled correctly. You are on your own to locate and correct these types of errors.

The Word Plus measures up to what is expected of a spelling checker. Not only does it find spelling errors, it helps to correct them. It works fast, and unlike other dictionaries, it checks spelling in one sweep of the document. This feature is what puts The Word Plus ahead of many other spelling checkers.

Four Components

The package's strongest point is its modular design. Instead of being one large spelling checker, The Word Plus is made of four separate tools: Spell, Review, MarkFix, and TW.

Spell finds spelling errors. Review shows them to you and helps you correct them (more on this in a moment). MarkFix makes the corrections within the document. TW is similar to a batch program; Oasis Systems describes it as the "orchestra leader." It directs the other three programs to do the work. TW is a real time-saver, and you seldom run the programs individually.

Learning to use The Word Plus is as easy as operating it. The user's guide is 48 pages and fairly well organized, though it could be clearer. The instructions are complete enough so that a novice computer user could quickly operate the program.

Within seconds after you enter the program it asks the name of the file to check. It then begins the task of checking your document file against the contents of its master dictionary and also any special dictionary you may have created.

The Word Plus does seem to take a long time to check spelling, but in reality it is fairly fast. On my Kaypro 2, The Word Plus checked a 22-page, 5500-word chapter in 3 minutes 15 seconds. I doubt even a spelling teacher could work that fast.

As soon as Spell has completed its scrutiny of your document, TW brings the Review program onto your screen. Review presents each misspelled word along with a 10-option menu. Selections include the following: show the misspelled word in the

(continued)

George Sheldon is a freelance writer whose interests include country music and personal computers. He can be reached at POB 228, Hershey, PA 17033.

AT A GLANCE

Name
The Word Plus (version 1.22)

Type
Spelling checker

Manufacturer
Oasis Systems
7907 Ostrow St., Suite 5F
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(619) 279-5711

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Price
$150

Audience
Users of compatible word processors

context it was used; add the word to the updated dictionary or a special dictionary; mark the word for further consideration; move to the previous or next word; or correct the word.

But the most remarkable feature of Review is its look-up function. When a misspelled word is presented on the screen and you do not know how to properly spell it, you can choose the look-up function; it will search the dictionary for similar words and present a list of possible choices.

Review also assigns a number to each word in the list of possible alternatives. When you locate the correct spelling in the list, you can then correct the word by typing C (for correct) and the number. Two keystrokes for a 12-letter word is a real time-saver, and it also insures against a second misspelling.

When Review is finished, MarkFix takes over. It quickly makes corrections to your document. If a corrected word is longer than the one it's replacing, the right margin of your document may no longer be justified, and MarkFix will remind you to reformat your document.

Many proper names, specialized words, and technical or medical terms may have to be added to any spelling checker. Adding words to The Word Plus is done quickly with a single keystroke. The Word Plus will remember these words whenever it searches a document.

The Word Plus has a lot of other features, including a word counter—great for writers and students who have to submit material of a specified length. Called Wordcount, this utility can count all of your words within 15 seconds. For people who like word puzzles, The Word Plus can help here, too. A program called Anagram unscrambles any word. It's great for solving the "Jumble" game found in many newspapers. A program called Find can help you locate words containing certain letters. For example, if you entered FIND ??OD, the program would print a list of all four-letter words ending in *od*. Unfortunately, with a dictionary of only 45,000 words (*Webster's Collegiate Dictionary* has about 110,000), you may still have problems with the unusual words that seem to crop up only in crossword puzzles.

If you have a habit of overusing certain words in your writing, the WordFreq program can help. It lists the number of words in your document and then tells you how many times you used each word.

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(continued)

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Inquiry 226

THE BERNOULLI BOX™

Often The Word Plus sent me scrambling to the dictionary to check plural forms I thought were correct and found they were.

aries, including one that has a limited vocabulary. This is ideal for a writer working on books for juveniles, where only a certain grade-level of words can be used.

PROBLEMS

There are, however, several things about The Word Plus that I do not like. Its dictionary of a mere 45,000 words is small in comparison with other spelling checkers. I dislike the way the dictionary does not know the plural forms of some words. Often the program sent me scrambling to *Webster's Collegiate* to check plural forms I thought were correct and found that they were.

Also, there is a homonym helper that does not seem very useful. First you have to review a long list of homonyms: words like *to, two, too; capital, capitol; waiver, waver.* You then delete those words you know how to spell and use correctly. The program will then search your text and mark those words that cause confusion. Unfortunately, by the time you delete all the homonyms you know how to use, there are so few words on the list that running the program is useless. And, if you are having that much trouble with a certain homonym, you will either learn how to use the word correctly or avoid it in your writing.

CONCLUSION

The Word Plus is compatible with several word-processing packages, including WordStar, PeachText, Word Master, Electric Pencil, and Perfect Writer. It operates on almost any 8080-, Z80-, or 8086-based computer and runs under MS-DOS or CP/M, as well as most variations of CP/M.

Although I've never admitted it, the real reason I bought my computer was for the spelling checker. I like The Word Plus. It's easy to use and easy to learn, and it *does* catch spelling errors. For a serious word-processer user, it will become as important as the word-processing software itself. For anyone who wants to make a finished document as perfect as possible, The Word Plus is worth the investment. ■

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SUPPORT FOR SYMPHONY

I enjoyed reading a review as thorough and fair as the one written by Dick Pountain on Lotus's Symphony (January, page 317). With products of this complexity, a few inaccuracies creep in that might leave false impressions on the reader. I would like to point these out.

The Search/Replace functions of the word-processing window are case-sensitive only when you enter uppercase characters in the search string. Thus, the user has the choice. The user also can disable automatic rejustification.

Indented numbered or lettered subparagraphs are handled such that Symphony recognizes the characters (like a) b) c) or 1. 2. 3.) automatically and puts them to the left of the margin setting provided there is enough space. This is a very handy feature, and the user can always overrun and control it by using hard spaces.

While it is true that a number of features usually found in word-processing programs (like hyphenation) are missing, other features (like speed search with the End key or when selecting a block of text) were incorporated that make working with Symphony's word-processing windows very pleasant.

You cannot enter all Extended ASCII characters. Instead, Symphony uses its own extended character set called LICS (Lotus International Character Set). LICS does not contain the IBM PC's graphics characters, but it contains many characters found in different foreign languages. Symphony goes a long way to establish the correct telephone-book collating sequence and to materialize the characters on screen and paper. If necessary it even switches character sets between two characters on a dot-matrix printer.

The inability to display color graphs and high-resolution text on the same screen lies entirely within the Color Graphics Adapter. (Lotus recently hinted that it will provide a driver for the new IBM Enhanced Graphics Adapter.)

The communication function does provide a mainframe protocol. Symphony emulates an ANSI-compatible terminal so a PC running Symphony acts like a VT-100 or similar terminal. Thus, it is easy to interface to a host providing ANSI signals (e.g., DEC mainframes or any other host with a suitable protocol converter) while at the same time filing transfers in both directions without the need to install any special software.

Symphony does use a rectangular "active area" beginning at the upper left cell A1. Whenever you enter something into the spreadsheet outside this area it automatically and invisibly expands to cover the newly used cell. When you erase such cells, the active area does not shrink. However, the spreadsheet is shrunk to its minimum required size whenever you save it to disk. It is not normally necessary to use XTRACT.

Be aware that even an erased cell can keep your active area expanded if it contains formatting information or an allow-changes setting. (To find the lower right corner of your active area, press the End and Home keys.)

While "sparse matrix" storage methods would certainly save some memory under certain circumstances, Lotus's method contributes to the program's speed. Note that it outruns nearly all its competitors, often by a factor of three or more.

HANS-GEORG MICHNA
Munich, West Germany

HP'S THINKJET

Your article on the HP ThinkJet printer by Mark Haas (January, page 337), while well done, left out some information a prospective buyer should know. I've owned one and used it heavily for four months.

Mr. Haas perhaps misleads your readers about the paper required by the ThinkJet, saying "the ink will bleed on paper that is too absorbent—roughly equivalent to writing with a fountain pen on tissue paper." This implies that the special HP paper isn't very absorbent. The exact opposite is true. If you write on HP paper with a medium- or wide-line pen, you can see the ink bleed through. The back of the HP paper should be, but isn't, treated to resist such wicking.

The ThinkJet cannot print acceptably on any paper that is not highly absorbent. From trials, I conclude that the tiny globules of ink expelled by the ThinkJet must spread by absorption to form a legible character. If the globules come to rest on a relatively impermeable surface, they remain at original size—much too tiny to form characters of acceptable width.

I agree with Mr. Haas that the ink cartridge is reliable even if not used for a week or more. HP apparently employs ethylene glycol to keep its ink from evaporating. Unfortunately, the glycol creates a serious problem: The ink is not fast and it remains forever water-soluble.

Next, I cannot print mailing labels successfully. All commercial labels are treated to resist staining from handling so they are not absorbent. Labels printed with normal output are faint and illegible. Those in boldface smear either going through the printer or when handled.

Because the ThinkJet has no platen, you cannot use paper less than 7½ inches wide (the two friction rollers that substitute for a platen are set this distance apart). Therefore, you cannot print postcards, notes, or any small form unless it is made up in special absorbent paper and is several forms wide. No such forms are now commercially available.

The paper-loading arrangement in the ThinkJet is cumbersome. I don't mind this when loading the first sheet of fanfold, but I gave up on loading cut paper. It takes longer to load a sheet than to print it.

Last, my ThinkJet has a paper-feed problem. After fanfold paper sits overnight, the top of the sheet takes on a permanent curve. The next document then catches on the paper separator, folds into a V, and arches the middle of print lines upward. Although a simple modification to the paper guide prevents this, HP should have caught it on the prototype.

In sum, the ThinkJet does a fast, reliable job for quick drafts. It definitely isn't a general-purpose printer. If your readers want one printer to handle everything, I'd advise they look elsewhere.

DICK BARNES
Hatteras, NC

BASIC STRING VARIABLES

I write in response to Robert S. Hunter's query on page 356 of Review Feedback

(continued)

(January) about how to use the OPEN statement in BASIC with a string variable for the filename.

In any BASIC program it is possible to substitute a variable for a string when it is not acceptable to the BASIC interpreters by leaving blank spaces within the quotation marks that need the string, then POKEing the string variable into the blanks character by character. This works in any variation of any BASIC.

Most BASICs store keywords like OPEN, CLOSE, and GOTO as a 1-byte token instead of correctly spelling the keyword. This saves memory and speeds searches for the correct routine to execute the command. Some versions of Microsoft BASIC use 153 as the token for OPEN. The numbers are usually above the highest printing ASCII codes (above 127) and appear as graphics characters if you PEEK into the spot where the OPEN token is stored. If you loop through the computer's memory looking for the OPEN command's token, you will locate the line of code that needs to have the variable POKEd into the blanks between the quotation marks. In other words, you tell the computer to look through its memory starting at the beginning of your program and find the line you need by searching for OPEN.

You need to look at a memory map of your computer to find out the address of the pointer that stores the address of the start of a BASIC program. The BST variable in line 200 of listing 1 is the address that points to the start of the BASIC program area, sometimes referred to as the BASIC buffer. BEND is the variable found by PEEKing the address of the start of the variables found in the pointer table. Some BASICs do not use a pointer to the end of your program; the end is simply defined by a series of zeros when the program is entered. You should find both BST and BEND before running the subroutine by PEEKing at the table of pointers and using the appropriate math. You can find them during program execution if you know the pointers for sure.

If you do not have a memory map and do not know what the token for OPEN is, loop through the entire memory looking for a dummy line of text, then branch out of the loop and get the address where the dummy text was found (see listing 2).

Listing 1 POKEs FL$ into the filename after OPEN in line 110. This whole section is treated as a subroutine and is exited after the CLOSE statement in line 130. More string manipulation could be done to check for a filename extension in FL$ instead of truncating FL$ when it is too long and forcing the extension to DAT. BST, BEND, and FL$ must be initialized before entering the subroutine.

After you run this program, get a listing and see how line 110 is changed with FL$ in place of the blank spaces.

Listing 2 should be run independently of the first program and run several times using different characters in the remark statement in line 10, and in lines 50 and 110 to be certain there isn't a felonious group of Xs. After finding the start of BASIC, you find the end by adding the available memory in an empty buffer to the start address.

Listing 1: *Program to* POKE FL$ *into a filename.*

```
105: GOSUB200
110: OPEN"0",#1,"          /DAT"
120: PRINT#1,"SOME DATA"
130: CLOSE#1
140: RETURN
200: FOR A=BST TO BEND
205: REM BST & BEND ARE START AND END OF BASIC BUFFER
210: IF PEEK(A)=(TOKEN FOR "OPEN") THEN 250
215: REM LINE 210 BRANCHES AT THE OPEN TOKEN
220: NEXT A:RETURN
250: IF PEEK(A+1)=34 THEN 280
260: REM LINE 250 CHECKS CHARACTER AFTER OPEN
265: REM AND BRANCHES AT CHR$(34) OR " SIGN
270: NEXT A:RETURN
280: IF PEEK(A+2)=ASC("0") THEN 310
290: REM LINE 280 IS SECOND REDUNDANCY CHECK
300: NEXT A:RETURN
310: FL=8:IF LEN(FL$)<>8 THEN GOSUB 500
320: REM LINE 310 BRANCHES TO PADDING ROUTINE TO
325: REM BRING LENGTH OF FL$ TO 8 CHARACTERS
330: C=0:FOR B=A+9 TO A+9+FL
340: C=C+1:POKE B,ASC(MID$(FL$,C,1))
350: NEXT B:NEXT A:RETURN
500: IF LEN(FL$)>8 THEN 550
510: FOR PAD=LEN(FL$) TO 7
520: FL$=FL$+" "
530: NEXT PAD:RETURN
550: FL$=LEFT$(FL$,8):RETURN
```

Listing 2: *Program to find the start address of the* BASIC *buffer and the token for* OPEN.

```
10: REM XXXXXXXXXXXXXXXXX
20: OPEN"0",#1,"DUMMY"
30: CLOSE#1
40: FOR X=0 TO 65536
50: IF PEEK(X)=ASC("X") THEN 100
60: NEXT X:END
100: FOR Y=X TO X+16
110: IF PEEK(Y)<>ASC("X") THEN 60
120: NEXT Y:PRINT"START ADDRESS OF BASIC IS";X-8
130: FOR Y=X TO X+25
140: IF PEEK(Y)=34 THEN 200
150: NEXT Y
200: PRINT"TOKEN FOR OPEN COMMAND IS";PEEK(Y-1)
```

JEROME P. CIGNA
Rochester, NY

NEWWORD

I must take you to task for John Heilborn and Nanci Reel's review of NewWord (February, page 291). The reviewers make it sound as though the installation procedure is a terribly long process. To me, this is the strength of the program. Versions of WordStar prior to the 3.3 release allowed little flexibility—they didn't even let you set the help level until you were into the file on which you were working.

Further, the price of NewWord is about half that of WordStar and includes MailMerge. NewWord's powerful printing drivers are especially useful in an office environment with several different printers.

The support offered by Rocky Mountain Software is excellent. If one must find fault, one should complain that NewWord will not support the Random House Thesaurus program, or that there should be a way to delete the printing drivers one doesn't require from the working copy to make additional disk space.

NewWord's few shortcomings are minor compared with its power, flexibility, and price. I feel your reviewers should have given far more plaudits to this outstanding and relatively inexpensive program.

HAL REMMES
Hyde Park, MA

THE MT 160

In the review by Mark J. Welch of the Mannesmann Tally MT 160 printer (February, page 325), there is one important bit of misinformation.

Mannesmann Tally does not provide end-user support. Service-department personnel insist that you direct your question only to your dealer. My dealer was incredulous about this policy and refused to call for an answer to my question about how to configure WordStar with this printer.

My question was how to obtain superscripts. The answer (which I was forced to discover on my own) might be of interest to others. Using WordStar's Install program, select the Epson MX-80 printer option; you can then change the printer name to Mannesmann Tally if you care to. Enter 1B, 53, 00 (hexadecimal) for ^PT. Enter 1B, 53, 01 (hexadecimal) for ^PV. Finally, enter 1B, 54 for ^PR. If you type

the last time. ^PT1^PT^PR

in WordStar, a superscript 1 will follow the word time.

The printer has been reliable and the print quality in correspondence mode is better than that of most other printers in a similar mode (although the quality of print in draft mode is below average). What I especially like is that the characters are of normal typewriter size. However, the lack of user support makes the printer unsuitable for anyone inexperienced in configuring software and printers.

RICHARD WAGNER
Tallahassee, FL

CORRECTION

We have been informed that the $7.95 price paid by Mr. Dobson (November Review Feedback, page 352) for a Juki daisy wheel was erroneous. We apologize for any inconvenience this may have caused our readers. ■

REVIEW FEEDBACK *is a column of readers' letters. We welcome responses that support or challenge* BYTE *reviews. Send letters to Review Feedback,* BYTE *Publications, POB 372, Hancock, NH 03449. Name and address must be on all letters.*

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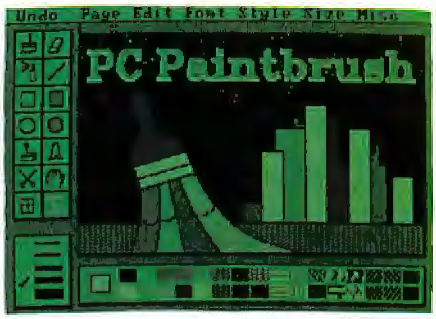

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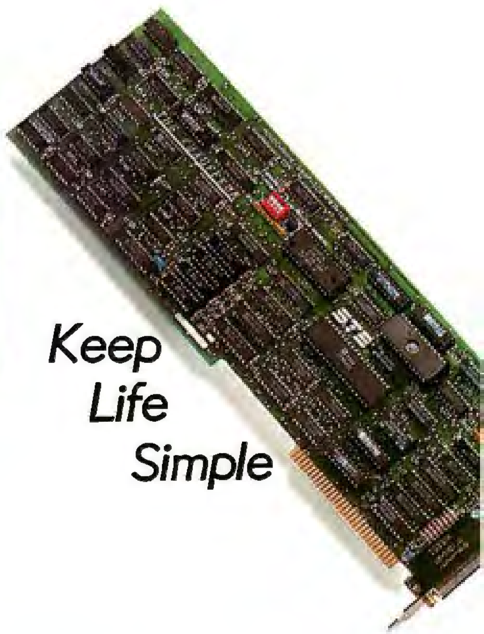

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CHAOS MANOR'S RENOVATION continues and likewise do Jerry Pournelle's impressions of sundry hardware and software products. First, though, he discovers why reliable ol' Zeke at last needed some attention, then proceeds with this month's offerings. Finally, as usual, he finds time to answer some of his mail.

From London, BYTE U.K.'s Dick Pountain takes a look at International Computers Ltd.'s One Per Desk telecomputer. This interesting piece of equipment is built around the Sinclair QL and uses a real multitasking operating system to expand computing and communicating capabilities.

Bill Raike muses about the continuing introduction of interesting new computer products in BYTE Japan. In this installment, he takes a look at three significant upgrades to NEC computers, an impressive hard-disk-cartridge system, and the escalating use of PCs as tour guides.

The troops at our BYTE West Coast outpost spent some of their time this month at a Digital Research seminar on GEM, a Macintosh-like environment available for non-Macs. Our intrepid editors also comment on a Macintosh disassembler and technological advances in disk controllers.

In Circuit Cellar Feedback, Steve Ciarcia also finds time to share some of his correspondence with readers who have built his projects.

Longtime BYTE readers will notice that Sol Libes's BYTELINES has returned. Sol offers us his perspective on the happenings in the personal computing world with news and speculation on a wide variety of topics.

—Gene Smarte, Managing Editor

C·O·M·P·U·T·I·N·G
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From the Living Room

BY JERRY POURNELLE

Jerry Pournelle holds a doctorate in psychology and is a science-fiction writer who also earns a comfortable living writing about computers present and future.

Readers sometimes ask if Chaos Manor is *really* as disorganized as all that. They wouldn't if they'd been here this last month. Just today the contractors got a roof on my house; for the past week we have been naked to the stars. I am at present writing this in the living room because my office has no ceiling. The stairway to the new upstairs suite goes through the old office—and although the upstairs now has a roof, it has no walls.

It's February, and even in Los Angeles it gets cold at night. I can put on enough sweaters and vests to make it nearly endurable, but it's impossible to write with gloves on, so after two nights of stiff fingers I gave up. I've promised Mrs. Pournelle that the computers will be out of her living room Real Soon Now...

CLEANUP

Zeke II, the Viasyn CompuPro Z80 I do nearly all my writing on, hasn't been opened for two years. If it ain't broke, don't fix it; but without a ceiling my office is effectively broke, so we had to move Zeke. I brought him out to the living room, set him up, and turned him on.

There was a sharp click as he tried to access the disk, then blooey: a screen full of garbage. Resetting didn't help. Zeke just wasn't communicating.

I have a lot of computers, and I'm not usually nervous about opening them up; but one reason for my nonchalance is that no matter what might happen to any of the other machines, I could always go back to good old superreliable Zeke to get my work done. Now, with all my other machines covered with plastic, my office two inches deep in sawdust and powdered plaster, and nearly everything I own packed away in boxes, Zeke wasn't working.

"Don't panic," I told myself that several times, then opened the cover.

Zeke was *full* of dust and dirt. Dog hair, dust balls, you name it. The dust filter had obviously died years ago. First thing, then, was to use the vacuum cleaner. He still didn't work, so next I removed all the boards, flexed them a bit, pushed the chips into their sockets, and put them back. This time he booted up fine, and I was able to get some work done. Next day, though, when I tried to connect up the printer, we got more garbage.

Up to then I'd hoped to solve the problem myself, but I had no more time. What with the new construction, plus a trip to New York to promote my new book, plus the Mini/Micro show in Anaheim this week, Stride Faire this coming weekend, and a trip to Texas Instruments next week—I'm scheduled to go directly from Reno to Dallas Sunday without ever coming home—there was no way to lose any more time and still meet the deadline for the column. Nothing for it: I called Tony Pietsch, who built Zeke.

"Dust," he said. "Dust and dirt."

"But it worked fine—"

"While it was just sitting there. Moving it moved the dirt. These machines aren't maintenance-free, you know."

"Tell me what to do—"

"Just stay there. I'll come over. You watch."

JUST ROUTINE...

He had a box of solvents. The most important one is called DE-OX-IDE. There was also a standard tuner cleaner, a bottle of alcohol, a can of compressed air, and a can of Instant FD Zero Residue Cleaner, which contains mostly trichlorotrifluoroethane. Some computer stores carry these, but most don't; a big electronics supply house is a more reliable source.

What Tony calls routine maintenance consists of using common sense and solvents. Tony knows what he's doing, but if I were working alone, I'd start by making a chart of every cable and board; it's amazing how easily you can forget which way things are hooked up. Then disconnect everything that's easy to disconnect, remove all boards, and start in, using compressed air, solvents,

(continued)

paper towels, and tissue paper. Be sure to clean all cable connectors, board connectors, sockets, and anything else that comes apart easily and makes electrical connection. First use solvent, then the DE-OX-IDE.

You probably want to open a window when you do, unless your office happens to have no roof like mine.

Before replacing the boards, lay them down on a flat surface and carefully push each socketed chip firmly in place. Then put the boards in as they were, replace the cables—

We did all that to Zeke. Tony, being confident that there was nothing actually wrong with the machine, put the cover back on before testing it. The universe generally punishes me for such arrogance, but it works for Tony. We fired up the machine and everything ran. Indeed, the letters on my screen seem somehow steadier and crisper, although that may be overenthusiastic imagination.

JAZZING UP ZORRO

I'm told those with late-model Z-100 machines don't need to do this.

Zorro, our Z-100, was one of the first that Zenith made. The Z-100 comes with a color board. The early model used 32K-bit memory chips. A 32K-bit chip is really a 64K-bit chip with problems on one side of it. When 64K-bit chips first came out, the yields were low and the chips were expensive. It made sense to use the partly defective ones. The result was acceptable color resolution, but only half of what the machine was capable of.

There are two ways to find out if you have the older model with 32K-bit chips. The complicated way is to disassemble the Z-100 and look at the jumper on the video board. (The video board is the small upper upside-down board you see after you remove the disk drives.) The jumper has three positions: 32K-bit upper bank, 32K-bit lower bank, and 64K-bit. If it's set for 64K-bit, you have a newer machine.

You can also find out by running one of the tests built into the Z-100 ROM (read-only memory); just boot the machine without a disk, and when you get the "hand prompt" device error message, type H for help, and on the menu that follows, type S for system information. The machine will tell you what kind of video it has. [*Editor's note: Early versions of the Z-100* ROMs *do not have this feature.*]

Ours had the 32K-bit variety. Omnitrend's Universe game is designed to work with an IBM PC color board or a full 64K-bit Z-100 color system. I blush to say that after three years of putting up with the 32K-bit video, the Universe game was what finally induced me to buy enough chips—24 of them—to bring Zorro up to full video strength. We used 4164-type 150-nanosecond parts. Replacing the 32K-bit chips and changing the jumper takes about a half hour.

We had problems afterward, but it wasn't Zorro's fault. One wants to be careful when putting the Z-100 back together; it's fairly easy to crimp a keyboard cable or jam one of the keys so that it binds on the case. The keyboard simply sits on foam in the case, so it's not surprising that it happens. The result isn't a disaster, but it seemed like one until we opened the machine and reassembled it with a bit more care.

Alas, after all that I discovered that I don't yet have Z-DOS II for the Z-100, so I *still* haven't seen how Universe looks on Zorro. I have Zenith disks marked "MS-DOS 2.0 for the Z-100 PC"; it seemed reasonable to suppose that would work with Zorro, but "Z-100 PC" refers only to Z-150 and Z-160 machines.

DYSAN'S INTERROGATOR

One way to be sure your machine is in good shape is to run diagnostic programs. You generally get a set of them with a DOS (disk operating system), but to really check out disk drives you can't beat the Dysan diagnostics programs. The Dysan Interrogator comes in both Z-100 (including Z-110 and Z-120) and IBM PC versions. The IBM PC variety will work with the IBM PC and the Zenith Z-150 and Z-160 machines; I presume it works with other PCompatibles. The

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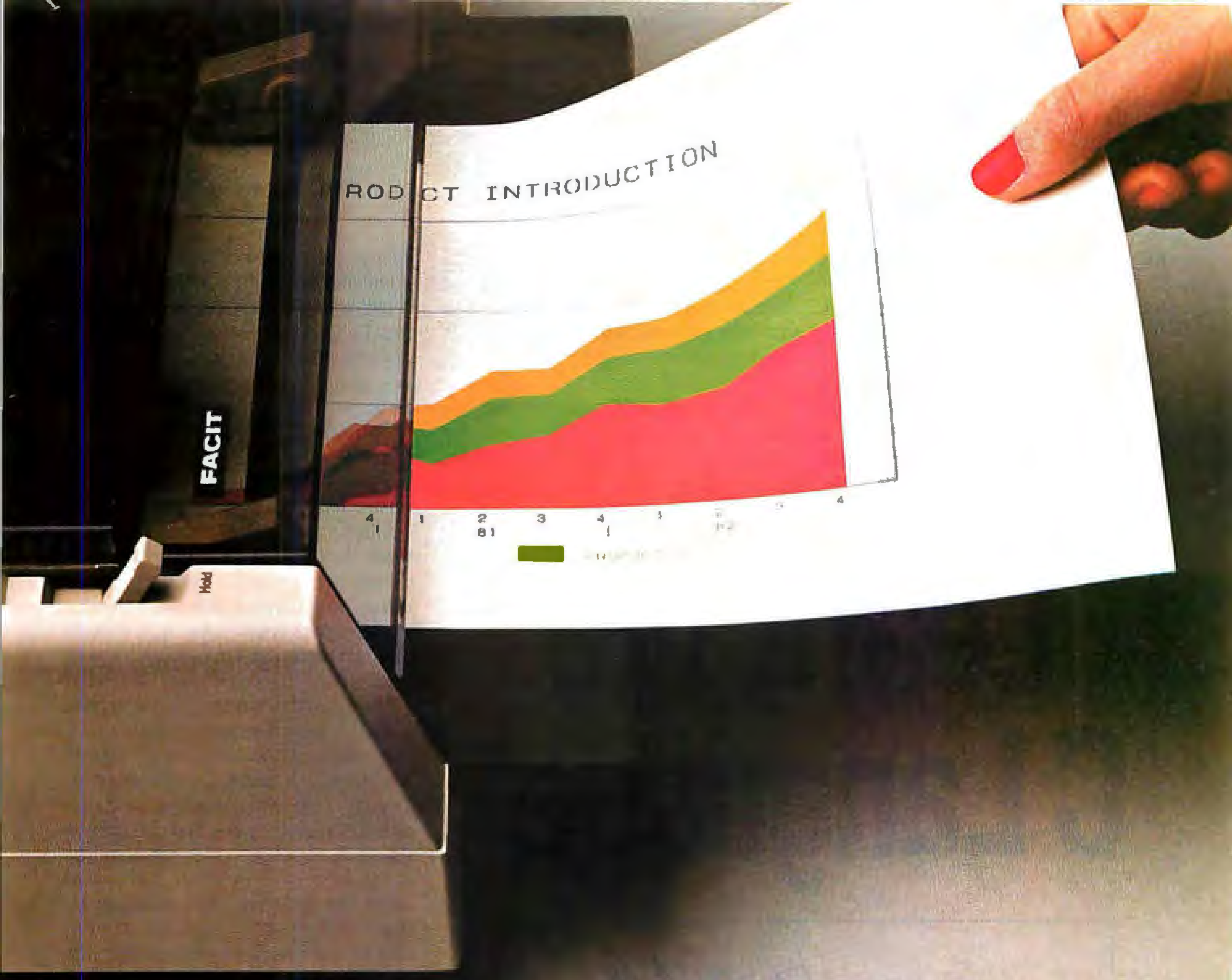

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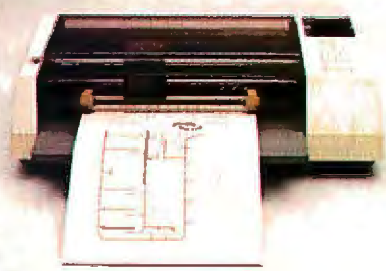

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Head Office: *Facit AB, S-17291 Sundbyberg. Sweden. Phone: (8) 7643000.* USA: *Facit Inc. P.O. Box 334, Merrimack. NH 03054. Phone: (603) 424-8000* only reason it wouldn't would be if the computer used a disk controller radically different from what the PC uses, and anything that does that isn't likely to be PCompatible.

The Interrogator comes in two disks: the Interrogator disk, which you boot up, and the Digital Diagnostic disk (DDD). The DDD is a *very* precisely formatted disk. You want to be careful to protect it. If it gets lunched, the replacement costs 50 bucks. The disk isn't copy-protected, but copying it is a waste of time, since what you're paying for is the precision formatting.

You can get DDDs for 40- and 80-track 5¼-inch drives and also for 8-inch drives. Running the program is extremely simple: boot the Interrogator disk, and when prompted, remove the Interrogator and put in the DDD. The test program is self-documented with on-screen help. If you want to test for write-error problems, you'll need scratch disks; the program will tell you when to insert them.

Dysan also makes an Analog Diagnostic disk (ADD), which, used with an oscilloscope, allows drive realignment. In my opinion, realigning disk drives is a black art best left to experts, but I'm told that anyone with the proper tools can do it with enough patience. I'm unlikely ever to find out.

The software agreement that comes with the program says that you may use it on one and only one computer, and if you transfer the program to anyone else, your license is terminated. One supposes that the person you give or sell it to thereby acquires some kind of license to use it; and since the program can't possibly be used on more than one computer at a time—as I said above, copying it is an exercise in futility—I can't see what would prevent a club from buying a copy, selling it to a member, and repurchasing it after the member is finished. The Dysan Interrogator is a tool you won't need often, but when you do need it there's no real substitute.

HAVE A CARE...

Just after they removed my roof, I (sensibly, I thought) took Mrs. Pournelle to New York. The ostensible reason for the trip was to tape some promotional materials for the latest Niven and Pournelle novel (*Footfall*, Ballantine Books), but Roberta knew better. The *real* reason we went was to get away from the hammering and sawing, and besides, the Metropolitan Opera was in season. (We saw *Ariadne auf Naxos*, which was good only if you like mountainous sopranos and superegotistical tenors, and *Tales of Hoffmann*, which was just plain wonderful no matter what you like.)

Of course I worried: it doesn't often

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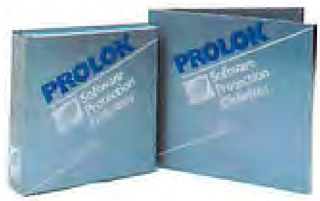

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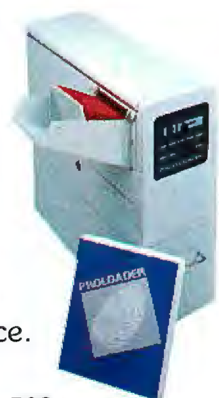

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rain in Los Angeles, but anything can happen in February. Sure enough, during one of Roberta's calls to check up on the kids, I heard what I'd feared: it was raining, the contractors hadn't got the plastic covering put up in time, and the office ceiling was dripping. Fortunately, nothing was spoiled except the newest version of Cygnus's Star Fleet I, and I have backup copies.

Alas, that wasn't the entire story. The disk had been thoroughly wetted. The boys dried it out. When it was dry, not knowing where the backup copy was, they put it into the IBM PC. The result was a real disaster: media came off the disk, and no amount of cleaning would restore the disk drive. We've had to replace it. It may be repairable, but I have my doubts.

The moral of the story is clear: if the disk is ruined, it's ruined. Trying to salvage a $2 disk can be pretty expensive. Don't. For that matter, it doesn't hurt to *look* at disks once in a while; if they look like they have crud on them, you want to think hard about using them.

COLOR AND CABLES AND LUGGABILITY

We're becoming increasingly fond of the Zenith Z-160. It's as PCompatible as the Z-150, has the same great keyboard, contains the same wonderful ROM-based diagnostics as the Z-150, has four totally empty slots, and, while not portable, it's luggable. The disk drives pop down, the keyboard snaps into place, and there's a handle. You won't *quite* get a sprained back from carrying it; indeed, when we had our big Space Conference at Larry Niven's house, we discovered just how easily moved the Z-160 could be. Everyone liked it.

Do understand what we mean by movable: it weighs about the same as a PC, but it does fold up, has no sharp corners, and has a handle. A nice *big* handle. There are also some funky little compartments into which you stuff keyboard and power cables. They're covered with little sliding doors. Rachel Klau, one of the Zenith software gurus, claims they're for toast. . .

The amber screen is a bit small for me, but it's 9 inches, as big as any portable, and it will do. I managed to write 10 pages or so with it and play Universe for days. Universe requires a color system for your IBM, and I don't have color in Lucy Van Pelt, our fussbudget genuine IBM PC. The Z-160 doesn't care. Colors are shown as shades on the amber screen.

There are also composite and RGB (red-green-blue) color outputs on the back of the Z-160. When we first tried to hook up the color, it didn't work, even though we were using Zenith monitors. I couldn't figure that one out. I should have: we also have an STB color board for the PC, and we couldn't get *that* to work with the Zenith monitor. I didn't figure it out, though, and asked Zenith's technical gurus for help. They didn't quite laugh at me.

As it happens, it's no wonder we couldn't get the monitors to work: we were trying to hook up the Z-160 (and the IBM PC) with a Z-100 monitor cable. The Z-100 and PCompatible cables have exactly the same connectors, but the Z-100 uses different pin-outs from the Z-150 and Z-160. This is presumably because the Z-100 was designed before the IBM PC came out, and the Z-150 and Z-160 were intended to be as PCompatible as possible. I can't think Zenith *enjoys* having to stock two identical-appearing video cables. Anyway, if you use the wrong cable, you get video, but the vertical won't lock and the horizontal is in the wrong place. Alex thinks you could probably reset the Z-100 pin-outs—the Zenith technical documents set new standards for what we mean by *complete*—but I'd think that more work than it's worth. The cables appear identical, but they do have different

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The only complaint I have about the Z-160 is that the disks pop up out of the top at an angle that makes it very difficult to figure out where to put an external monitor. I'm having the carpenters make a gizmo that's open in front to give access to the disk drives and sits above them so that the Zenith ZM-135 color monitor is level when put above the machine. I suspect that anyone who gets a Z-160 will need something like that, and it's a pity that Zenith doesn't furnish a neat plastic thing made for the purpose.

Other than that, the Z-160 is a compact and luggable version of the Z-150. If you're in the market for a PC or PCompatible, I recommend either of these Zenith machines in preference to the genuine IBM PC.

FONTS

Unless this is the first time you've encountered this column, you have to know that I love the Hewlett-Packard LaserJet printer. Last month it got even better: HP sent me four different font cartridges. You plug the cartridge in, send the printer a hideously complex sequence of codes preceded by the escape character, and voilà! With proper controls you can make the LaserJet print on legal-size paper, print sideways—that is, across the long dimension of the paper—do *italics* and **boldface**, change from Gothic to Helvetic typeface, etc.

There is a catch. You have to figure out the HP documentation for the fonts. I couldn't. When the HP people called me to discuss the new fonts, I read them their own documents and asked what they meant. The result was interesting: an engineer who already knew how to do everything got confused when I read him the instructions. He had to forget what I'd read him before he could recall how you really do it.

They claim they're going to rewrite the instruction sheets that come with the fonts. I hope so. I've also suggested that they come up with a new font cartridge that contains a complete font set: normal uppercase and lowercase, boldface, italic, small capitals, a symbol set, and the other stuff that you find in a standard case of type. The LaserJet isn't really up to book standards. It is, however, more than good enough for newsletters, manuals, manuscripts, and correspondence; it looks better than anything the Diablo or NEC Spinwriter ever produced.

Tony Pietsch has borrowed my new type fonts; within a week or so he'll bring them back, along with a new version of WRITE (my favorite text editor) that makes use of them. I'll

(continued)

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RESOLVED...

The new Apple printer has 300 dots/inch resolution. That means 90,000 dots per square inch. Multiply that by the 8½ × 11 inches of a standard sheet of paper, and you'll see why Apple needed so much memory in its new printer. The HP LaserJet is character-oriented. It needs more memory if it's going to do graphics. I'm sure HP will do something about that.

Real typesetters consider 300 dots/inch to be far too little; but give the micro world a couple more years, and nearly anyone will be able to typeset a book.

MACROTECH AND GIFFORD

In my review of the Macrotech 80286/Z80 board for S-100 systems, I said that the CompuPro people have been concerned about using the "B-step" revision of Intel's 80286 chip for multiuser systems because the B-step has known bugs. On the other hand, Macrotech's engineers believe they have compensated for the chip's problems. Certainly I never had a problem while using the Macrotech board in my otherwise all-CompuPro system with CompuPro single-user software.

The Macrotech board was designed to drop into an existing CompuPro 8/16 system, replacing the processor but leaving the CompuPro Disk Controller, Hard Disk, System Support Board, memory boards, and communications equipment intact; and the Macrotech system ran on 8/16 software as obtained from CompuPro. When CompuPro (well, Viasyn; I'll get used to using the new name one day) began changing over to Concurrent DOS and the SPUZ concept (see below), they made significant changes in their software. Their latest stuff won't work with the Macrotech board. I'm a CompuPro test site, and what with all the construction here I didn't have room to set up two S-100 systems, so in order to test the new CompuPro software I switched back from the Macrotech board to my older CompuPro 8085/8088 processor. I wasn't too happy with the change; the Macrotech was significantly faster.

I've now heard from the people at Gifford Engineering. They have multiuser software for the Macrotech board, and they say they have never had any problems with what they're shipping; they don't hesitate to recommend the Macrotech system to customers. Gifford has done a lot of work with CompuPro equipment and software and has a deservedly high

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reputation for delivering quality systems. They will continue to provide software support for the Macrotech board.

I'm no great fan of multiuser systems. I continue to believe that "one user, at least one processor" is the motto to follow. The multiuser system I use is the CompuPro C-10, better known here as Shirley. Each user has a Z80 board and a block of memory, with yet another processor to network them together and do traffic management for access to common files and common equipment like the hard disk and printer. However, in my opposition to timesharing I may be bucking a trend: the IBM PC AT is supposed to offer multiuser capabilities (although the last I heard there have been some problems), and Gifford reports good success with multiple users on the Macrotech 80286/Z80 board.

Anyway, I want to make it clear that I liked the Macrotech board a lot; I never had any problems with their final version; and I haven't heard from anyone who did have problems. I've still got mine, and when things settle down here I intend to set up two S-100 8/16 systems—one based on the Macrotech, the other on Viasyn's latest 80286 plus Z8OH SPUZ—and flog the daylights out of them.

THE SPUZ IS HERE

While I was down at the Mini/Micro show my new 80286 and Z8OH boards arrived from Viasyn. Alas, I have to go to the Stride Faire tomorrow morning, and this has to get out tonight; Tony came over for an hour to set things up. It didn't take him more than about 5 minutes; Viasyn's documentation and installation instructions are steadily improving, partly in response to my carping.

Anyway, I was able to use the new system for spelling checking and sending this to New Hampshire on BYTEnet, but I haven't had time to do more extensive testing. On the other hand, Tony has been running his CompuPro 80286 and Z80 for nearly three months, so no one anticipates any problems—but we'll see. I often find glitches no one else does, which is one reason that Viasyn uses me as a test site.

Unlike the Macrotech 80286/Z80 board, the new CompuPro 816/286 system uses two different boards. The 8-MHz Z80H board is a SPUZ, which is CompuPro shorthand for Slave Processor Unit Z80. (There will be other SPU boards, such as an 80186.) The 80286 processor boasts the newest "C-step" revision 80286 chip from Intel. Together, they make up a superfast system with true concurrent operations: the Z80 SPUZ can be doing one job while the 80286 is doing another.

In fact, you don't need the 80286 board to run the Z80 as a SPUZ. Before we installed the new 80286 processor, we dropped the SPUZ into my existing 8085/8088 system and installed the new Switch! (that's generally pronounced "switch-bang!") software that comes with the SPUZ, after which all my 8-bit software (such as WRITE) ran on the newer and faster Z80H. The 8085 aboard the 8085/8088 Dual Processor board is awakened on power-up, then immediately told to go to sleep; after that, the SPUZ handles all 8-bit operations. So long as you stick to 8-bit stuff, the system is just as fast with a Dual Processor and SPUZ as it is with the 80286 processor; meaning that you can upgrade a Dual Processor in stages, if you don't want to pop for everything at once.

The 80286 runs 16-bit operations, like directory sorts, and PIP, and assemblies, and disk accesses, at surprisingly noticeable higher speeds. I haven't tested the CompuPro 80286 against the Macrotech. They're both fast.

The SPUZ without the 80286

(continued)

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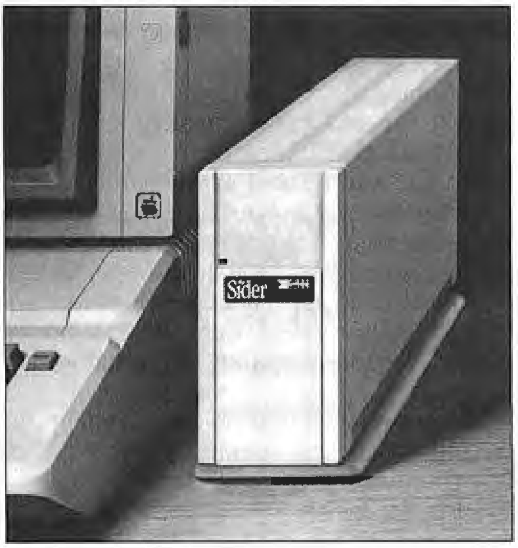

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I saw little of interest at this year's Mini/Micro show. All the exhibits were in two large rooms of the Disneyland Hilton.

speeds up 8-bit operations something wonderful. WRITE blazes along; indeed, the system drives the TeleVideo 950 (connected up at 19,200 bits/second) almost as fast as Zeke II works with memory-mapped video. I guess it won't be long before I abandon my ancient VDM (video-display module) memory-map board. That will sever my last link with Zeke I, my friend who happened to be a Z80 computer. The VDM board we use at present is not the same one that we had in Zeke I, but the character-generator chips in the board are.

WAITING...

What we're waiting for is the first production run of the CompuPro PC-Video board. You drop that into an S-100 system and connect up either a color or a high-resolution monochrome monitor (both are combined on the PC-Video board), after which your 80286/SPUZ, Dual Processor, or 8086 system can be made to think it's an IBM PC AT. Tony designed the PC-Video board to work with any PCompatible keyboard, so I'll use the Wico Smartline Smartboard. My system will then run under Concurrent DOS: meaning that I'll have available, on one computer system, the whole world of 8-bit CP/M software (such as WRITE, The Word Plus, and Calendar/1); all of my CP/M-86 16-bit software, including all the 8-bit stuff I wrote in CBASIC and recompiled with CBASIC-86; *and* about 98 percent of the IBM PC software, including SideKick, Lotus 1-2-3, ThinkTank, Flight Simulator, and WordStar 2000. Moreover, I'll be able to run 8-bit programs, such as WRITE, simultaneously with 16-bit, such as long compilations.

I'd hoped to get Concurrent DOS running tonight, but it turns out that the version I have is intended for use with a Dual Processor. Due to my bouts with flu and our construction orgy it never got installed, and now we've retired the 8085/8088 Dual Processor board, hopefully forever. (Actually, of course, that board, along with Jim Hudson's 8087 board, will go to an educational nonprofit organization, such as a school or the L-5 Society. That's what happens to all equipment that doesn't get returned to the supplier. We try not to let anything stay idle for long.)

I'd hoped to change to Concurrent DOS because I wanted to send this at 1200 baud. (I know, I know; the modern convention is to say "bits/second" rather than baud, and technically that's a bit more accurate; but I learned the older terminology, and "baud" is much simpler and shorter to write. After all, we say "hertz" rather than "cycles per second.") Alas, this goes off at 300 baud. A story goes with that.

I'm writing this column on Zeke II, a plain vanilla Z80 system. When I get done, I transfer the text (with a 1-megabyte 8-inch floppy disk) to the new 80286/SPUZ machine for spelling checking. (I've got to find out that machine's name; 80286/SPUZ is clumsy.) After that, it gets transmitted to New Hampshire via BYTEnet. What I'd hoped to do was use Concurrent DOS to output the text onto a 5¼-inch disk in IBM PC-DOS format. I could then take that disk over to the Zenith Z-160, which has our OmniTel Encore 1200-baud modem, and squirt the files off at 1200 baud. Alas, the only modem I had for the Dual Processor (and thus the only one I have for his successor, the 80286/SPUZ) is an ancient PMMI (Potomac Micro Magic Inc.) 300-baud system; it works fine, but I never knew how *slow* it was until I started fooling around with the OmniTel Encore at 1200. Now, though, I'm anxiously awaiting Concurrent DOS, because even with all that monkey motion it would be worth the extra effort to communicate at 1200.

Of course, I could break down and get another modem. Tony tells me he no longer recommends an internal modem for S-100 systems. Fortunately, the people at OmniTel have sent me their Hayes-compatible external 300/1200 modem. That will run MITE just fine.

HOW FALLEN ARE THE MIGHTY

The Mini/Micro show used to be combined with WESCON. I remember it as large and exciting. I first saw the Zenith Z-100 at a Mini/Micro. The DEC Rainbow was introduced at another Mini/Micro. I first saw Modula-2 in action, and got Modula-2 and a Sage II to run it on, at a Mini/Micro show.

This year there was nothing. At the last Mini/Micro in Anaheim, WESCON filled the Anaheim Convention Center, and Mini/Micro completely filled two floors of exhibit space at the Disneyland Hilton. This year, all of the Mini/Micro exhibits were contained in two large rooms of the Disneyland Hilton. One of those rooms was the ballroom in which we held the ice-cream social, Meet the Pro's, at last year's World Science Fiction Convention; and indeed, the World Con had considerably higher attendance than Mini/Micro.

I saw little of interest at Mini/Micro. There were about 20 booths exhibiting VME and Multibus stuff, which may or may not be a portent of the future. I saw for the first time a Motorola 68000 computer intended as a development system for 68000 software; it has some of the finest high-resolution color graphics I've ever seen. Otherwise, nothing new, and little to grab my attention.

PRICE GOUGING?

One thing I was looking for at Mini/Micro was an expansion box for our IBM PC. Lucy Van Pelt is *full*, and we have lots of new boards for her, including two Hercules boards (see below), modem boards, hard disk (we

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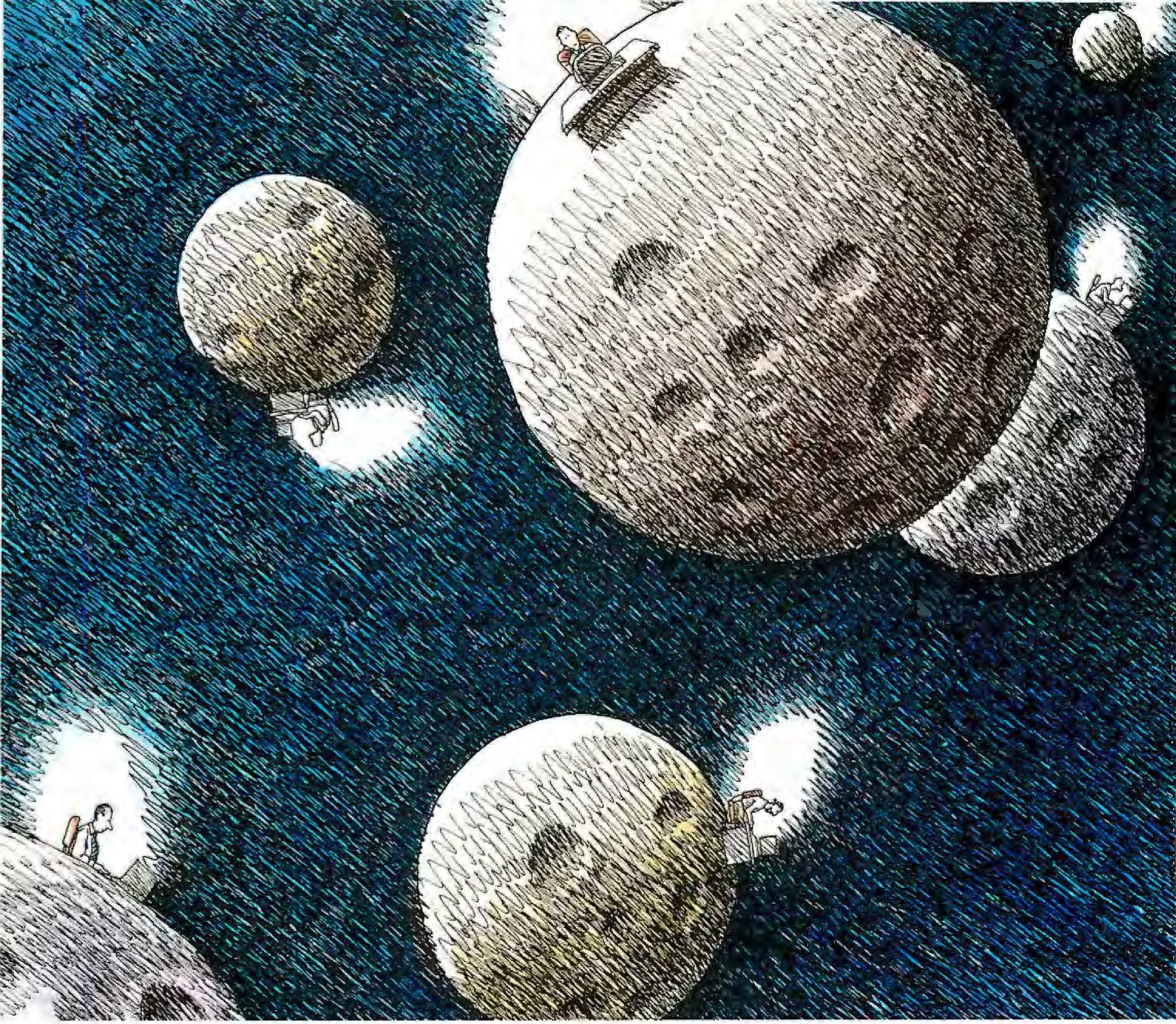

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A lot of software, including many spreadsheet programs, has special code to make use of the graphics capabilities of the Hercules board.

still have the bubble-memory hard-disk emulator), and such like. There was only one manufacturer of PC expansion boxes at Mini/Micro (or at least I saw only one, and I was looking). They want about $850 for a 6-slot box with power supply. This seems unreasonable.

After all, I can get a CompuPro 21-slot S-100 box with the splendid CompuPro boat-anchor power supply (that power is so well regulated that we've actually had the power cord unplugged by the kitten and got it plugged back in in time to avoid any glitches; I don't recommend you do that, but it did happen to us)—I can get that system for considerably less than $850. What is there about the PC bus and power supply that makes it worth so much?

Anyway, I'm still looking for an expansion box. One day I suppose I'll gulp hard and pay the money, but I sure hate to.

HERCULES BOARD

One thing I want to install in the PC is the Hercules color board. The other day, quite out of the blue, there arrived two Hercules boards: the color board and the high-resolution graphics monochrome board. The monochrome board installs in place of the IBM high-resolution monochrome board, so we put that one in almost instantly. For some software the PC doesn't know the difference, and neither will you: text and such like are crisp and steady, but then they were with the IBM board, too.

However, a lot of software, including many spreadsheet programs, has special code to make use of the graphics capabilities of the Hercules board. The result is a dramatic improvement.

The Orchid Technology PCturbo 186 board we're so fond of can also take advantage of the Hercules board. Alas, I've mislaid my PCturbo 186 manual. It isn't lost; I'm sure it has been packed in one of the innumerable boxes that fill the office extension. After all, I've mislaid almost everything else I own. . .

More on the Hercules boards next month; so far I like them.

A MACWARNING

This comes from the ARPANET Mac-Enthusiasts.

The Macintosh Reset button (also called the "Programmer's button") does not reset memory, nor does it cause the system to reboot. If used to bail out of certain kinds of system crashes, it can cause the Macintosh to trash disks.

The safest thing to do is to turn the machine off and make it reboot. Don't use the Programmer's button unless you really know what you're doing. Because it doesn't cause the system to reboot, it can, of course, save time; but the cost can be high. I was taught always to open the disk-drive doors before doing anything as radical as turning the machine off, or even resetting it, but of course you can't do that with the Macintosh, since there's no simple mechanical way to make it eject disks; either you must plead with the Macintosh to get it to give your disks back or use a hairpin on the drive mechanism. As long as the disk is in the Macintosh it can be written on, and the Mac writes on disks a *lot*. The present Finder is pretty dumb and doesn't check the disk directory before writing on the disk; the Reset operation can get the Finder pretty thoroughly confused. It's safer all around simply to turn the machine off, count five, and turn it back on again. [*Editor's note*: *A hardware engineer at Apple reports that the Reset button does*

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Micromint, Inc. Dept. 14, 25 Terrace Drive, Vernon, CT 06066 *in fact connect to the* 68000's RESET *pin and will cause the system to reboot.*]

Launch a Thousand Slips...
I reported in March on Mike Lehman's Fast Finder, which substitutes for the regular Finder program in the Macintosh operating system. We still like it, and anyone who writes programs for the Mac would be well advised to get it. It is, however, pretty well a hacker's tool. There are very few built-in safeguards.

It also uses Macintosh hacker terminology. In particular, there's the term *launch*.

So far as I know, launch is a term peculiar to the Macintosh and perhaps the Lisa. The Macintosh operating system allows you to access programs that aren't really programs; that is, if you "double-click" a text file created with MacWrite, the Finder is smart enough to know that what you really want is to load (launch) MacWrite and have MacWrite read in the text file so you can edit it.

Lehman's Fast Finder program gives you another alternative. Fast Finder will ask you if you want to launch your text file. The first time I was asked that, I thought, "Well, of course I want to," and said yes; whereupon Fast Finder dutifully tried to run the text file as if it were a command file. The result wasn't pretty, and I could recover only by turning the machine off. It turns out that launch is a MacTechnical term meaning "run independent of anything else." To launch a file means to treat it as a command file. If it isn't one—if it's a MacPaint file or a document file—the result is unlikely to be what you wanted.

Fast Finder is a really convenient program, but it does give you the opportunity to really screw things up. Fortunately, there's always a way out:

Fast Finder is pretty well a hacker's tool.

one option under Fast Finder is to launch the old Finder program.

Sick Jokes
Another bit of information I got from the ARPANET: be careful what you put into your machine. There is out there making the rounds of the remote bulletin boards a program called VDIR.COM. It's a little hard to tell what the program is supposed to do.

What it actually does is trash your system. It writes garbage onto any disk it can find, including hard disks,

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and flashes up various messages telling you what it's doing. It's a time bomb: once run, you can't be sure what will happen next because it doesn't always do anything immediately. At a later time, though, it can crash your system. Does this remind you of some of the imbecilic copy-protection schemes threatened by companies such as Vault and Defendisk? Anyway, you'd do well to avoid VDIR.COM. I expect there are a couple of harmless—perhaps even useful—public-domain programs floating about with the name VDIR; and, of course, anyone warped enough to launch this kind of trap once can do it again. Be careful about untested "free" software.

EEEEEK!

One more tip, which comes from, alas, practical experience: when you load a telephone number into a modem disk file, double-check the number. I gave Alex the local ARPANET access number to record for the 1200-baud modem and inadvertently transposed two numbers. Alex dutifully put it into the system. Then we tested it. Each time we'd see the number come up, hear it ring, be answered, hear our own carrier—then no communications. Nothing.

Eventually I listened on an extension. To my horror I heard an exasperated lady answer the telephone. Naturally all she would hear would be the high-pitched whine of our carrier. Since we'd "tested" the number five times (at 0300, alas!), she was rapidly losing patience. I can't blame her. Since then I've checked all the modem access number files three times.

VALDOCS 2.0

Just before going to Mini/Micro I had a talk with Jim Bell of SemiDisk, the people who make RAM-disk hardware for S-100, IBM PC, and Epson computers. Jim tells me he has been talking to Roger Amidon of Rising Star, the outfit that is supposed to be supplying the Valdocs operating system for the Epson QX-10 computer line. Amidon says that Rising Star is working on SemiDisk drivers for Valdocs 1.19, which is, I guess, the currently supplied version of Valdocs. (The last one I have is 1.18, and I suspect that I don't *really* have 1.18. That, however, is another story.)

Anyway, Rising Star promises that you'll be able to use SemiDisk with Valdocs 1.19 "within a week," which, given the track record of Rising Star, translates to Real Soon Now.

Rising Star also assures SemiDisk that the drivers to make use of SemiDisk are already built into Valdocs 2.0. Alas, SemiDisk doesn't yet have a copy of 2.0, nor, to the best of my knowledge, does anyone else.

Interestingly enough, there was an Epson America dealer at Mini/Micro; he had large posters proclaiming the virtues of Valdocs 2.0.

"When will it be done?" I asked.

"It's done now."

"You mean I can buy it?"

"Yes."

"Can I take a copy home with me?"

"No, we're quoting 60 to 90 days

(continued)

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delivery time."

"Wait," says I. "You mean I can order it now, but it will be 60 to 90 days before you'll deliver it to me?"

"Yes."

In other words, Valdocs 2.0 will be available Real Soon Now. I sure wouldn't hold my breath. If they ever get things set up to use SemiDisk with Valdocs in any form whatever, I advise all Valdocs users to take advantage of the opportunity. Valdocs with a RAM disk would be both simple to learn and conveniently fast; I'm amazed that Rising Star hasn't done something about the situation already.

EAGLE FLIES?

They didn't have an exhibit, but I did meet Gary Kappenman, CEO of the newly reorganized Eagle Computer, at Mini/Micro. Eagle went through some hard times. As a result, they offered reviewers the opportunity to buy their review machines at good discounts. I bought both of mine, the Eagle 1600 (a very fast 8086 machine) and the Spirit XL, an IBM PC XT work-alike that's about 99 percent PCompatible.

Alex promptly borrowed the Spirit XL. The Spirit runs PC-DOS 2.0, which allows tree-structured disk directories. Working late at night Alex managed to erase an entire disk directory. He makes backup copies, of course, but he'd made the last backup just before his most productive hour of the week. When he realized he'd erased everything, he left the machine running and locked up the room so no one would touch it. The next morning he called Eagle and explained his problem.

"Norton Utilities," the Eagle people said. "Go buy them."

He went out and got Norton Utilities 3.0; the program took care of his problem. Alex says the Norton Utilities are self-prompting, very easy to use, and let him completely recover from his blunder.

We're still fond of the Eagle Spirit XL. I am told I will get Eagle's newest machine, the Turbo, within a week or so. I'm looking forward to it; I've heard good things about the machine.

Eagle always did have excellent hardware. The problem was that their software was never complete and their documentation was wretched. Gary Kappenman tells me they had too many bright people: before they would get one development completely finished, the hackers would rush off to invent yet another marvel.

"As technology improvement that was a great way to go," Kappenman says. "As a way to generate marketable products it wasn't such hot procedure."

According to Kappenman, Eagle has stacks and stacks of excellent new technology on the shelf; they've cut way back on personnel and expenses; and they intend to concentrate on bringing their on-shelf technology to market, one *finished* product at a time.

I always did like their hardware and their protechnology attitude. I wish them well.

WINDING DOWN

It's 0200, and I have to catch a plane to Reno at 1000. The guest of honor at the Stride Faire this year is Niklaus Wirth, and I confess I'm greatly looking forward to meeting him. Stride Micro also promises a remarkable new human/computer interface system based on cursor control through eye and head movement. It sounded like a good idea when they told me about it last year; and people I respect at Stride Micro are enthusiastic, so that's something else I want to see.

After Reno I go to Dallas to see some late developments at TI. My Chrysler LeBaron convertible talks to me through a TI Speech Synthesizer chip; I confess that one thing I'd like to get from TI is a way to program my car so that it will say outrageous things at the touch of a hidden button. Things like "Beep Beep Beep: Your passenger is stupid," or "Beep Beep Beep: Passenger should prepare for extreme lateral acceleration," or even "Beep Beep Beep: Ejection seat is armed." I'd also like to have a way to connect the voice to the security system so that it might say "Warning: Lethal gas now being released into driving compartment." I don't sup-

(continued)

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Inquiry 292

pose I'll really be able to do that, but I can dream.

The game of the month is Universe by Omnitrend. I've put far too much time into it, despite the fact that the game is completely menu-driven, which makes it very easy to learn and very hard to use; I long to write a long command string, then go have coffee while the machine executes each command in turn. The fact that I'm still playing despite the tedious menu command system should say volumes about the game's complexity and inherent interest factor.

The book of the month is by Michael Crichton (author of *The Andromeda Strain*), *Electronic Life* (Ballantine, 1984, $3.95). Dr. Crichton has managed to pack a great deal of useful information, philosophy, and common sense into 250+ pages. Recommended for almost anyone; even experienced hackers will find parts interesting and can then keep the book around to lend to beginners.

Next month I should have Concurrent DOS and the PC-Video board. Tony ought to have the software to make use of all the new type fonts for the LaserJet. I also have a Hewlett-Packard 150 computer, which hasn't even been uncrated; alas, I do not think my upstairs suite will be finished, so I may not have a place to set it up. There's a strong possibility that I'll have the new HP portable as well; I'm looking for a good portable to carry about on trips. I'll also have more on the Hercules boards.

Seneca once said of relocating that "two removes are equal to one fire." I find that rebuilding requires shifting things about like Chinese checkers, so that we get the equivalent of *three* removes. I make no doubt it will all be wonderful when it's finished. It's a great life if you don't weaken. ■

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

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C·H·A·O·S M·A·N·O·R M·A·I·L

GERMAN QUERIES

Dear Jerry,

As I sit here blinking at the screen of my computer, the screen is blinking right back. There was a time when I had no such problem, but then I had a voltage-regulating gizmo. It was about the size of a husky paperback novel and had two sockets. It set me back some, but it was worth it, I guess. When Uncle Sam sent me to Germany, I left the voltage regulator in the States—the juice here, after all, is 220 V; I figured I would get one in a local computer store.

But that has not been easy. Do you know anyone back there who sells a small, lightweight one for 220 V?

Another question. My thinking machine is an Actrix with CP/M. It cost me a fortune, but I am a linguist, and a computer is the ideal thing for translations and for memorizing vocabulary. Unfortunately, all the languages I speak use diacritical marks, and Russian uses an entirely different alphabet. The questions: Is there a word-processing program available in Russian? German? Italian? Is there a program I can hook into (with BASIC or Pascal) that will display foreign characters on the monitor?

Thanks.

PETER A. KISS
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Alas, this sounds like a job for Super Ciarcia!

As to part two, I can't help, but perhaps one of the readers can.—Jerry

LEAD TIME

Dear Jerry,

I must agree with Mr. Penner (Chaos Manor Mail, September 1984) that the six-month lead time for your wonderful column is outrageous. In your response to his letter, you itemized the ordeal a BYTE article undergoes. It seems to me that the editors of a magazine like BYTE could devise a more high-tech method for handling the column.

First, you could submit the column electronically over the phone. The technical editor and copy editor could edit the copy on their terminals and transmit it back to you for corrections and approval. Once finalized, it could be proofread and typeset by computer. Meanwhile, the layout people can reserve a fixed space for the column in each issue and paste it in as soon as it is typeset. The entire process above could be done in a week, it seems.

I am by far no expert in publishing, but what I suggest seems completely possible. I believe BYTE could halve the lead time by making fuller use of the technology they describe so well each month. What say you?

CLAUS BUCHHOLZ
New York, NY

P.S. I hope to find out what the lead time is for a letter to Chaos Manor Mail.

We are reducing the time. We can't use telephones, because the phone lines to New Hampshire are, uh, interesting *even in good weather; but we can send disks Federal Express.*

A week is too short a cycle time; but we are getting it down to about six weeks, which is pretty good for a magazine this size!

As to the letter cycle times, that depends on the phase of the moon . . . —Jerry

Editor's note: We hope to have an integrated electronic-publishing system installed before the end of 1985. The money is budgeted. The only question is how soon the vendor can deliver what we need. —*Phil Lemmons*

CHINESE MATTERS

Dear Jerry,

I am writing to you concerning a small inaccuracy on page 350 of your column in February. It concerns your incorrect dating for Confucius. You said, "The *I Ching* or *Book of Changes* has been around a long time; Confucius thought it was old at the time of Christ. It is supposed to have been composed about the time of the Trojan War." While I found the syntax of your sentence about Confucius and Christ a little perplexing, I assume you mean that Confucius lived around or after the time of Christ. This is not true. While dates for Confucius are not accurate, he is generally thought (by sinologists) to have lived from 551 to 479 B.C. Dates for the *I Ching* are also not very accurate, but sinologists generally accept that the book dates from at least 1123 B.C.—the beginning of the Chou dynasty (the book's other name is the *Chou I*).

It was a book of divination. Confucius is supposed to have done some editing work on the book, writing the 10 wings, or appendixes, to it, but his authorship has been disputed by Chinese scholars since the Sung dynasty (960–1123, 1125–1279 A.D.), especially in the works of Ou-yang Hsiu. Most Chinese classics were destroyed in a massive book-burning and censorship campaign carried out by the first Ch'in emperor, Ch'in shih-huang-ti, in 213 B.C. The *I Ching* was one of the few books to have survived intact, and its line of transmission from the pre-Ch'in era has been documented in at least one source.

I know that the above is probably more than you need or want to know, but my scholarly training and perhaps a bit of lecturitis compels me to run off at the keyboard.

Thank you for your kind attention. I thoroughly enjoy your columns and opinions; it is one of the reasons I get BYTE.

RONALD GANS
New York, NY

I'm no sinologist, but the Encyclopaedia Britannica *gives the same dates for Confucius as you do. Perhaps I meant old* before *the time of Christ? The Trojan War is traditionally supposed to have happened about 1150 B.C., so that part was right.*

I gather there is considerable dispute regarding the proper use of the I Ching; *divination can mean "prediction," but it can also mean "determine the godly thing to do," which is the way many people use the book. Thank you for the details on the* I Ching's *history.*—Jerry

COPY-PROTECTION SOLUTION

Dear Jerry,

For some time you and your readers have been frustrated by software copy

(continued)

protection. I gather numerous software producers believe they will lose their investment without it. Some time ago you said you did not know a solution. I think I might have one. As a user, you should continue to have access to the program once you have bought it, unless you willfully destroy or lose your disk. How can we accomplish this and still protect the software producer?

My suggestion is simplicity itself. The terms of the sale should include duplicate disks of the software, each protected if the producer wishes. It should also include a guarantee by the producer to replicate the protected program on either of these disks if their magnetic program becomes unworkable. In this way, both interests should remain protected.

There are, of course, operational details. The program would be replaced on an identifiable disk originally supplied by the software producer. The postage (if needed) might be borne by the buyer, the cost of duplication by the producer or his agent. It seems gratuitous to fix the maximum number of duplicates unless this proves necessary. It should surely be 10 or more to that unlucky user.

I get the impression that a similar procedure is already followed by some companies, which update their software either free or for some fixed fee. Obviously, replacement would not automatically entitle one to an update, but then some users might be tempted to update at the time of duplication if the price is right. There should be no obligation to do so.

FRANCIS MARBURG
Falls Church, VA

Your plan certainly seems viable. My colleague John Dvorak argues that any kind of copy protection is economically counterproductive: most software can't take off unless it is adopted by a lot of old-time users, and the old-timers already have software that they're reasonably happy with. They won't buy expensive new packages unless they're really *good. However, if they try a free copy of something new and like it enough, they will not only buy that but influence a lot of others to do likewise.*

I think I agree with him.—Jerry

TECHNICAL-SUPPORT SOLUTION

Dear Jerry,

Your December 1984 column discussed the support problem. I have a suggestion that may solve the problem, and I have my own story to relate.

A year ago I decided to buy a computer. My dad and I have shared a TRS-80 Model I since 1978, and I had pretty much outgrown it. I had to get a new machine in a hurry—my parents were moving—because I wanted to transfer all my source files by an RS-232C interface, and I did not want to type all the files in again.

I chose an Advanced Digital Super 6 single-board computer. It is S-100-based, has all the I/O I need for now, and supports CP/M 3.0. Priority One's price for the computer was steep, about $1000. I figured that before I sent away for a computer that I knew little about, I should at least send away for the manual. (The ads looked great, but I wondered what kind of nightmare I would find when I actually fired the thing up.) I visited a local dealer who gave a price of $1100. My first reaction was, "That's okay because if I need any help in bringing it up they could at least help and make sure the board worked." I asked about the high price, compared to Priority One, and they said they might cut it to $1000. However, the bottom line on support was that I could get it only if I spent $3500 on a complete system from them! The complete system was a 12-slot mainframe and supply, two 8-inch drives, and the processor card. This I could not handle.

I ended up buying the board from American Square Computers for $555 and CP/M 3.0 for $350. My total outlay for the processor, software, an 8-inch drive, a mainframe, and a Qume terminal was less than $2400.

All I wanted was that the dealer sell me CP/M and the board and make sure it would boot on a Shugart 801. I could get no answer from the manager as to what the cost of this onetime support would be. I was willing to pay $100 for it, figuring that's a cheap way to find out if all the hardware is going to work.

I had to sweat a few details. The manual on the disk drive did not match the drive that Priority One sent—all the jumpers were different when they made a printed-circuit-board change for a semicustom VLSI chip. The drive would not fit in the mainframe without a slight amount of metalworking in the cabinet. The Super 6 manual had a few errors, too.

The fact is, I got it all going in plenty of time, and I am very happy with the machine. The only software that I purchased at the time was Turbo Pascal, on your recommendation, and I am truly impressed.

What should the computer stores do? The one I went to lost a sale because they could not handle the case of the knowledgeable customer who did not want to blindly buy their package. I was not willing to spend an additional $1000 for a system integration, which they had done hundreds of times before.

The computer store should determine what kinds of support they can provide, to whom they will provide it, and what it will cost. Then tell their prospective customers. The companies that do the mail-order business should state the same in their ads. The computer-buying public will likely follow the lead if they know that a discount house will have limited service and that a full-service computer dealer will service only its legitimate customers.

CLYDE R. SHAPPEE
Walpole, MA

Priority One would have sent you the proper manual if you'd asked; at least they tell me they would, and I believe them.

You do know what you're doing.

Best.—Jerry

NEWMEDIA

Dear Jerry,

Why did you describe the Newmedia program in the February issue ("Small Disks!," page 352) and then list it as "not available" in the "Items Discussed" box? I have a Cromemco Z80 system with no software support and need a program like that.

BILL PINKERTON
Palm Bay, FL

When I put together the information for the "Items Discussed" box I try to include prices and telephone numbers, but I don't always have them. In those cases our intrepid and hardworking BYTE editors have a go. They're usually successful. Sometimes, though, they simply can't find anyone who'll answer the question, or a company won't have a firm price at press time; in which case you'll find "not available" in the slot where you'd hope to see the price.

In the case of Newmedia, alas, the program is available only as part of the CompuPro 8/16 software-support package. I doubt that it would run on your Cromemco. My first computer was a Cromemco Z-2, so I have considerable sympathy for you, but I fear there's little we can do: Newmedia was written especially to run on a CompuPro 8/16 using a CompuPro Disk Controller.

Wish I could be more help.—Jerry ■

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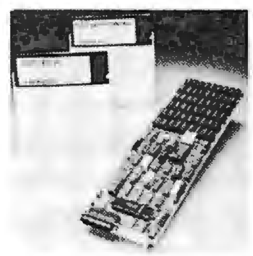

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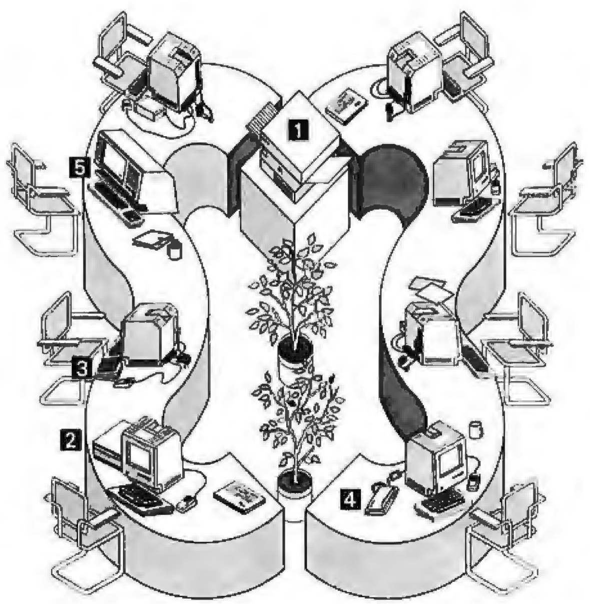

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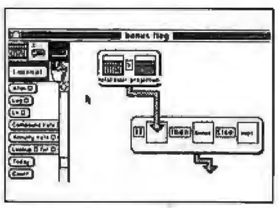

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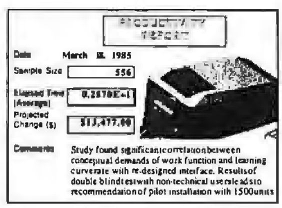

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ODESTA HELIX™

Inquiry 310

Telephone Computers

A look at the One Per Desk telecomputer

BY DICK POUNTAIN

Of the areas in which nontechnical people use personal computers, telecommunications has the most potential for expansion and improvement. In the industrialized countries at least, more people own telephones than computers.

For the person with a computer at home, teleshopping, telebanking, and remote database access seem more productive than filing the stamp collection or storing recipes.

Telecommunications can be advantageous for businesspeople in the same way. So much of the business day is spent on the phone that much time can be saved by simplifying the processes of establishing contact and transferring information.

The quality of telecommunications facilities on general-purpose microcomputers still falls somewhere between highly technical and positively hair-raising. Even with an auto-dial modem, you are exposed to more of the nasty details of the RS-232C interface than is necessary or wise. Mindful of these facts, a number of manufacturers have recently turned their attention to producing dedicated "telephone computers"—personal computers with built-in telephone hardware, tightly integrated telecommunications software, and general-purpose desktop computer facilities.

Two such machines have just been introduced in the U.S. by Rolm Corporation. One of the machines is a peripheral for the IBM Personal Computer (PC). Perhaps a harbinger of the growing importance of this technology, IBM has bought the company outright.

International Computers Ltd. (ICL), the U.K.'s largest national mainframe computer company, has just produced an interesting and innovative *telecomputer* called the One Per Desk (OPD). The name is suggestive of ICL's marketing strategy, namely, to get one of these machines onto every executive's desk in the large corporations that ICL currently services.

ICL, like many mainframe companies, came fairly late into the personal computer arena and then made its entrance by "badge engineering" products from established U.K. personal computer firms using industry-standard software. (Badge engineering means buying a product and relabeling it with your own "badge" for resale.) The first ICL offerings were 8-bit multiuser systems running MP/M; more recently, 8088- and 8086-based IBM compatibles have been added.

The OPD, however, represents quite a new departure. It was largely designed in-house by ICL, though it uses the processor board, microdrives, and custom gate arrays from the Sinclair QL, which is based around the Motorola 68008 8-/32-bit central processor. ICL has written its own truly multitasking operating system for the OPD that permits telecommunication to take place while running business-application programs. Such an investment of corporate energy suggests that the OPD is closer to what ICL thinks businesspeople need on their desks than a conventional personal computer; the purchase of Rolm by IBM suggests that at least one other large computer corporation may agree.

The OPD differs, however, from the Rolm offerings in an important way. It's cheap by business computer standards (starting price £1200, approximately $1450 at the current exchange rate), and it works on ordinary phone lines, not special PBX (private branch exchange) systems. In other words, it comes close to what you need for a domestic telecomputer.

FUNCTIONS

The OPD is capable of acting as a sophisticated automatic telephone and as quite a powerful desktop computer and calculator. It also contains a battery-backed clock and calendar.

In its role as a telephone, it allows direct dialing of calls, storage and retrieval of telephone numbers for automatic dialing,

(continued)

Dick Pountain is a technical author and software consultant living in London, England. He can be contacted c/o BYTE, POB 372, Hancock, NH 03449.

monitoring of the cost of phone calls, and a limited form of automatic answering. It also contains a twin-standard modem (300 bits per second [bps] and the 1200/75 bps used for Viewdata systems in the U.K.) that can access remote computers using all the above automatic facilities.

When making ordinary phone calls, you can switch on an internal loudspeaker to monitor the progress of your call, but there is no internal microphone. Therefore, upon connection, you must revert to the telephone handset. The OPD remembers the last 10 numbers dialed and allows single-key redialing by selecting one of them from the screen.

A built-in voice synthesizer acts as a simple answering machine. You can choose two different messages for appropriate times of day (e.g., hours spent in and out of the office), but the OPD can't record messages from callers.

When using the OPD as a terminal for data communications, you can create a directory of frequently used services and have them automatically dialed, complete with appropriate log-on procedures. In addition, the OPD can auto-answer a data call.

ICL is also developing an optional message system, a ROM (read-only memory)-based application that allows electronic mail to be sent between OPDs with full auto-answer capability. It wasn't ready at the time of this test.

Since an OPD can control two phone lines (plugging straight into the wall sockets), you can make a voice call simultaneously with a data transmission. In general, you can always make or receive a voice phone call, regardless of whatever else you are doing on the OPD, and then when you hang up, return to where you left off.

The Hardware

The OPD bears no external resemblance whatever to the Sinclair QL. It's packaged as two units: a console unit containing the keyboard, telephone receiver, central processor, and two microdrives; and a VDU (visual-display unit), which contains the power supply as well as a 9-inch high-definition black-and-white monitor (see photo 1).

The VDU is small and neat, only slightly larger than that of the Apple IIc. It has only two controls, a slider to adjust the contrast and the main power switch. The black-and-white-monitor tube is of very high definition and has two display modes: 26 lines by 80 characters and 26 lines by 40 characters. It can display a gray scale, with two shades of gray in 80-column mode and six shades in 40-column mode, which lets you create nice screen designs.

The OPD can support internally all the colors and font sizes of the Sinclair QL, and ICL does offer an optional color monitor; however, it is much larger than the black-and-white unit, and the company feels that most business users will prefer the lower cost and smaller size of the latter.

The bottom two lines of the screen are dedicated to the *notice-board*, a status area where various messages—as well as date and time—are displayed. And when you dial a phone number—either manually or automatically—the digits of the number appear in this area as they are dialed.

The console unit has a removable sloping cover over the microdrives, which you must remove to install the dry-cell backup battery. The rear of the case contains huge slots to receive the ROM mounting module and the telephony module, which are supplied separately. The advantage of this arrangement is that you can substitute a new telephony module when the OPD is sold in different national markets; it contains the modem as well as the connectors for two telephone lines.

The keyboard has typewriter-style keys of normal pitch and feel and is quite suitable for word processing. The separate numeric keypad differs in function from that on an ordinary computer; rather than being a mere supplement to the top-row numeric keys, it is a telephone-dialing pad. Special keys surrounding the pad perform functions like last-number-redial and select-the-internal-loudspeaker.

The telephone handset sits to the left of the main keyboard in a cradle with a conventional receiver-rest switch. Lifting the receiver interrupts the computer and prompts you to dial a number; the call is disconnected by replacing the receiver or through software.

Photo 1: *The One Per Desk from International Computers Ltd.*

(continued)

If you should hear a modem whistling at the other end of the line when you pick up the receiver, the Auto button will switch that line over to data auto-answer, while the Hold key holds a voice or data call and switches you to the other line.

The OPD is principally a ROM- and RAM (random-access read/write memory)-based computer, with the tape-cartridge microdrives serving only as backup devices. The machine should be left connected permanently to a main power supply and *not* switched off at the end of the day. To save wear and tear on the VDU, the screen blanks itself when not used for 10 minutes and is restored either by an incoming call or by pressing any key. There's no power switch on the console unit; the one on the VDU lets you switch the monitor off (over weekends or holidays) but leaves the console energized.

The machine comes with 128K bytes of RAM and an expansion box at the rear of the console that accepts ROM capsules containing the operating system and optional application programs. Telephone numbers and other data used in telephone communication are stored in RAM most of the time. Obviously, it's essential to make a microdrive backup to guard against power failure. (An internal battery ensures that the telephone part of the OPD will function even in the event of a power failure.) Some applications require more data than RAM can hold (word processing, for instance), and you can store less frequently used telephone directories on the microdrives to save RAM space.

ICL's idea is that the average user does not want to be involved with operating systems, files, and mass-storage devices, and it's a sound idea. Most of the time the OPD behaves like a telephone that remembers things; in other words, it behaves like a consumer appliance rather than a computer. When the microdrives *must* be used, the filing system is of a fairly rudimentary and obvious sort that merely dumps a memory image to tape, driven by menu selections.

Apart from considerations of operational simplicity, this RAM-based way of working overcomes most of the objections to the Sinclair QL microdrives; namely, their relatively slow access speed and questionable long-term reliability. (ICL has made some internal modifications that it claims have improved reliability.) In normal use you might only use the microdrives once or twice a day.

You can also connect a serial printer to the OPD. Pressing the Print key prints the current screen contents; continuous print is available when you are using the word processor or monitoring a remote computer session.

SYSTEM SOFTWARE

The ROM-based operating software of the OPD is controlled by a combination of screen menus and dedicated keys. Its design looks rather staid in these days of overlapping windows and icons, but it is nevertheless well thought out and easy to use with few exceptions.

The three fundamental control keys—Start, Resume, and Review—are situated on the main keyboard. Pressing Start brings up the top-level menu, which is the starting point for all activities.

The OPD operating system is fully multitasking and distinguishes two types of applications called *transient* or *extended*, respectively. Transient applications stop dead when you press the Start key and can only be rerun by selecting them again from a menu.

Extended applications, on the other hand, will, if possible, go into the background when you press Start and continue running there. For example, if you were connected to a remote database and downloading data to the OPD, this activity would continue even if you pressed Start to do something else. Some extended applications (e.g., a word processor or spreadsheet) require the use of the keyboard and screen, however. These are *suspended* rather than put into the background and can be restarted where they left off by pressing the Resume key. If there are several suspended applications, Resume presents a screen menu of them so you can choose which one to restart.

The top-level menu provides access

(continued)

to the telephone directory, BASIC, a desk calculator, and submenus that control voice and data automated-call facilities, the microdrive utilities, and ROM applications software.

The telephone directory is a built-in database that acts as an electronic phone book. In addition to the name, phone numbers (both voice and data, and extension numbers for PABX [private-area branch exchange]), and a descriptive comment for each person or firm, you may store a *shortcode* and a telephone *charge band*. The shortcode is a three-letter abbreviation used for ultraquick dialing, while the charge band permits the OPD to calculate the cost of calls made to this number.

You can display the directory on the screen as a list of single-line entries. A keypress expands these to give more information (e.g., the identifying comment) or to retrieve a whole record for amendment. You can dial a number by selecting it from this list in one of two ways, either by moving a block cursor to the appropriate entry or by using a search command that can match words or parts of words anywhere in a record.

To dial numbers using a shortcode, lift the receiver and type the code; you don't have to access the directory at all.

The telephone-control submenu permits you to set up voice auto-answer messages and to inspect the total cost of calls made in all the different charge bands. You can set the attributes call-timing and auto-answer on or off for a particular telephone line with this menu.

The voice synthesizer integrates nicely into the system. Answer messages are named and stored in a library. You can create a new one with an editor that offers a screen display of all the words available. (The words will more than fill the screen, so it can be scrolled.) You compose your message from this vocabulary by typing it on the input lines at the foot of the screen. Once it's entered, a single press of the key makes the OPD speak the message so you can see how it sounds and edit it immediately. The vocabulary contains most of the words you need to compose polite business-type messages, plus all the letters of the alphabet, the digits, the numbers up to 59, the suffixes "ing" and "s" (hard and soft), and "breath" pauses. The speech quality is clear and intelligible but somewhat expressionless.

You may select a message from the library and assign it to a telephone line. By specifying a start and finish time, it's possible to allocate two different messages for different times of

(continued)

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day, e.g., hours you are in and out of your office.

The computer-access submenu contains another database similar to the telephone directory, to hold phone numbers of remote computer services. An entry is much like a telephone-directory entry except that it contains a field for the profile, a named file of communications parameters (parity, stop bits, etc.) and log-on information. The system provides two skeleton profiles, one for a 300-bps "glass Teletype" and one for a Viewdata terminal to the U.K. Prestel standard; other types will become available later as ROM capsules. By editing these skeletons, you can create and store profiles for specific sources; you can apply a single profile to more than one source.

Data captured from a remote source can be stored in the page store, which is yet another database holding numbered, screen-size pages of data. It can store up to 99 pages for later inspection or printing.

Logging on to a remote source is not quite fully automatic. The OPD dials the number automatically, but you must manually press a function key to send the log-on sequence stored in its profile once connection is established—hardly an onerous task.

The last option on the top-level menu is Housekeeping, which covers all the utilities, such as setting the date and time, saving and loading memory images to the microdrives, and viewing a directory of the RAM contents. This latter option shows how many 512-byte blocks each memory file occupies and allows manual deletion of files to free up space.

THE OPD AS A COMPUTER

In the rare moments when you are not using the OPD as a telephone, it can serve as a desktop calculator and computer.

You access the calculator from the top-level menu; it has a full-screen display that emulates a printing desk calculator whose printout shows the last 16 results, complete with memory operations.

BASIC, also accessible from the top-level menu, is Sinclair's SuperBASIC, a superior but rather slow structured dialect, which I examined in some detail in my September 1984 BYTE U.K. column (page 415).

Although the OPD derives some of its components (especially the custom gate arrays that handle analog control of the microdrives) from the Sinclair QL, it uses a completely different operating system and therefore, in general, it cannot run QL software. By choosing to implement SuperBASIC in full, ICL hopes to provide a high-level language bridge to QL compatibility; BASIC programs written for the

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latter should run, although I was unable to get hold of any samples to test this.

The OPD can be optionally supplied with Psion's Xchange suite of applications in ROM. This is based on the four-program suite supplied with the Sinclair QL, but is, in fact, a later version that is more integrated and features a limited form of multitasking (in addition to that provided by the OPD operating system).

The QL versions are bedeviled by slowness caused by their heavy use of overlays from the microdrives; running from ROM on the OPD renders a significant improvement, though the screen updating in Quill (its word processor) is still irritatingly slow.

The four component programs, Quill, Archive (database manager), Abacus (spreadsheet), and Easel (business graphics), are run from an executive program called Xchange, which allows you to create named tasks. For example, you could have two Quill tasks in existence at once with different names. These tasks are, strictly speaking, interruptible rather than truly multitasking; a single keypress suspends the current task and returns you to Xchange, from which you can enter another task. Xchange also facilitates the exchange of data between different applications, e.g., from a spreadsheet to the word processor.

Xchange applications can use files that reside either in memory or on the microdrives. However, the program isn't fully integrated with the OPD operating system, in the sense that its applications can use only Xchange-created files and cannot access the memory files used by, for instance, the telephone directory or the page store.

OVERVIEW

Having to revert to a boring ordinary telephone after several weeks with the OPD came as somewhat of a shock to me. It seems so right that my telephone should be part of my computer, or vice versa. Certainly, it's possible to buy fancy phones that do last-number-redial and store a few numbers, but to call up a remote database with a single keystroke and then return immediately to where you left off typing a document is something else.

ICL has aimed the OPD at the business market, where its small size—don't forget it can replace *two* telephone receivers as well as a personal computer—could make it an attractive purchase for managers and executives whose desks have begun to resemble a TV studio floor.

There are some things that the OPD lacks that I would eventually like to see in such a product. In particular, I should like to download documents from a remote source and incorporate them directly into a word-processing document, which requires a text editor that is more fully integrated into the system. Also, given that its RAM-based way of working is very effective, it could use more RAM.

The lack of an industry-standard operating system could be perceived as a weakness, but ICL is adamant that the OPD is not aimed at computer buffs, nor at those with sophisticated computing requirements; the supplied ROM software should provide all that's needed in its intended market.

Such doubts apart, playing with the OPD has convinced me that it's as much of a milestone in personal computing in its own way as the Macintosh. It's hard to imagine how a future personal computer can avoid having integral telephone facilities; plug-in modems and acoustic couplers suddenly seem very clumsy.

With post-Macintosh user interfaces and possibly video as well as voice channels, the personal computers of the future could at last become truly useful in the home as well as the office. Remote banking and shopping are already with us in a limited way. Downloading books and pictures (maybe movies, too?) from the world's libraries could soon follow, as could wholly electronic mail (with photographs as well as text).

The OPD will be available in the U.S.—with a suitable U.S. telephony module—probably in the latter half of this year. ■

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New NECs and a Cartridge Disk

PC-8801 Mk II SR
Mr. PC
PC-6001
Tomas drives
Shoppers' guides
Readers' queries

BY WILLIAM M. RAIKE

I'm always impressed by the pace of introductions of new computer products here; not a month goes by without at least one noteworthy new computer or peripheral device appearing under exhibition spotlights or on dealers' shelves. This month's newcomers include three substantial upgrades of NEC computers and an impressive new cartridge hard-disk system from Tomas. In this month's BYTE Japan I'll also comment on a growing application area here: computers as neighborhood guides.

NEW TRIO FROM NEC

Japan's leading personal computer manufacturer, NEC, recently introduced, of all things, three 8-bit personal computers. The first is an upgrade of its PC-8801 Mk II, based on NEC's version of the Z80 microprocessor and now more than a year old. The older version of the PC-8801 Mk II is still selling well at the major computer outlets in Tokyo's madhouse Akihabara electronics district, with discount prices in the under-$800 range.

The new version is called the PC-8801 Mk II SR. It's a mystery why NEC didn't simply call it the Mk III; I'm not even sure I want to know what the "SR" stands for.

Like its predecessor, the SR comes in three versions (with zero, one, or two floppy-disk drives) and has 64K bytes of user RAM (random-access read/write memory), plus an extra 48K bytes of graphics video RAM. The SR also has the same multiple personality as the earlier PC-8801 systems, which allows it to maintain compatibility with its ancestors all the way back to the PC-8001 computer that first appeared almost six years ago. In addition to its 64K bytes of N88-BASIC ROM (read-only memory); the SR also has the older N-BASIC ROM; you select one bank of ROM or the other by an external DIP (dual-inline package) switch.

The SR isn't identical to the plain old Mk II model, though. For one thing, it offers a 3000-plus-character kanji ROM as standard. This feature is currently almost universal; even the low-priced MSX machines (now in the $100 to $350 range) offer some kanji support. The SR also has a switch that lets you select between two different versions of N88-BASIC.

The SR handles graphics several times faster than the old Mk II and supports additional color graphics features. In either the 640- by 200-dot (low-resolution) or 640- by 400-dot (high-resolution) mode, each dot can assume any of eight colors. You can select the eight colors on a character-by-character basis from a total of 512 colors. Finally, the computer includes a programmable sound synthesizer with an eight-octave range, offering piano, brass, and percussion effects along with insect sounds, bird calls, and others.

There's very little software to run on the SR, except for the Japanese-language word-processing packages from outside vendors that also run on the older versions of the PC-8801 with optional kanji boards installed. I can't imagine anywhere except Japan where hardware of this caliber would be sold completely unsupported by corresponding graphics software (except for BASIC), leaving it up to the hobbyists to figure out whether they can do anything useful with their $1000 new computer. Judging from the rapid turnover in used computers, many users discover that they're limited to buying commercial games or keying in thousands of lines of BASIC coding for public-domain games that appear in computer magazines every month. (There's only one magazine here that's published on disk as well as paper.)

It's revealing that, with all the hype surrounding the graphics and sound-synthesizer features of this computer, including extensive magazine advertising, there is absolutely no mention of an operating system. Having owned an earlier PC-8801, I know it can run CP/M, but there's not much in the

(continued)

William M. Raike, who has a Ph.D. in applied mathematics from Northwestern University, has taught operations research and computer science in Austin, Texas, and Monterey, California. He holds a patent on a voice scrambler and was formerly an officer of Cryptext Corporation in the U.S. In 1980, he went to Japan looking for 64K-bit RAMs. He has been there ever since as a technical translator and a software developer.

The Tomas drives are quieter, offer more capacity than a floppy-disk drive, and provide a reasonable way to maintain backup storage.

way of vendor support for users who want access to that software base.

MR. PC

Another NEC entry is apparently designed to attract people who want a system one step above the low-priced MSX machines. It's called the Mr. PC, and advertising for the machine is directed toward young people; magazine ads and brochures feature people dressed in the latest teen-age fashions and bill the Mr. PC as the Roppongi *pasocom* (personal computer), a reference to one of the more bustling disco and nightlife districts of central Tokyo. The computer comes in either red or black. A major feature is its cordless keyboard, doubtless also designed for people who want to dance with the keyboard. The list price is just under $600, although 20 or even 30 percent discounts are almost universal at most of the major Akihabara computer department stores.

The Mr. PC is an enhancement of the NEC PC-6601 computer I talked about in the September 1984 BYTE Japan ("Show Time," page 407). It comes with one 320K-byte 3½-inch microfloppy-disk drive and 64K bytes of RAM as standard; you can add another drive for about $150 extra. There are five banks of ROM, including two versions of BASIC, a ROM for the sound synthesizer (which isn't quite as elaborate as the one in the PC-8801 Mk II SR), and a 1024-character kanji ROM. Even without any separate graphics video RAM, the color graphics capabilities are adequate: 320 by 200 dots, with a 15-color palette.

The main processor is a μPD780C, equivalent to a Z80, and runs at 3.58 MHz. The Mr. PC also uses three subprocessors: one 8049 for controlling cassette and RS-232C serial I/O (input/output) (the RS-232C board is a $25 option), one 80C49 for a timer and television controller (a video superimpose feature is standard), and another 80C49 used as a keyboard controller.

This machine's software situation is only marginally better than that of the PC-8801 Mk II SR; the Mr. PC comes with a Japanese-language word processor, a music software package called Musicwriter, and a game. The computer stores are jammed with games for the PC-6601, all of which run on the Mr. PC.

PC-6001 UPGRADED

Although NEC doesn't have an entry in the MSX market (there are over two dozen competing MSX machines now), it recently upgraded its slow-selling PC-6001 computer; the result is the PC-6001 Mk II SR. Similar to the Mr. PC but without a disk drive, it offers 80-column display capability and accepts almost all of the Mr. PC peripherals and options. It costs about $350, the same price as the top-of-the-line MSX computers. Since it doesn't accept MSX software cartridges, though, it's hard to imagine this machine finding much acceptance.

CARTRIDGE HARD-DISK SYSTEM

A new disk system from a small company called Tomas Electronics has really big potential. The Tomas cartridge-disk system incorporates the best features of floppy-disk systems and hard disks. Most floppy disks are limited to about a megabyte (although the new Hitachi 6.5-megabyte 5¼-inch floppy-disk drives I talked about in the February BYTE Japan ["Disks and Printers," page 367] should start appearing before long); as density increases, manufacturing quality control and the sensitivity of the disk to dust contamination and wear become increasingly serious problems. And the idea of keeping a box or more of floppy disks as backup for a hard-disk system deserves to become obsolete.

Besides being quieter and offering more capacity than a floppy-disk drive, the Tomas drives offer a reasonable way to maintain backup storage. The Tomas disk cartridges consist of a 3.9-inch Winchester-type hard disk enclosed in a protective cartridge; the cartridges are about ½ inch thick and about 4½ inches square. The rigidity of the cartridge allows the drives to use a fast rotational speed (just over 3500 revolutions per minute) and a high recording density (12,000 bits per inch). The cartridge also protects the sensitive magnetic surface from contamination or careless handling.

The individual cartridges plug into the front of the Tomas drives (single- and dual-cartridge drives are available), giving the same flexibility and ease of backup as floppy-disk drives. Each cartridge holds 5 megabytes when formatted; the average time to access a track is only 90 milliseconds, and the high rotational speed and high recording density combine to give a data-transfer rate of 5 megabits per second. According to Tomas, a carbon-coating technique and improved manufacturing facilities contribute to making the system highly reliable.

The price of the system is comparable to the price of a hard-disk system of similar capacity; the list prices for the single- and dual-drive versions (the RX-0600 and RX-0606) are about $1750 and $2450, respectively. An individual 5-megabyte cartridge, called a Q-Pak, sells for about $80; that's more than floppy disks on a per-byte basis, but Tomas claims the life of a Q-Pak is several times longer than the life of a floppy disk, and the speed advantage more than offsets the price difference.

The drives have built-in controllers; from the computer's point of view, they work just like conventional hard-disk units. According to Tomas, you can connect either the single- or dual-disk drive to an IBM Personal Computer (PC) or PC XT with a hard-disk interface, as well as to the NEC PC-9800 series computers (running under CP/M or MS-DOS), the IBM 5550, the Oki if800 series, and the DEC LSI-11 (running under the RT-11 operating system). The company says a Fujitsu version will be out soon; I'd welcome the chance to try one on my own system.

ON THE STREET

As still another sign of the diffusion of personal computers into everyday life in Japan, video-display units are starting to appear on Tokyo sidewalks, used as directories and guides to local services and businesses. They are usually found in relatively sheltered locations near subway stations or major shopping districts. The hardware, based on standard personal computer technology, is usually housed in protective plexiglass, and the weather has dictated the use of sealed membrane-type keyboards or touchpads. Other than that, the systems have no particular anti-vandalism or security precautions. The software is all menu-driven; it allows you to select from categories such as "restaurants," "shopping," "services," "entertainment," etc., and then to request more detailed information about particular listings. Color graphics are both eye-catching and informative, and the systems usually provide maps to guide the user to individual establishments, an essential feature in view of Tokyo's sometimes chaotic street addresses. Some systems are free, others are coin-operated; I don't know what it costs an establishment to be included in the directory.

These high-tech directories aren't limited to Tokyo; for example, I saw a particularly handy system in Matsumoto, a scenic city in north central Japan. Installed next to the main downtown train station, the system didn't have a video display; instead, a menu with a hundred or so three-digit codes was posted on a large board, similar to the type of building directory used in most large office buildings. When I keyed in my desired code, the system produced a one-page information brochure, including maps and other graphics. It was printed on a high-speed 24-pin dot-matrix kanji printer. This particular service was free, and I noticed that over a period of 20 minutes or so many of the system's users were children, some obviously in the process of showing their parents how to use the directory.

ANSWERS

I get a number of questions from BYTE readers, but it's impossible for me to answer all of them personally. One question that comes up repeatedly is whether you can get a board for the IBM PC that will let it handle Japanese characters. According to the president of the local IBM PC users group, the answer is no, although it is rumored that Chinese-language systems exist in Taiwan. The language gap is not surprising in view of the many technologically superior Japanese personal computers that sell for a fraction of the price of the IBM PC and the computers sold by IBM Japan Ltd. that have Japanese-language capability. As I've mentioned before, the IBM PC and compatibles are not in widespread use in Japan.

If you have a question about the Japanese personal computer world, or comments or suggestions about past and future topics for the BYTE Japan column, you can write to me c/o BYTE, POB 372, Hancock, NH 03449. I'll try to reply to as many queries as possible here in the column.

NEXT MONTH

In the July BYTE Japan I'll tell you about the new Silver-Reed EB50, a battery-powered, lap-size, four-color printer/plotter/typewriter, the ongoing battle of memory chips, and more. ■

A GEM *Seminar*

Also, a Mac disassembler and advances in disk-controller technology

BY JOHN MARKOFF AND PHILLIP ROBINSON

In the March BYTE West Coast (page 355) we mentioned GEM (Graphics Environment Manager), a new program from Digital Research (DR) that gives a computer a Macintosh-like face of icons, windows, multiple fonts, and pull-down menus. In February we attended the GEM Seminar in Monterey, California, where DR began teaching programmers to adapt their software to the GEM environment. What began as an interesting and impressive technical presentation gave way to a marketing brouhaha, which in turn led to a demonstration of DR's flexibility.

Why is GEM so important? DR's John Hiles claims that personal computers with GEM will not only reach the people who read *PC*, *MacWorld*, and *Scientific American* but also will reach those who read *Time* and *TV Guide*. Those people will be more at ease with GEM than with standard operating-system interfaces. DR, the company that once ruled the microcomputer roost with its CP/M operating system for 8-bit microcomputers, hopes to set a new standard with GEM. The Digital Research folks want to provide the advantages of the Mac (and more, such as color displays) to people with other computers. Although the new Atari Inc. under Jack Tramiel (former head of Commodore) is the only company that has committed itself to building GEM into its computers, DR is clearly hoping to penetrate the software-rich, business-standard world of the IBM Personal Computer (PC).

To do this, DR has to do two things. First, it must convince people to use GEM, to build it into hardware and to adapt software to it. Second, DR must teach hardware and software developers how to do those things. Programs will not automatically run on a computer that is equipped with GEM; special files must be added, icons must be designed, and program connections must be developed. (By the way, the bindings for GEM are written in C, though Pascal will be added later. If you want to work with GEM, you certainly should learn C.)

DR decided to begin its education effort with seminars. The one we attended in Monterey was followed by one in London. The seminars had three goals: to continue to pitch GEM, to demonstrate some of the fundamentals of GEM programming (and hand out a software toolkit full of programming utilities and sample code), and to show doubters that GEM is real. That last goal may seem unnecessary, but the fate of Desq, Visi On, and Windows seems to show that such software environments have been jinxed. Visi On disappeared and almost took one of yesterday's largest microcomputer software firms (VisiCorp) with it. Desq has lapsed into limbo, and Microsoft Windows, from one of today's largest software companies, has been repeatedly delayed. In fact, because GEM competes with Windows as much as it does with the Macintosh, DR was clearly happy to be handing out kits and discussing a real product when Microsoft was still months away from its planned summer release of Windows.

To stress the importance of the seminar, DR handed out a list of the attending companies. These were broken into three groups: software houses, original equipment manufacturers (OEMs), and the press. In all, more than 200 people from 30 OEMs and 105 people representing various software firms were there. However, not everyone came with firm intentions to adapt to GEM. In fact, many would only admit coming to have a look at it or check it out. The list of firm commitments is short but substantial. Atari, ACT (makers of the Apricot computers), Commodore, Northern Telecom, and Texas Instruments have all bought licenses to use GEM. Atari has already employed the license to put GEM in its new ST series of computers. We've heard rumors that Atari isn't alone. The software companies—known at the seminar as ISVs (independent software vendors)—who have announced that they will write to GEM

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MacNosy is a sophisticated disassembler written by veteran compiler designer Steve Jasik.

are Blue Chip, Chang Labs, Hayden, Lifetree, Matrix/Systems Group, ProVue, Quadratron Systems, Schoenburg and Hoxie, Software Products, Spinnaker, and Thorn EMI.

Most of the two-day seminar was devoted to explaining GEM architecture and to walking through GEM program code. Throughout the sessions, the DR team demonstrated GEM running on a variety of IBM machines including a PC AT, a PC XT, and an IBM PC with two floppy-disk drives and 256K bytes of memory. (The PC AT used IBM's advanced graphics adapter with the 640- by 200-pixel resolution.)

A description of GEM's VDI (virtual device interface), which allows programs to think they have control of the terminal when they are in fact being handled by GEM, was followed by a short discussion of fonts. As Lee Lorenzen, senior software engineer for DR, explained, DR is only providing a sans-serif font called Swiss (which looks like Helvetica) and a serif font (which looks like Times-Roman) but is encouraging third-party fonts. In fact, the folks from DR started referring to IFVs (independent font vendors).

Tom Rolander of DR explained some of the tough technical stuff, walking through the code of a sample GEM application he had written (a simple paint program). Then DR's Tim Oren began a detailed overview of the RCS (resource construction set). On Friday morning we completed the RCS overview and then quickly learned how to use the Icon Editor from Greg Morris of DR (he wrote the editor). Rolander returned to walk us through some more C listings for a simple desk accessory.

Friday afternoon's discussion of marketing set off a small explosion. Have you ever seen a room loaded with loud, hostile, and sometimes profane programmers? Except in software project-status meetings, of course. We witnessed one after the DR marketing team presented the licensing facts about GEM. Basically, we were told that there will be two ways for software developers to work with GEM. They can develop GEM-compatible applications and sell them to people who already have GEM on their computers. That's no market at all right now: No one has GEM. Or they can pay DR a license fee that will allow them to sell the application and GEM in a bundle. This license costs $1000 per product per year (with no guarantee that it won't rise)—so far, not so bad. But then DR mentioned that GEM would only run on IBM (PC, PC AT, and PC XT) equipment. It wouldn't even run on compatibles like the Compaq. Why? Because DR didn't want it to. DR deliberately wrote GEM—crippled it—so it wouldn't run on clones. Again, why? Because DR wanted hardware manufacturers to pay OEM license fees to have GEM run on their computers. All OEMs except IBM, that is.

DR didn't mention this until the final hours of the seminar. In fact, the DR marketing people didn't hand out the sheets detailing licensing until just before this session. Did they anticipate the attendees' reactions? The software developers certainly didn't anticipate having to support different GEM versions of their applications for every compatible and clone. What had seemed up until then a crowd of programmers willing to give GEM a shot quickly changed. While not everyone objected to the IBM constraint, there were a number of hostile questions from the audience. In fact, when one person asked how many thought GEM's inability to run on the Compaq was a serious limitation, 50 to 60 percent of the attendees raised their hand. DR responded that it has to make some money on the product and OEM fees are a place to do so. While some developers felt this was reasonable, many others seemed to think they'd been bushwhacked.

Gary Kildall, the president and founder of DR, tried to calm the attendees. Discussions after the conference centered on the marketing plans and what a pain they were. Things looked black for GEM.

Then DR changed its mind. In late February, the folks in Monterey decided to change the code in GEM that checks for machine type. Now, GEM will run on IBM compatibles and clones. Imagine, a sizable software company that really pays attention to its developers and makes major changes because of what it hears.

We were impressed by GEM, as were a number of the developers at the seminar. Everyone went home with two big binders full of some useful information and some fluff, a lot of C code, an invitation to a CompuServe GEM support group, a toolkit disk, and a list of toolkit bugs. While GEM had been in beta test for a couple of months, the toolkit had just reached the beta-test stage and had a number of bugs. For instance, in a certain circumstance, if you tried to drag something out of a menu and then accidentally dropped it on a divider line, the entire computer system would hang and have to be reset.

GEM lets you have the same kind of fun as working with a Macintosh and yet lets you step back into the IBM PC world with a quick exit instruction. GEM even has a limited multitasking facility (it can handle some background processes). It is reasonably quick and thorough, but it does have limitations. For example, it has some arbitrary limits, such as a maximum of four open windows at a time and no more than six desk accessories (and a memory-limit size for those).

At press time DR was planning to release its own GEM applications, including GEM Draw (April), GEM Write and GEM Paint (June), and GEM Graph and GEM Wordchart (July).

How will GEM impact the microcomputer world? Right now that depends mainly on DR, Atari, and Apple. Can DR convince developers to work in a GEM world? Will Atari be able to produce huge numbers of inexpensive GEM machines, as Tramiel claims? And finally, how will Apple respond? If people can have the Macintosh juice in a cheaper computer, or on an IBM PC-compatible, will they continue to buy Macs? Does Apple have the next evolution or revolution (like a cheaper or more powerful Mac) up its sleeve? If so, the Cupertino Corps may well find that GEM's imitation has confirmed Mac ideas and put Apple out in front of the microcomputer race. If Apple isn't ready to take the next step, it may be run over by a horde of "Macalikes" egged on by a smiling DR.

COMPANIES MENTIONED

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Monterey, CA 93942
(408) 649-3896

JASIK DESIGNS
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Menlo Park, CA 94025
(415) 322-1386

SUNOL SYSTEMS
1187 Quarry Lane
Pleasanton, CA 94566
(415) 484-3322

MACNOSY: "A DISASSEMBLER FOR THE REST OF US"

Better software-development tools have become available for the Macintosh during the past half year. Currently there are a number of C programming languages, several assemblers, several BASICs, LISP, Logo, FORTH, Modula-2, and an interpretive Pascal to name just a few. Add a licensed version of Xerox Smalltalk-80, which Apple is rumored to have in the works for release soon, and the Macintosh becomes a reasonable programming environment.

For those who want to go further, programming editors and a variety of debugging tools are now readily available. Possibly one of the ultimate Macintosh "exploring" tools is MacNosy, a sophisticated disassembler written by veteran compiler designer Steve Jasik.

Jasik has written compilers for Control Data Corporation for a number of years and is best known for his work developing a global optimizing FORTRAN compiler for the Control Data Cyber 170 system. While attempting to gain a clearer understanding of the Motorola 68000 and the Macintosh operating system, he grew frustrated with the poor quality of the documentation and the general lack of source listings. So he decided to write MacNosy.

Jasik considers his program to be as much a "decompiler" as a disassembler. MacNosy, which consists of more than 7000 lines of Pascal code and about 300 lines of assembly-language code, contains many features associated with compilers including a table manager, symbol-table enter/lookup routines, a reference map, and global flow analysis.

MacNosy runs on either a 512K-byte Macintosh or a 1-megabyte Lisa under the Workshop operating system or the MacWorks environment. It is capable of disassembling the resource fork of an application, ROM (read-only memory), or various resource types in the system file (DRVR, PACK, INIT, CDEF, WDEF, etc.).

A partial list of MacNosy features also includes symbol dictionaries of the ROM names and global symbols (0 to hexadecimal B00) with value-to-symbol substitution, selective listing of procedures in a file by procedure name or substring., the ability to search a program file for references to selected addresses, ROM calls, resource-type references, constant or string references, a full or selective listing of the resources in a file in a format similar to that of the Macintosh Resource Mover, and the ability to translate the segment-relative address of an instruction to the disk-file relative address for code-patching purposes. MacNosy also records its input on a text format .jrnl file for later playback. A future program addition will be a built-in mini-editor for viewing and modifying files while in MacNosy.

Jasik claims that MacNosy is set apart from other disassemblers because it treats a program as a tree of procedures. It begins at the main entry point and does a tree walk to mark the program areas that are procedures. Areas not included are considered data. Currently the program doesn't reconstruct enough information about data areas that are actually code (procedures passed as addresses), and programmer intervention is needed to decode these areas.

In addition to its use as an educational tool and as a tool for developers who want to examine the Macintosh ROM to find out what the ROM routines are doing and for those who want to learn advanced 68000/Macintosh programming techniques by examining others' code, MacNosy has a more controversial use. Advanced programmers can use it to remove copy-protection schemes from commercial software. Jasik takes the position that he is not opposed to copy protection as long as it is not "obnoxious" in the sense that it prohibits the user from booting an application from a hard disk without having to insert a key disk each time. He is also critical of Apple's decision not to make more information about its ROM-based operating system available for the Macintosh.

FASTER AND FATTER WINCHESTERS

Personal computer hardware designers are constantly confronted with the task of squeezing increased performance from limiting standards. Particularly in the area of mass storage, personal computers are bumping up against I/O (input/output) bottlenecks imposed by existing floppy-disk and

(continued)

An RRL data-encoding technique improves on traditional techniques because it represents a given bit stream using significantly fewer flux reversals.

Winchester fixed-disk technology.

To at least partially get around these restrictions it is possible to design new disk controllers that extract more performance out of current-generation Winchester disks. Large performance gains will soon be made by a new generation of disk controllers that offer higher data-transfer rates and greater storage capacity based in part on new data-encoding techniques.

One interesting example of this trend is a new two-chip mass-storage controller set recently announced by Sunol Systems of Pleasanton, California. The DC1001 disk-controller chip plus the RB1002 RAM (random-access read/write memory) buffer support chip are based on CMOS (complementary metal-oxide semiconductor) custom gate-array technology and can be designed into a single controller card that will handle a hard-disk drive, a floppy-disk drive, and even a file-addressable tape backup system. Because it is fabricated in CMOS technology, the chip set will consume far less power than other commercial controllers. Each chip consumes just 100 megawatts when operated from a 5-volt power supply.

The chip set implements the ST506 5¼-inch, the ST412 buffered-seek, and the ST412HP high-performance hard-disk interfaces, the SA 5¼-inch, SA800, and SA850 8-inch floppy-disk interfaces, as well as the ESDI (enhanced small-disk interface) file-addressable tape, and the QIC 36 streaming-tape interface.

The new controller set is addressable in a fashion similar to other popular controllers such as the NEC μPD765. It is simply necessary to send a byte sequence through a host central processor or a local control microprocessor.

The key feature that lets the Sunol controller set achieve increased capacity and faster transfer rates than standard Winchester and floppy-disk controllers is the use of an RLL (run-length limited) data-encoding technique that offers significant advantages over traditional MFM (modified frequency modulation) or FM (frequency modulation) methods.

RLL improves on traditional techniques because it represents a given bit stream using significantly fewer flux reversals. According to Dr. Robert McCullough, Sunol's founder, RLL permits recording up to 60 percent more bits than MFM and can transfer data 50 percent faster.

FM is a self-clocking encoding technique that is used to record bit-serial data on magnetic media. Clocking is done by first writing a flux reversal to define the leading edge of a bit cell. If the value of the cell is 1, a second flux change will occur midway through the cell; however, if the value of the cell is 0, a second flux reversal will not take place until the leading edge of the next bit cell.

MFM keeps the flux reversals for 1s but removes the clock bits except those between two consecutive logic 0s. Rather, the MFM bit cell is defined by an external phase-locked oscillator synchronized with the data-bit stream.

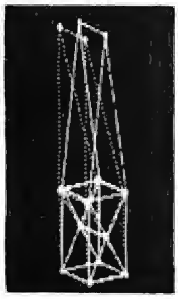
In contrast, in RLL encoding there is nothing that can be identified separately as a "clock bit" or a "data bit." Instead there are only data patterns and corresponding code patterns. Each binary data string can be represented as an RLL encoded data pattern. A minimum and maximum number of 0s are inserted between flux transitions. McCullough claims that RLL offers the best trade-off available between flux-reversal density and bit density.

Ultimately, this will translate into significant performance increases. When used as part of a newer high-performance interface standard such as the ST412HP, for example, RLL encoding can permit a 15-megabit-per-second data throughput. ■

Structural Analysis Software for Micros

A book/disk pkg that shows how to write structural analysis software. Uses the 'direct stiffness' method of analysis with Gauss Jordan sol'n of eqn's. Eleven programs show how to plot 3D structures, rotate in 3D, store on disk, analyze with force and moment loads. Handles linear and non-linear structures (plastic mat'ls, large displacements) via incremental solution strategy. Can be used for professional analysis of small structures. Book with theory, operating instructions. Disk with BASIC source code.

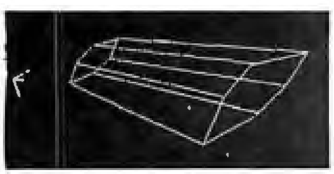
- ☐ IBM version....................$96
- ☐ Apple version....................$96
- ☐ Z-100 version....................$96



S/SAM

3D truss and frame analysis with graphics. Easy method of describing structure via keyboard input, store structure on disk, recall and modify. Loadings include forces and moments at nodes, prescribed node displacements and rotations, thermal loads. S/SAM gives node translations and rotations, member forces and moments in global and member coordinate systems. Handles up to 150 degrees of freedom. Graphics shows original structure in 3 dimensions with deflected shape superimposed in color (dotted lines is b&w), scale deflections up or down, rotate in 3D. Features stress post-processor which does accurate stress analysis on members, material properties and beam cross section disk catalogs, multiple load case analysis. Source code in BASIC on disk. Manual. Demo kit available.

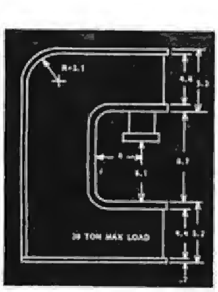
- ☐ IBM S/SAM....................$385
- ☐ Apple S/SAM....................$385
- ☐ Z-100 S/SAM....................$385
- ☐ IBM dem kit....................$35
- ☐ Apple demo kit....................$35
- ☐ Z-100 demo kit....................$35



Designer^{3D}

A 3-dimensional CAD program. Interactively create 3D drawings on screen via keyboard commands. Position points, connect by lines, fit curves through points with B-spline routine, scale, rotate in 3D, translate, view in perspective, store on disk, recall up to 5 drawing simultaneously. Move each independently. Move a point and all lines, curves move with it. Input data is in terms of real physical dimensions such as inches or millimeters. Drawings automatically scaled to fit on screen. Attach physical data to drawing elements such as weight, resistance, etc. Use disk files as input to your own applications software. *..inexpensive, versatile, a very powerful design package..can do things Autocad can't..-Boatbuilder Magazine.* Programs on disk in BASIC fully documented. Manual.

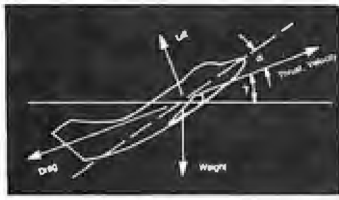
- ☐ IBM version....................$85
- ☐ Apple version....................$85
- ☐ Z-100 version....................$85



CAD-BASIC

A professional quality CAD program with source code in BASIC fully documented. Use keyboard commands to create any 2D drawing, store on disk, recall, store standard shapes, scale, rotate, automatic curve fitting, semi-automatic dimensioning. Perfect low-cost CAD system for professionals, software hobbyists, educators. Screen dump or plotter versions available.

- ☐ Screen Dump CAD-BASIC..........$120
- ☐ For Houston Instruments Plotter...$120
- ☐ For Hewlett-Packard Plotter.......$120



BASIC Aircraft Performance

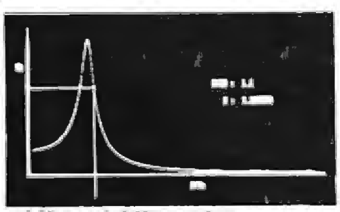
A system of 8 programs to estimate the performance of aircraft on prescribed missions and in maneuvering flight at prescribed conditions. Features state-of-the-art drag prediction program, thrust/fuel input and evaluation program, simple method of describing complex missions. This system will take you from a 3-view drawing of an aircraft to a completed performance envelope and a mission performance description. Use of thrust/fuel flow tables permit any engine type - turboprop, turbojet, etc. All programs in BASIC, source code on disk, 240 pg manual with theory, operating instructions.

- ☐ IBM version....................$120
- ☐ Apple version....................$120
- ☐ Z-100 version....................$120

Engineering Software for Micros

A collection of programs for engineering applications of micros. CAD graphics, mechanisms, Fourier Series, Fourier Transforms, Guass Jordan sol'n of eqn's, Monte-Carlo optimization. Emphasis on graphics.BASIC source code on disk.

- ☐ IBM version....................$50
- ☐ Apple version....................$50
- ☐ Z-100 version....................$50



Visual Vibrations

Solves 1 and 1 degree of freedom damped oscillator problems with emphasis on graphics. Response to applied harmonic force, foundation motion, impulse and step loading, response spectra, log plots, complete description of system including natural frequencies, time constants, damping factors, etc. Book reviews theory with operating instructions. BASIC source code on disk.

- ☐ IBM version....................$75
- ☐ Apple version....................$75
- ☐ Z-100 version....................$75

Visual Statistics

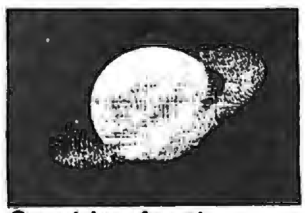
Statistical analysis with emphasis on graphics. Create data files interactively thru keyboard. See x,y data points on screen as entered. Add, delete, move points, store on disk, recall and merge data files. Customize plots - define axes, flash point numbers, define grids, connect point with lines, bar charts, sort, percent between limits, running average, x-mean, y-mean, weighted x-mean, standard deviation, Z-values, correlation coeff', coeff' of determination, linear regression thru specified point. BASIC source code on disk. Manual.

- ☐ IBM version....................$65
- ☐ Apple version....................$65
- ☐ Z-100 version....................$65

Statistics Software for Micros

19 programs for statistical analysis: summary statistics, binomial and normal probabilities, chi-square test, 1 and 2 sample hypothesis testing and confidence intervals, multi-factor ANOVA, comparison procedures, latin squares, cross-over designs, repeated measures design, simple and multi-linear regression, regression thru origin, logistic response analysis, graphics with profile of means, scatter plots, residual plots, histograms. Numerous example problems. 320 pg manual, BASIC source code on disk.

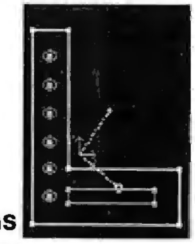
- ☐ IBM version....................$62
- ☐ Apple version....................$62
- ☐ Z-100 version....................$62



Graphics for the IBMpc, Apple, Z-100

64 programs that show how to write graphics software. They advance from elementary graphics to advanced concepts in small steps. Shows how to create 2D and 3D shapes, rotate, translate, scale, stretch, store on disk, view in perspective, clip, window, remove hidden lines. Applications to CAD/CAM, business, games. Named *'the best book on microcomputer graphics' -Creative Computing Magazine..* Book with BASIC source code on disk.

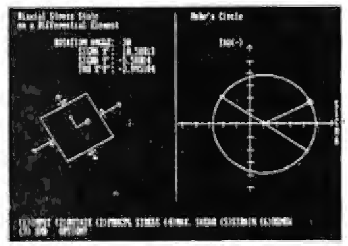
- ☐ IBM version....................$50
- ☐ Apple version....................$50
- ☐ Z-100 version....................$50



Sections

Calculates properties of composite or uniform beam cross-sections. They can have any shape, regions of different material properties, reinforcing rods and holes. Properties calculated: area, wgt/unit length, centroid coord's, bending and polar inertias, principal angle, inertias about principal axes, axial stiffness, bending stiffness, torsional stiffness, distance to outermost fibers. Create shapes via keyboard input using real physical dimensions, plot section on screen with principal axes, outermost fiber shown in color or b&w, store on disk, recall and modify. BASIC source code on disk. Manual.

- ☐ IBM version....................$65
- ☐ Apple version....................$65
- ☐ Z-100 version....................$65



Stress & Strain

Solves 2 and 3 dimensional combined stress problems. In 2D case, specify stresses, program draws stress element with Mohr's circle. Rotate element, new stresses are calculated, Mohr's circle is redrawn, stress vectors drawn to scale on rotated element. Also get principal stresses, strains, principal angle, max shear. 3D case is similar but no Mohr's circle. Principal stresses found via matrix iteration. BASIC source code on disk. Manual.

- ☐ IBM version....................$85
- ☐ Apple version....................$85
- ☐ Z-100 version....................$85

C Graphics

A collection of programs that show how to write graphics software in C on an IBMpc. Learn how to turn on the graphics mode and place a point on the screen at x,y coordinates with assembly language, then develop SCREEN, PSET and LINE functions in C. Develop C functions to create 2D and 3D shapes, rotate, scale, translate in 3D, store drawings on disk. Build your own graphics language. Book with C and BASIC source code plus compiled modules on disk.

- ☐ IBM version....................$66

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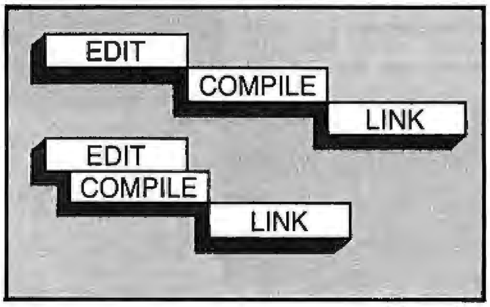

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There are also multiple editor windows that let you refer to one file while you edit another. And that can add even more hours of creative, productive time to your day.

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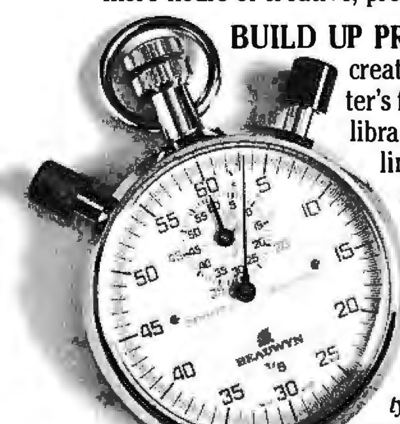

Our compiler turns 100 lines of typical Modula-2 text into optimized machine code in under five seconds.

SDS-XP runs on the IBM® PC family or any 100% compatible computer. The system is non-copy protected. And any programs you develop using it, you own.

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Conducted by Steve Ciarcia

Offer Extended

Dear Circuit Cellar Project Builders,

In my November 1984 article on the Lis'ner 1000 voice-recognition board, I offered the software separately to Circuit Cellar project builders for $17 through March 1, 1985. Requests have poured in throughout the offering period, but the majority of foreign mail has just started to arrive. To give everyone time to properly evaluate the project and respond, I am extending the availability of the software through August 1, 1985. Thanks for your support.—Steve

Trump Card Questions

Dear Steve,

I recently read your articles in BYTE about the Trump Card, and I am considering the purchase of the board. However, I have several questions I would like to have answered before I make such an investment.

You mentioned that there are a few minor differences between IBM BASICA and TBASIC. What are these differences? Does TBASIC support the 8087 math coprocessor? How long can I expect Trump Card to take to compile very large and complicated programs? Our IBM PC system has an expansion unit. Can Trump Card be placed in the expansion unit, or must it be put in the system unit as is the case with the monochrome monitor adapter and some other cards? Is it possible that some IBM software will not run properly when Trump Card is in the system? Is it possible that some of the other cards we have in our system will interfere with Trump Card?

Grieg A. Olson
Tucson, AZ

The Trump Card manual supplies a listing of the IBM BASIC statements, functions, variables, and commands that are either fully supported, supported with some differences, or not supported by TBASIC. The items not supported by TBASIC generally comprise the special PC BASIC commands associated with input/output control. For example, some of the items not supported by TBASIC are DEF USR, DELETE, KEY, LLIST, MERGE, MOTOR, PEN, STICK, TRON, *and* TROFF. *In some cases, the item is not supported because it is handled in a different manner by TBASIC. For example, items like* DELETE, LLIST, *and* MERGE *are handled by the built-in EE editor that comes with TBASIC and are not needed by the TBASIC compiler. A chapter on the EE editor is included in the TBASIC manual.*

TBASIC does not support the 8087 math coprocessor. However, the increase in speed acquired by using TBASIC is remarkable without the 8087 coprocessor.

The compilation time for large programs is still quite fast. A 25K-byte BASIC program will compile in about 8 seconds.

The Trump Card should be able to be placed in an expansion unit, since the memory associated with the Trump Card is on the Trump Card itself.

The Trump Card should not affect the operation of any IBM software packages, and the Trump Card should not interfere with any of the other cards in your system. At least, it has never interfered with any of my hardware or software.
—Steve

British Sweet Talker II

Dear Steve,

I thoroughly enjoyed the article that you wrote in the March 1984 BYTE regarding the new Sweet Talker II.

I am a beginning computer enthusiast, and I have just ordered this board to begin experimenting with a number of projects.

One of the more involved projects is to create a computer-generated British voice. While I will be experimenting with the Sweet Talker II to learn a lot of the basics and further understand that the chip can be best utilized by programming it with an assembly language to take advantage of its many features, I am wondering whether it will be possible to get a British accent out of its synthesized voice.

George E. Handley
Shawnee Mission, KS

It may be possible to obtain a British accent from the Sweet Talker II, but I have not tried to do so. The Apple II text-to-speech algorithm generates some words that have a distinct (though unintentional) Irish brogue, and some phoneme changes might produce the British accent. It would be strictly a trial-and-error approach, however.

Each of the methods of speech synthesis is a compromise. The phoneme approach allows an unlimited vocabulary at the expense of accuracy. The linear-predictive-coding (LPC) method offers accurate speech reproduction, but the vocabulary is limited, since the coding for each word must be computed. The adaptive differential pulse-code modulation (ADPCM) method, described in my June 1983 Circuit Cellar article, may represent an acceptable solution, but it uses large amounts of memory. As the 256K- and 1024K-byte memory chips become available in quantities to drive the price down, this may be a cost-effective approach to your application.—Steve

Audio Down-Converter

Dear Steve,

I am an avid reader of your articles in BYTE, although I'm not quite a project builder. Your recent articles on "talkers" and "listeners" prompted me to write to you regarding my friend's hearing problem. It has seemed to me that her hearing could be enhanced by some of the technology that goes into your projects.

Her problem is that she hears only sounds below 700 cycles. It seems to me (quite possibly because of my lack of knowledge) that it might be possible to build a device that would take in all noise and shift it to a frequency where she can hear. Do you have any suggestions? Thanks.

Ralph M. Carlson
Poulsbo, WA

Though the Lis'ner 1000 (November 1984, page 110) has the capability to extract filter coefficients from speech in real time and also synthesize speech, the routines required to lower the frequency spectrum make it impossible to do in real time. The speech would have to be received, analyzed, and synthesized in chunks. Also, it would not be very portable.

A technique that might work was

(continued)

described in "Listen to a New World of Sounds with an Ultrasonic Detector" in the July 1978 issue of Popular Electronics. *Though the circuit described would not work for your particular frequencies, the technique of heterodyning might be applied. If you have had any trigonometry, you have seen this identity: (sin x)(sin y) = ½ cos(x−y) − ½ cos(x+y). Multiplying a signal of constant frequency (y) by a signal of varying frequency (x) produces two signals having a frequency equal to the sum and difference of the input signals. If you choose 1000 Hz as frequency y, all frequencies in the signal x would be increased and decreased by 1000 Hz. The component that is increased in frequency would be rejected by your friend's ears, leaving only the lower frequencies.*

The resulting signal would not be the same as playing a record at half speed, because that process divides all frequencies by two. In fact, the resulting signal may be less intelligible than the original. By changing the frequency and filtering the results, some intelligible signal may be produced.

Books on operational-amplifier circuits are available from advertisers in BYTE. One such book, Design of Op-Amp Circuits, with Experiments *by Howard M. Berlin (Howard W. Sams & Co., 1978), gives a circuit for multiplying two signals together using two logarithmic amplifiers, a summing amplifier, and an antilogarithmic amplifier. A hitch in using the circuit is that a DC offset must be added to the two signals before they can be multiplied, since you can't take the log of a negative number. It is easy to add the offset, but the resulting signal will have components of x, y, and x+y left, which may need to be filtered out.* —Steve

WHITHER SIGNALS?

Dear Steve,

I enjoyed your article about the Trump Card (May and June 1984). Your system interests me because it improves BASIC execution time, supports CP/M-80, and provides development tools. It also is a direct demonstration of how to build quality hardware.

I am interested in using the Trump Card to run real-time data analysis in electrophysiology. But before I can I need to know several things. First, what is the exact meaning of the connecting symbols in the schematic? Second, I had trouble following the signals in the schematic. Can you tell me their origins and destinations? The signals are $\overline{\text{HOLD}}$, $\overline{\text{HOLDPC}}$, LA1–LA11, $\overline{\text{MRFSH}}$, R/$\overline{\text{W}}$, Z, AD8–AD15, $\overline{\text{BIOR}}$, $\overline{\text{CAS}}$, $\overline{\text{INC}}$, $\overline{\text{INTOP}}$, $\overline{\text{SPIO}}$, MREQ, MUX, and $\overline{\text{RESET}}$.

F. MARION
Paris, France

The connecting symbol notation used in my articles is as follows:

An arrow with a line emitting from its point means that a connection to that point comes from some other point in the schematic.

An arrow with a line entering the flat side means that signal goes somewhere else in the schematic.

An arrow with a number in it means the connection comes from or goes to an external connector.

A double-pointed arrow denotes an intersheet connection.

Now that the connecting notation is explained, let's address your list of Trump Card signals.

The $\overline{\text{HOLD}}$ *line that goes to IC24, IC31, and IC10 is generated at pin 3 of IC10 and is shown on page 48.*

The $\overline{\text{HOLDPC}}$ *line is generated at pin 8 of IC35 and goes to pin 2 of IC10 on page 48.*

The LA1 through LA11 signals are generated by IC5 and IC6 on page 45.

The $\overline{\text{MRFSH}}$ *signal is generated at IC11 pin 6. It does not come from another source, as indicated on page 46. Also, the line shown between pins 10 and 12 of IC20 should not be there, and the* $\overline{\text{MRFSH}}$ *signal should also be connected to pin 10 of IC20.*

The R/$\overline{\text{W}}$ *signal is generated at pin 30 of IC1 and connects to pin 1 of IC23.*

The Z signal is generated at pin 10 of IC13 and connects to pin 9 of IC31 and to pin 3 of IC32.

The AD8 through AD15 lines are the upper data lines of the Trump Card and connect to all locations with the same labels on pages 45 and 47.

The $\overline{\text{BIOR}}$ *line is not used in the Trump Card.*

The $\overline{\text{CAS}}$ *signal is generated at pin 3 of IC33 and connects to pin 4 of IC15 and pin 4 of IC16 (the arrows on ICs 15 and 16 are reversed).*

The $\overline{\text{INC}}$, $\overline{\text{INTOP}}$, *and* $\overline{\text{SPIO}}$ *lines are not used.*

The MREQ line is used only as shown on page 46. It does not go anywhere else in the circuit.

The arrow on pin 1 of IC17 should be reversed. The MUX line is generated at pin 5 of IC19.

The $\overline{\text{RESET}}$ *signal is generated at pin 13 of IC9 on page 49.*

I hope these comments will make constructing your Trump Card a little easier. —Steve

TRUMP CARD USERS GROUP

Dear Steve,

As one of the original users of the Trump Card, I'd like to take this opportunity to bring you up to date on current developments.

We have a Trump Card Users Group (TRUG) in San Jose, California, and we are in the early stages of setting up a Trump Card software exchange on my BBS. I have chosen what I believe is the best BBS software, Tom Jennings's Fido system. The BBS is Fido #13. With the support of Sweet Micro Systems, much of the software that comes with the Trump Card is available for downloading. Also, one of the charter members of TRUG, Lloyd Zusman of Master Byte Software, has written some nice C utilities and enhancements to the C library that you can download as well.

Currently, we are running version 1.6 of Zoom, the operating system that comes with Trump Card. It supports context switching on the Trump Card itself, but as of this writing, it doesn't yet support concurrent processing between the Z8000 and the 8088. We are slowly working on that capability and we hope to have it in the near future.

We'd like to invite any and all Trump Card users to call in and download what we have. Also, we'd like to invite any of you who are interested to help us develop a nice repertoire of software for this nice processor. We are ultimately looking for a bunch of UNIX-like utilities to make the Zoom system appear closer to UNIX, but feel free to upload anything you'd like.

Call Fido #13 at (408) 923-5565. 300/1200 bps, 8 bit, 1 stop, no parity. Or you can drop a line to TRUG, 3152 Penitencia Creek Rd., San Jose, CA 95132.

VERNON CRAWFORD
San Jose, CA ■

Over the years I have presented many different projects in BYTE. I know many of you have built them and are making use of them in many ways.

I am interested in hearing from you telling me what you've done with these projects or how you may have been influenced by the basic ideas. Write me at Circuit Cellar Feedback, POB 582, Glastonbury, CT 06033, and fill me in on your applications. All letters and photographs become the property of Steve Ciarcia and cannot be returned.

B·O·O·K·S R·E·C·E·I·V·E·D

THE ABCs OF LOTUS 1-2-3, Bill Kling. Glenview, IL: Scott, Foresman and Co., 1985; 432 pages, 21 by 23 cm, spiral-bound, ISBN 0-673-15996-5, $18.95.

ADA SOFTWARE TOOLS INTERFACES, Peter J. L. Wallis, ed. Lecture Notes in Computer Science #180. New York: Springer-Verlag, 1984; 168 pages, 16.5 by 24 cm, softcover, ISBN 0-387-13878-1, $13.

APPLE SOFTWARE FOR PENNIES, Bertram Gader and Manuel V. Nodar. New York: Warner Books, 1985; 320 pages, 13.5 by 20.5 cm, softcover, ISBN 0-446-38206-X, $9.95.

APPLE IIE, Vincent Kassab. Englewood Cliffs, NJ: Prentice-Hall, 1985; 238 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-039421-1, $16.95.

APPLIED CALC RESULT, Erik Fagerland. Mount Laurel, NJ: handic Software, 1984; 176 pages, 17 by 23 cm, softcover, ISBN 91-7880-001-5, $19.95.

APPLIED PROGRAMMING TECHNIQUES IN C, Terry A. Ward. Glenview, IL: Scott, Foresman and Co., 1985; 368 pages, 19 by 23.5 cm, softcover, ISBN 0-673-18050-6, $19.95.

ARTIFICIAL INTELLIGENCE: HOW MACHINES THINK, F. David Peat. New York: Baen Enterprises, 1985; 384 pages, 13 by 21 cm, softcover, ISBN 0-671-55933-8, $8.95.

BASIC BASIC PROGRAMS FOR THE ADAM, Timothy Orr Knight and Darren La Batt. Blue Ridge Summit, PA: Tab Books, 1984; 124 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-0716-1, $8.25.

BASIC STATISTICS: AN INTRODUCTION TO PROBLEM SOLVING WITH YOUR PERSONAL COMPUTER, Jerry W. O'Dell. Blue Ridge Summit, PA: Tab Books, 1984; 462 pages, 13 by 21 cm, softcover, ISBN 0-8306-1759-0, $15.95.

BEFORE YOU BUY WORD PROCESSING SOFTWARE, Dona Z. Meilach. New York: Crown Publishers, 1984; 208 pages, 15 by 22.5 cm, softcover, ISBN 0-517-55340-6, $8.95.

BUSINESS APPLICATIONS FOR THE APPLE II & IIE UNDER CP/M, Steven Zimmerman, Leo Conrad, and Donald Smith. Bowie, MD: Brady Communications, 1985; 272 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89303-354-5, $15.95.

C: AN ADVANCED INTRODUCTION, Narain Gehani. Rockville, MD: Computer Science Press, 1985; 352 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-88175-053-0, $29.95.

CHILDREN'S PROGRAMS FOR THE COMMODORE 64, Susan Sutphin. Englewood Cliffs, NJ: Prentice-Hall, 1985; 190 pages, 17.5 by 23 cm, softcover, ISBN 0-13-132499-3, $12.95.

COCO LOGO FOR THE TRS-80 COLOR COMPUTER, Dale Peterson, Don Inman, and Ramon Zamora. New York: John Wiley & Sons, 1985; 136 pages, 21 by 28 cm, softcover, ISBN 0-471-87921-5, $12.95.

THE COMPLETE INVESTMENT BOOK, Richard Bookstaber. Glenview, IL: Scott, Foresman and Co., 1984; 416 pages, 19.5 by 23.5 cm, softcover, ISBN 0-673-15952-3, $19.95.

COMPUTATION AND PROOF THEORY, M. M. Richter, E. Börger, W. Obershelp, B. Schinzel, and W. Thomas, eds. Lecture Notes in Mathematics #1104. New York: Springer-Verlag, 1984; 488 pages, 16.5 by 24 cm, softcover, ISBN 0-387-13901-X, $22.50.

COMPUTER AND MICROCOMPUTER SYSTEMS FOR SMALL BUSINESSES, Russell E. Wilcox. Phoenix, AZ: Oryx Press, 1984; 256 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-89774-131-5, $27.50.

COMPUTER CULTURE: THE SCIENTIFIC, INTELLECTUAL, AND SOCIAL IMPACT OF THE COMPUTER, Heinz R. Pagels, ed. Annals of the New York Academy of Sciences, Volume 426. New York: The New York Academy of Sciences, 1984; 300 pages, 15 by 23 cm, softcover, ISBN 0-89766-245-8, $66.

COMPUTER SOFTWARE, *Scientific American*. New York: W. H. Freeman and Co., 1985; 132 pages, 21 by 28 cm, softcover, ISBN 0-7167-1712-3, $13.95.

CRACKING THE "PEANUT": YOUR IBM PCJR COMPANION, Hank Mishkoff. Plano, TX: Wordware Publishing, 1984; 248 pages, 19 by 23.5 cm, softcover, ISBN 0-13-188319-4, $16.95.

DATA ADMINISTRATION, William R. Durell. New York: McGraw-Hill, 1984; 222 pages, 16 by 23.5 cm, hardcover, ISBN 0-07-018391-0, $32.95.

DATA AND COMPUTER COMMUNICATIONS, William Stallings. New York: Macmillan Publishing, 1985; 608 pages, 18.5 by 26 cm, hardcover, ISBN 0-02-415440-7, $38.50.

DATA COMMUNICATIONS: A USER'S GUIDE, 2nd ed., Kenneth Sherman. Reston, VA: Reston Publishing, 1985; 464 pages, 18.5 by 24 cm, hardcover, ISBN 0-8359-1226-1, $32.95.

DATABASE FOR THE IBM PC, Sandra L. Emerson and Marcy Darnovsky. Reading, MA: Addison-Wesley, 1984; 336 pages, 19 by 23.5 cm, softcover, ISBN 0-201-10483-0, $14.95.

DIGITAL LOGIC DESIGN: TUTORIALS AND LABORATORY EXERCISES, John F. Passafiume and Michael Douglas. New York: Harper & Row, 1985; 128 pages, 21 by 28 cm, softcover, ISBN 0-06-045028-2, $17.50.

EFFECTIVE DESIGN OF CODASYL DATA BASE, George T. Fadok. New York: Macmillan Publishing, 1985; 160 pages, 16 by 24 cm, hardcover, ISBN 0-02-949530-X, $29.95.

THE FFT: FUNDAMENTALS AND CONCEPTS, Robert W. Ramirez. Englewood Cliffs, NJ: Prentice-Hall, 1985; 192 pages, 18 by 24 cm, hardcover, ISBN 0-13-314386-4, $26.95.

FIRST NIBBLES OF THE APPLE COMPUTER, Melba Bennett. Bowie, MD: Brady Communications, 1985; 288 pages, 21.5 by 28 cm, softcover, ISBN 0-89303-456-8, $17.95.

THE FORTRAN COOKBOOK, 2nd ed., Thomas P. Dence. Blue Ridge Summit, PA: Tab Books, 1984; 238 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1737-X, $11.95.

FROM BASIC TO FORTRAN, Alfred J. Bruey. Blue Ridge Summit, PA: Tab Books, 1984; 144 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1753-1, $9.95.

FUNDAMENTALS OF OPERATING SYSTEMS, 3rd ed., A. M. Lister. New York: Springer-Verlag, 1984; 176 pages, 15 by 23 cm, softcover, ISBN 0-387-91251-7, $13.95.

GETTING STARTED WITH MICROSOFT WORD, Janet Rampa. Bellevue, WA: Microsoft Press, 1984; 312 pages, 19 by 23.5 cm,

(continued)

THIS IS A LIST *of books received at* BYTE *Publications. It 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 all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.*

BOOKS RECEIVED

softcover, ISBN 0-914845-13-6, $16.95.

A Handbook of Software Development and Operating Procedures for Microcomputers, Paul Holliday. New York: Macmillan Publishing, 1985; 208 pages, 16 by 24 cm, hardcover, ISBN 0-02-949510-5, $24.95.

The Hewlett-Packard Software Catalog, Summer 1984, Hewlett-Packard. New York: John Wiley & Sons, 1984; 384 pages, 17.5 by 23 cm, softcover, ISBN 0-471-81912-3, $9.95.

The Human Factor in Computer Crime, Julia Van Duyn. Princeton, NJ: Petrocelli Books, 1985; 168 pages, 16 by 24 cm, hardcover, ISBN 0-89433-256-2, $24.95.

The Illustrated MS/PC-DOS Book, Russell A. Stultz. Dallas, TX: Wordware Publishing, 1985; 224 pages, 19 by 23.5 cm, softcover, ISBN 0-915381-53-2, $15.95.

Inc. Magazine's Databasics: Your Guide to Online Business Information, Doran Howitt and Marvin I. Weinberger. New York: Garland Publishing, 1984; 638 pages, 15.5 by 23 cm, softcover, ISBN 0-8240-7287-1, $16.95.

Interactive Media, Diane Gayeski and David Williams. Englewood Cliffs, NJ: Prentice-Hall, 1985; 240 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-469131-8, $12.95.

Interfacing Your Microcomputer to Virtually Anything, Joseph J. Carr. Blue Ridge Summit, PA: Tab Books, 1984; 336 pages, 13 by 21 cm, softcover, ISBN 0-8306-1890-2, $13.95.

Introduction to Computer Engineering, Franco P. Preparata. New York: Harper & Row, 1985; 336 pages, 16 by 24 cm, hardcover, ISBN 0-06-045271-4, $37.95.

Introduction to Logic Programming, Christopher John Hogger. APIC Studies in Data Processing #21. Orlando, FL: Academic Press, 1984; 296 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-12-352090-8, $46.

Introduction to Robotics: A Systems Approach, James Rehg. Englewood Cliffs, NJ: Prentice-Hall, 1985; 240 pages, 18 by 24 cm, hardcover, ISBN 0-13-495581-1, $29.95.

Introduction to Simulation and SLAM II, 2nd ed., A. Alan B. Pritsker. New York: John Wiley & Sons, 1984; 638 pages, 19.5 by 24 cm, hardcover, ISBN 0-480-20087-1, $29.50.

Introductory Theory of Computer Science, E. V. Krishnamurthy. New York: Springer-Verlag, 1985; 224 pages, 15.5 by 23.5 cm, softcover, ISBN 0-387-91255-X, $15.

The Kaypro Plain & Simple, William Houze and David Lenfest. Blue Ridge Summit, PA: Tab Books, 1984; 208 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1802-3, $12.95.

Learning BASIC on the IBM PCjr, Thomas C. Bartee. New York: Harper & Row, 1985; 384 pages, 18.5 by 23 cm, softcover, ISBN 0-06-040521-X, $14.95.

Logo Fun, Pat Parker and Teresa Kennedy. New York: Scholastic, 1985; 118 pages, 20.5 by 27.5 cm, softcover, ISBN 0-590-33243-0, $5.95.

Mac Multiplan, David Lenfest and Linda K. Woods. Blue Ridge Summit, PA: Tab Books, 1984; 272 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1851-1, $16.95.

Making MS-DOS & PC-DOS Work for You, The Human Connection. Blue Ridge Summit, PA: Tab Books, 1984; 222 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1848-1, $13.95.

Mastering the Commodore 64, Mark Greenshields. Englewood Cliffs, NJ: Prentice-Hall, 1984; 208 pages, 15 by 22.5 cm, softcover, ISBN 0-13-559535-5, $12.95.

Mastering Your Macintosh, William Skyvington. Englewood Cliffs, NJ: Prentice-Hall, 1984; 272 pages, 17 by 23 cm, softcover, ISBN 0-13-559527-4, $15.95.

Microcomputer Programming in BASIC with Business Ap-

PLICATIONS, 2nd ed., George Tsu-Der Chou. New York: Harper & Row, 1985; 316 pages, 18.5 by 23.5 cm, softcover, ISBN 0-06-041298-4, $18.95.

MICROCOMPUTERS IN EDUCATION CONFERENCE: LITERACY PLUS+, Ruth A. Camuse, ed. Computer Science Press, 1984; 480 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-88175-077-8, $35.

MORE FROM YOUR MICRO, Charles Platt. New York: Avon Books, 1985; 192 pages, 10.5 by 17.5 cm, softcover, ISBN 0-380-89529-3, $2.50.

NEW COMPUTER ARCHITECTURES, J. Tiberghien, ed. International Lecture Series in Computer Science. Orlando, FL: Academic Press, 1984; 304 pages, 15 by 23.5 cm, hardcover, ISBN 0-12-690980-6, $28.50.

OMNI COMPLETE CATALOG OF COMPUTER HARDWARE AND ACCESSORIES, Owen Davies, ed. New York: Macmillan Publishing, 1984; 352 pages, 21 by 28 cm, softcover, ISBN 0-02-008300-9, $13.95.

OMNI ONLINE DATABASE DIRECTORY 1985, Owen Davies and Mike Edelhart. New York: Macmillan Publishing, 1984; 336 pages, 21 by 27.5 cm, softcover, ISBN 0-02-079920-9, $14.95.

1001 THINGS TO DO WITH YOUR APPLE, Mark R. Sawusch and Tan A. Summers. Blue Ridge Summit, PA: Tab Books, 1984; 256 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1816-3, $9.95.

1001 THINGS TO DO WITH YOUR MACINTOSH, Mark R. Sawusch and Tan A. Summers. Blue Ridge Summit, PA: Tab Books, 1984; 250 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1846-5, $9.95.

PC TELEMART/VANLOVES IBM SOFTWARE DIRECTORY, Xerox Corporation. New York: R. R. Bowker Co., 1984; 966 pages, 21.5 by 27.5 cm, softcover, ISBN 0-8352-1969-0, $24.95.

POWERFUL PROJECTS WITH YOUR TIMEX/SINCLAIR, Jim Stephens. Glenview, IL: Scott, Foresman and Co., 1985; 238 pages, 19 by 23 cm, softcover, ISBN 0-673-18038-7, $12.95.

PRACTICAL PROGRAMMING IN PASCAL, Kent Porter. New York: New American Library, 1984; 272 pages, 18.5 by 23.5 cm, softcover, ISBN 0-452-25568-6, $14.95.

PROBLEM SOLVING WITH FORTRAN, Richard W. Dillman. New York: Holt, Rinehart and Winston, 1985; 368 pages, 16 by 23.5 cm, softcover, ISBN 0-03-063734-1, $22.95.

READY TO RUN ACCOUNTING WITH LOTUS 1-2-3 & SYMPHONY, William Urschel. Sherman Oaks, CA: Alfred Publishing Co., 1984; 226 pages, 21.5 by 27.5 cm, softcover, ISBN 0-88284-330-3, $39.95. Includes floppy disk.

RESUMES FOR COMPUTER PROFESSIONALS, Arthur R. Pell and George Sadek. New York: Simon & Schuster, 1984; 128 pages, 21 by 28 cm, softcover, ISBN 0-671-50338-3, $7.95.

ROBOTICS AND ARTIFICIAL INTELLIGENCE, M. Brady, L. A. Gerhardt, and H. F. Davidson, eds. New York: Springer-Verlag, 1984; 722 pages, 17 by 24.5 cm, hardcover, ISBN 0-387-12888-3, $62.50.

SCHOOL & HOME GUIDE TO THE IBM PCJR, E. Murdock and S. Sudbury. Englewood Cliffs, NJ: Prentice-Hall, 1985; 208 pages, 18 by 24 cm, hardcover, ISBN 0-13-793654-0, $21.95.

SOFTWARE LIFECYCLE MANAGEMENT: THE INCREMENTAL METHOD, William C. Cave and Gilbert W. Maymon. New York: Macmillan Publishing, 1984; 192 pages, 16 by 24 cm, hardcover, ISBN 0-02-949210-6, $27.95.

SOLVING ELLIPTIC PROBLEMS USING ELLPACK, John R. Rice and Ronald F. Boisvert. New York: Springer-Verlag, 1985; 512 pages, 16 by 24 cm, hardcover, ISBN 0-387-90910-9, $46.50.

TECHNIQUES OF EDP PROJECT MANAGEMENT: A BOOK OF READINGS, Alan E. Brill, ed. New York: Yourdon Press, 1984; 312 pages, 17.5 by 25.5 cm, softcover, ISBN 0-917072-42-1, $29.

TIM HARTNELL'S EXECUTIVE GAMES FOR THE IBM PC & XT, Tim Hartnell. New York: Ballantine Books, 1984; 312 pages, 15 by 22.5 cm, softcover, ISBN 0-345-31940-0, $9.95.

USING AND PROGRAMMING THE ADAM, Timothy Orr Knight. Blue Ridge Summit, PA: Tab Books, 1984; 128 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1706-X, $7.95.

USING SMALL COMPUTERS TO MAKE YOUR BUSINESS STRATEGY WORK, Richard M. Koff. New York: John Wiley & Sons, 1985; 408 pages, 15 by 23 cm, softcover, ISBN 0-471-87502-3, $19.95.

VISICALC MADE SIMPLE, Thomas M. O'Donovan. New York: John Wiley & Sons, 1984; 168 pages, 16.5 by 24.5 cm, softcover, ISBN 0-471-90457-0, $18.95.

THE WILEY SCIENCE CALENDAR, 1985. New York: John Wiley & Sons, 1985; 168 pages, 20.5 by 26 cm, hardcover, ISBN 0-471-87849-9, $16.95.

WORD PROCESSING ON THE IBM DISPLAYWRITER, J. M. Williford. New York: John Wiley & Sons, 1984; 144 pages, 21 by 28 cm, softcover, ISBN 0-471-88256-9, $14.95.

WORD PROCESSING ON WANG SYSTEMS, J. M. Williford. New York: John Wiley & Sons, 1984; 130 pages, 21 by 28 cm, softcover, ISBN 0-471-88258-5, $14.95.

WORD PROCESSING ON THE XEROX 860, J. M. Williford. New York: John Wiley & Sons, 1984; 112 pages, 21 by 28 cm, softcover, ISBN 0-471-88257-7, $14.95.

WORKING WITH 1-2-3 ON THE IBM PC AND COMPATIBLES, Richard Startz. New York: Harper & Row, 1985; 144 pages, 18.5 by 23.5 cm, softcover, ISBN 0-06-046426-7, $14.95. ■

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Conducted by Sol Libes

Watch out Commodore and Atari. IBM is rumored to be working on a low-end consumer computer to be sold as a mass-market machine. It is believed to be Z80-based; employ the Microsoft MSX operating system; and include ROM application packages, a built-in disk drive, and a port for a read-only laser-disk unit. IBM is reportedly aiming at a $300 list price. . . . Ashton-Tate is reported to be working on a Macintosh version of its Framework integrated software package, which might be out by the time you read this. . . . Zenith is said to be negotiating with Morrow Inc. to distribute the portable Pivot IBM PC-compatible computer under its own name. . . . Expect IBM to bring out a System/36 board for the PC AT and call the system the AT/36. The System/36 is IBM's lowest-cost office minicomputer system. The pricing of the AT/36 is expected to be in the $10–15,000 area . . . . Intel is expected to finally start shipping "samples" of its 80386 32-bit microprocessor in August, more than a year behind Motorola (68020) and National Semiconductor (32000). . . . The 64K-bit RAM chips, which were selling in the $3 range, now cost less than $2 in quantity as IBM canceled orders for more than 1.5 million chips. . . . Zilog has pushed back introduction of its Z800 microprocessor (an upgraded Z80) to this summer. The company had announced the unit about three years ago. Hurry up, the window is closing fast! And don't expect Zilog's Z80000 32-bit microprocessor to be released until the fall, at the earliest. . . . Boeing is reportedly testing pilot-voice command recognition, instead of switches, for the 747. . . . Digital Equipment Corporation is rumored to be testing the desktop Microvax III, an eight-chip version of the VAX-11/780 (its big system) for introduction next year. . . . Prices of 1200-bps modems are dropping as the market reaches the saturation point and 2400-bps units begin arriving. Many purchasers are holding off, waiting to see if the 2400-bps units take hold. . . . Texas Instruments and Radio Shack are reported to be getting ready to implement Digital Research's GEM (Graphics Environment Manager) on systems they will be announcing soon. Atari and ACT have already declared their intention to use it on new systems. GEM creates a color Macintosh-like environment.

Osborne and Franklin Exit Chapter 11

Hurrah! With the way IBM and Apple have been pushing competitors out of the business, it is terrific to see two companies return from bankruptcy proceedings. Osborne and Franklin were both reorganized, have straightened out their operations, worked out arrangements with their creditors, and got some financing. Both are now active and in there competing again. Give them three cheers and some support.

Osborne has released two new systems, which reportedly are selling well, primarily overseas. Franklin is promising to release a new system shortly.

It Was a Very Good Year

For many manufacturers, 1984 was a very good year. Future Computing, a Texas-based market research firm, reports the following sales for the 15 industry leaders (reported in millions of dollars):

IBM	$2750
Apple	710
Tandy	420
Compaq	300
Hewlett-Packard	260
Wang	250
DEC	240
Zenith	210
Kaypro	110
Sperry	90
Altos	90
TeleVideo	90
Texas Instruments	90
Corona	80
Epson	80

If someone had told me five years ago that in 1984 one company would do $2.75 billion in personal computer sales, I would have said they didn't know what they were talking about. Boy, would I have been wrong.

IBM Update

IBM has begun cracking down on dealers who resell PCs to nonauthorized dealers—the so-called "gray market." In an effort to control this practice, IBM canceled 40 of its value-added retailers and instituted a policy of prohibiting lateral shipping among dealers without its approval. The net effect will no doubt be a decrease in selling of systems at discount prices by non-IBM dealers.

IBM was blamed for stimulating the gray market by forcing dealers to order large volumes of machines with lead times that many dealers call ridiculous.

IBM is expected to reduce the prices of the IBM PC and IBM PC XT once again as some reports indicate that IBM has warehouses full of these products. In the meantime, an enhanced version of the PC AT is expected in the late summer. IBM has begun shipping XENIX (UNIX System III), which turns the PC AT into a three-user timesharing system. Several companies are introducing plug-in cards that allow XENIX with a 40-megabyte disk to handle up to 16 users.

Computers for Vision-Impaired Users

Maryland Computer Services, Forest Hill, MD, reports that it has taken a Hewlett-Packard HP 150 and enhanced it for use by blind computer users. The computer now speaks any information appearing on its screen, allowing blind users to create and manipulate material. The system was created with the aid of several blind engineers and programmers. A separate keypad enables the user to review material a word, line, or screen at a time; change the speech rate; and even announce screen enhancements such as underlining and boldface. An optional braille printer and software for blind users are also available.

NEC has also introduced a version of its personal computer in Japan that operates as a Japanese-language word processor with braille output. (This computer is distributed by the Y.D.K. Co. and the Vocational Development Center for the Blind in Tokyo.)

Apple Bytes and Pits

Word is that sales of the Macintosh have flattened out and that even Apple's offering to lend a Mac overnight to prospective purchasers was not a tremendous success. Looks like people are waiting for the software that will take advantage of the Mac's hardware and operating system. At the end of 1984, Apple claimed that there were some 300 Mac software packages, but many of these existed only in demo form, as far as I can tell.

Apple shipped about 275,000 Macs in its first year, less than was promised, but more than IBM shipped in the first year of the PC (fewer than 100,000). But by the end of IBM's first year with the PC, several hundred software packages were available. This was due mainly to the fact that IBM had three different operating systems for the PC (PC-DOS, CP/M-86, and the p-System) that already had application software available or that could be easily translated from 8-bit versions of the operating systems.

The Mac being such a radical departure from preceding products and its being a very powerful and sophisticated programming environment have delayed software developers. Apple's promised stand-alone development software is still not available, and the 3½-inch 800K-byte double-sided floppy disk announced last year has still not appeared.

The street price of the Mac has already dropped to less than $1400 for 128K bytes and less than $1900 for 512K bytes. More price cuts are expected shortly.

Also, reports have surfaced of interface problems encountered by outside vendors attempting to connect hard-disk drives to the Mac. The problem appears to be in the Mac's ROM, and there is talk of a new version of the ROM for systems using hard-disk drives.

There are rumors of the "SuperMac" in development, based on the 68020, Motorola's true 32-bit chip. It should have true DMA capability, multitasking ability, a color screen, and a bus for plug-in components. There are also rumors of the "FlatMac," a portable Mac using a CMOS 68000 chip, flat display, 3½-inch drive, and internal battery. Expect at least one of these products to be announced at the next Apple stockholders meeting in January. Apple is known to be evaluating a new 5-megabyte 3½-inch Sony floppy-disk drive for use on the Mac that can also read and write the present 400K-byte disk format.

The Apple IIe is also due for an upgrade to use the same internal circuitry as the IIc with 128K bytes (expandable to 512K bytes) of RAM. This will soup up its operation. An 8-/16-bit microprocessor chip is expected as an option. The case should remain essentially the same. Expect it to be promoted as an office machine, and the cost of the IIe and IIc machines should be cut.

Almost a year after Apple announced and demonstrated the flat display for the IIc, it began shipping the unit. This display, in effect, converts the IIc into a portable machine, if you also buy the carrying case. Just one problem—Apple does not have battery power for the IIc. However, you can buy battery units for the IIc from the following two companies: Power Systems, Wayzata, MN, and Discwasher of Columbia, MO.

While on the subject of the Apple, it is reported that it sold 430,000 IIs in the first quarter of fiscal 1985 and that the II accounts for nearly 85 percent of Apple's hardware sales. Also, some rumors say that Apple will change to 3½-inch drives on the II later this year. The company is expected to offer both single- and double-sided quad-density drives storing up to 800K bytes per drive. Apple hopes that this will put the II in a "business product" class.

Is the PC Window Really Open?

Windowing software for the IBM PC is available, but acceptance in the marketplace still appears to be far off because of a lack of application software to utilize windows. The problem is that software developers are unsure of which way to go and a huge investment in time and money to develop windowing versions of their software is required. IBM's Topview is out but of limited capability, and rumors say that Topview-II is just around the corner. Digital Research has decided not to directly market its powerful Macintosh-like GEM package but will rather sell it to OEMs. GEM software-development packages were delivered to software developers in February. Microsoft has been demonstrating Windows for nearly two years and has also shipped software-development packages. The final product is expected to be out this month.

Once software developers make a decision on how to proceed, it generally takes them a year to create a product, debug it, and get it to the marketplace. Since Topview, GEM, and Windows are all different from the software developers' point of view, many are sitting on the fence waiting to see which product will succeed. By this time next year, we should all know the answer.

The Housekeeping Computer

Mitsubishi and General Electric will shortly introduce home-management computers. The Mitsubishi machine, using a proprietary bus, will link sensors, appliances, telephone, alarm, temperature control, and entertainment systems to a distributed programmable microprocessor control system. The Mitsubishi home-management system is already being sold in Japan and is expected to reach our shores next year.

GE will soon introduce a system based on the BSR X-10 wireless system (which has been out since 1979, sans computer). Although not as powerful as the Mitsubishi system, it will control lights, appliances, heating, and cooling. GE has added graphics software and circuitry to use a television as a monitor and a hand-held remote-control unit to control devices.

BSR already sells a software package to enable the Radio Shack Color Computer to communicate with the X-10 system. PCjr, Apple IIc, and Commodore 64 packages are expected to appear within a short period of time.

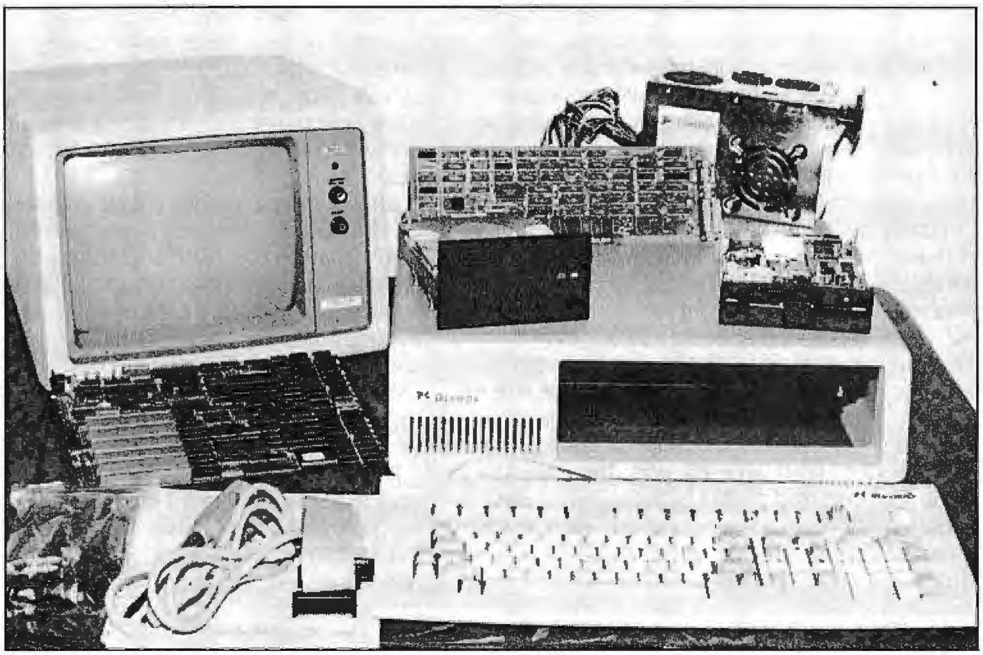
And the Electronics Industry Association has a committee working on the development of a consumer electronics bus (CEB), with participation from approximately 50 companies.

Random Bits

The Commerce Department recently released a competitive impact study on the world software market that found the U.S. in very good shape vis-à-vis foreign competition. They found that the U.S. held about 70 percent of the world's software market with a dollar volume 10 times greater than either Japan or France, its nearest competitors. . . . Future Computing contends that 50 percent of all personal computer software has been pirated (unauthorized use of backup copies). This is based on 45,000 responses from a mailing to 70,000 households. . . . AT&T is promising initial shipments of 1-megabit memory chips early next year. IBM, Toshiba, NEC, and Fujitsu are also working on 1-megabit devices with production promised for 1987. ■

BYTELINES, *news and speculation about personal computing, is conducted by* Sol Libes, *the author of numerous books and articles on computers. He is the founder of the* Amateur Computer Group *of* New Jersey *and a coorganizer of the* Trenton Computer Fair. *He edits and publishes* Micro/Systems Journal, *a bimonthly publication for system programmers and integrators. He can be contacted c/o* BYTE, POB 372, *Hancock,* NH 03449.

NEW SYSTEMS



The FD-1000 *kit for building an* IBM PC XT-*compatible computer.*

PC XT-Compatible in a Kit

PC Designs' FD-1000 kit lets you build a computer that is compatible with the IBM PC XT. The FD-1000 uses an 8088-2 microprocessor with a 4.77- or 8-MHz clock speed. It features up to 1 megabyte of on-board RAM, one parallel and two serial ports, a clock/calendar with battery backup, a hardware reset button, Princeton Graphic Systems' amber monochrome monitor, and all necessary cables. Two 360K-byte floppy-disk drives and a built-in floppy-disk controller are standard.

The FD-1000 supports PC-DOS, MS-DOS, CP/M-86, Concurrent DOS, and an optional 8087-2 math coprocessor. It also has five expansion slots and 52K bytes of user-definable ROM for custom applications. Available enhancements include a 10-megabyte low-power internal Winchester disk drive, the internal tape backup for the hard disk, and a color monitor.

The FD-1000 costs $1650 in its standard configuration and $2250 with an internal 10-megabyte Winchester drive. Contact PC Designs, 8238 South Gary, Tulsa, OK 74137, (918) 481-1734.
Inquiry 615.

Kaypro's 16

Kaypro recently introduced the IBM PC XT-compatible model 16. The Kaypro 16 uses an 8088 processor. It comes with 256K bytes of RAM (expandable to 640K bytes), a 10-megabyte hard-disk drive, a 360K-byte floppy-disk drive, and a green-phosphor monitor.

Several software packages come bundled with the Kaypro 16, including WordStar, MailMerge, InfoStar +, CalcStar, MITE telecommunications, MS-DOS with utilities, and GW-BASIC.

The Kaypro 16 is priced at $3295. Contact Kaypro Corp., POB N, Del Mar, CA 92014, (619) 481-4300.
Inquiry 616.

MultiUser-16 Computer System

Inner Access Corporation's MultiUser-16 has time-sharing and multitasking capabilities. It uses the Motorola 68000 processor running at a clock speed of 8 MHz; the 68010 processor is also available as an option. The system supports 8 users but expands to accommodate 64 users.

The MultiUser-16 has 2.76 megabytes of floppy-disk storage and ½ megabyte of memory expandable to 16 megabytes. You can expand the standard 40 megabytes of hard-disk storage with voice-coil seek to 1 gigabyte. The motherboard has eight slots. Included with the system is the Mirage multiuser, multitasking operating system.

Suggested retail price for the MultiUser-16 is $13,495. Contact Inner Access Corp., 517K Marine View, Belmont, CA 94002, (415) 591-8295.
Inquiry 617.

DEC Offers Rainbow 190

Digital Equipment Corporation's Rainbow 190 is compatible with the rest of the Rainbow family. It includes a 10-megabyte hard-disk drive, 640K bytes of memory, a monochrome monitor, and a DEC Gold Key keyboard. The 190's technical character set ROMs contain 96 letters and symbols for scientists and engineers.

Three software packages come with the Rainbow 190: MS-DOS 2.11, WPS-Plus/Rainbow, and Rainbow Office Workstation. WPS-Plus/Rainbow is compatible with the word processors offered on DECmate and VAX systems. Rainbow Office Workstation integrates Rainbow functions with VAX and All-in-1 environments.

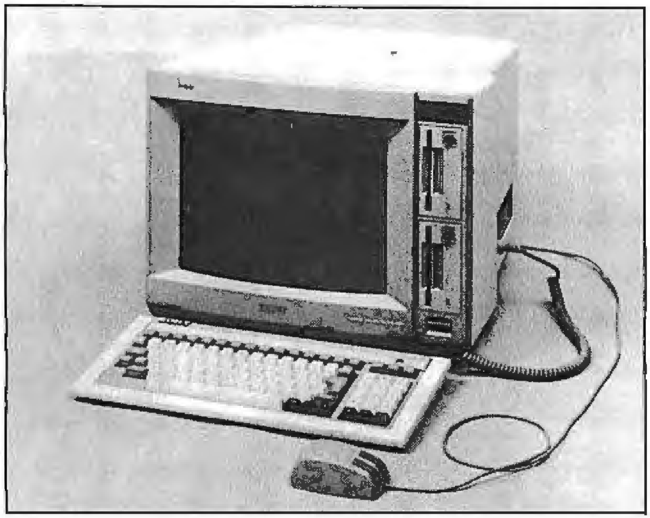
Single-quantity price for the Rainbow 190 system is $6495. The manufacturer expects the system to be available in July. Contact Digital Equipment Corp., Maynard, MA 01754, (800) 344-4825.
Inquiry 618.

NEW SYSTEMS

KTX-1350N Videotex Workstation

The KTX-1350N from Sony lets you interface with NAPLPS and ASCII databases. In addition, you can use the unit to display composite-video signals such as output from video cameras, videodisc players, and videocassette recorders, as well as high-quality RGB signals from computer graphics systems.

This videotex system features a built-in NAPLPS decoder, a 13-inch diagonal Trinitron color monitor, two standard RS-232C communication ports, Centronics and Video/Graphic Printer ports, dual 3½-inch microfloppy-disk drives, and a full-size detachable keyboard. The KTX-1350N's setup and operation are menu-driven.



Sony's KTX-1350N *videotex system.*

You can select a system communication rate from 75 to 19,200 bps.

Graphics on the workstation are 256 by 210 pixels. The display can use up to 16 colors simultaneously from a 2048-color palette. You can also choose a split-screen display feature.

MS-DOS and a 25-pin connector for RGB superimpose capability come with the KTX-1350N. CP/M-86 is an option. The KTX-1350N is designed to work with Sony's MDM-1200 Telephone Modem and UP-103 Video/Graphic Printer.

Suggested list price for the KTX-1350N Videotex Workstation is $3750. Contact Sony Communications Products Co., Sony Corp. of America, Sony Dr., Park Ridge, NJ 07656, (201) 930-6432.
Inquiry 619.

PERIPHERALS

UDS Series of FasTalk Modems

Universal Data Systems has bundled SignOn communications software with its line of FasTalk modems. The models available include FasTalk 300, a stand-alone 300-bps modem; FasTalk 1200, a stand-alone 300/1200-bps modem; and FasTalk 1200PC, a 300/1200-bps plug-in card modem for the IBM PC and compatibles.

All models are Hayes-compatible. The modems feature auto-dial/auto-answer, automatic selection of pulse- or tone-dialing modes, a talk/data toggle, a built-in audio speaker, and true call-progress detection.

The list price for FasTalk 300 is $345; FasTalk 1200 and FasTalk 1200PC are $525 each. Contact Universal Data Systems, 5000 Bradford Dr., Huntsville, AL 35805-1953, (205) 837-8100.
Inquiry 620.

Priam Hard Disk for the AT

InnerSpace is a 5¼-inch add-in disk-drive kit that enhances the IBM PC AT's storage capacity. The kit includes hardware, cables, installation software, instruction manual, and reference guide. InnerSpace is available in the ID40-AT version, a 43-megabyte drive, and the ID60-AT version, a 60-megabyte drive. Both models access data at about 30 milliseconds.

InnerSpace protects data by providing automatic defect management and guards against data loss with a dedicated head-landing zone, shock mounts, and spindle and head locks.

The ID40-AT is priced at $2195, and the ID60-AT costs $2595. Contact Priam Corp., 20 West Montague Expressway, San Jose, CA 95134, (408) 946-4600.
Inquiry 621.

IEEE-488 Interface for the Macintosh

IOtech's Mac488A can communicate at up to 57,600 bps. It lets you interface more than 4000 different instruments to the Macintosh. The unit is compatible with all languages that can access the Mac's serial port.

Bus commands and protocol for the Mac488A are the same as those used by Hewlett-Packard computers. High-level commands are sent from the Macintosh serial port to the Mac488A. The interface unit's microprocessor interprets the commands and controls the bus.

With the power supply, manual, and 12-foot cable, the Mac488A costs $595. Contact IOtech Inc., POB 21204, Cleveland, OH 44121, (216) 831-8646.
Inquiry 622.

HP-Compatible Series 8000 Disk Subsystems

Bering Industries' Series 8000 line of hard disks comprises 12 models with storage capacities from 10.4 to 70.4 megabytes. A 3½-inch double-sided floppy-disk drive with a formatted capacity of 788K bytes is available as a built-in option.

The Series 8000's Opt. 7xx multiport configurations let two or three computers access a common disk drive

(continued)

PERIPHERALS

and share files. A dedicated and a shared disk area at each port support the basic features of a local-area network. The configuration is set up by using standard HP-IB/GPIB cables in a cluster.

This disk subsystem implements HP's CS/80 and Subset/80 disk-drive command sets. It works with HP technical and business computers, development systems, and personal computers such as the Touchscreen, Portable, and Integral.

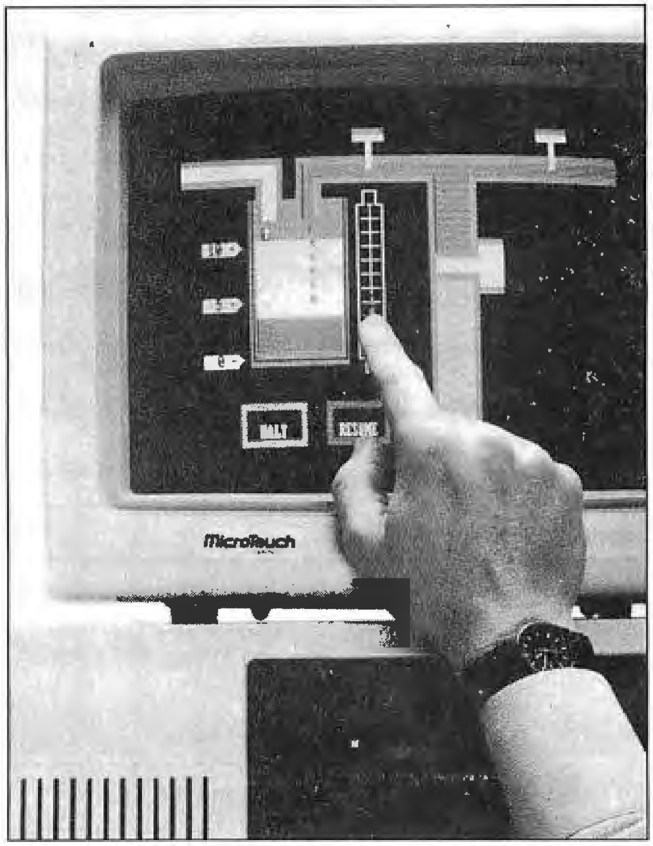
Prices for the Series 8000 range from $1790 for a 10-megabyte subsystem to $6090 for a 70-megabyte subsystem. The floppy-disk option costs $300. A two-port disk-sharing option is $980 and a three-port option is $1280. Contact Bering Industries Inc., 1400 Fulton Place, Fremont, CA 94539, (415) 651-3300.
Inquiry 623.

MicroTouch Screen with Glass Sensor

MicroTouch Systems uses a solid glass sensor as the basis for its continuous touchscreen. The MicroTouch Screen has a resistive coating bonded to the surface of its glass overlay. The glass surface allows transmission of up to 85 percent of the display light.

The MicroTouch Screen has a resolution of 256 by 256 touch points. An intelligent controller transmits touch data over an RS-232C serial line to the host computer.

The manufacturer produces the screen in 12-, 13-, and 19-inch sizes. Single-quantity cost for the 13-inch size is $995. Contact MicroTouch Systems Inc., 400 West Cummings Park, Woburn, MA 01801, (617) 935-0080.
Inquiry 624.



The MicroTouch Screen.

Tandy 1000 Hard-Disk Upgrades

Osicom has introduced a line of hard-disk upgrade products for the Tandy 1000. Fixed-disk drives for internal installation come in 10- and 20-megabyte configurations. External drives are available with 10-, 20-, and 30-megabyte capacities.

Each upgrade package contains the drive hardware, a controller card, cables, and the manual. After installation, your 1000 will boot directly from the hard-disk drive once you load DOS from a floppy disk.

Suggested list price for the internal drives is $999 for 10 megabytes of storage and $1199 for 20 megabytes. The external drives cost $1009 for the 10-megabyte version, $1229 for 20 megabytes, and $2239 for 30 megabytes. Contact Osicom Inc., Suite 300, 18 Bank St., Morristown, NJ 07960, (800) 922-0881; in New Jersey, (201) 540-0144.
Inquiry 625.

40-Megabyte Hard Disk for AT&T UNIX PC

Bell Technologies has developed the B40, a 40-megabyte hard-disk drive for AT&T's UNIX PC system. The B40 fits inside with no modifications. It has an average access time of 85 milliseconds.

Users can trade in their existing drives for a $300 refund for 10-megabyte units and $500 for 20-megabyte units. The B40 sells for $2995. Contact Bell Technologies Inc., POB 8323, Fremont, CA 94537, (415) 792-3646.
Inquiry 626.

Multi-User Disk Server for IBMs and Apples

The Multi-User Disk Server from Space Coast Systems lets Apple II+, IIe, and III, IBM PC, and PC XT users share the same hard-disk subsystem. With this unit, eight computers can use a 10- to 84-megabyte Space Coast Systems Storage Module. An extender unit allows connection of eight more computers.

The Multi-User Disk Server requires no communications software and is compatible with several multiuser software packages, including Great Plains accounting software, WOSbase database, Omnius 1-2-3, and SunData bulletin-board communications systems.

Retail pricing for the Multi-User Disk Server is under $2000. Contact Space Coast Systems Inc., 301 South Washington Ave., PO Drawer 2767, Titusville, FL 32781-2767, (305) 268-0872.
Inquiry 627.

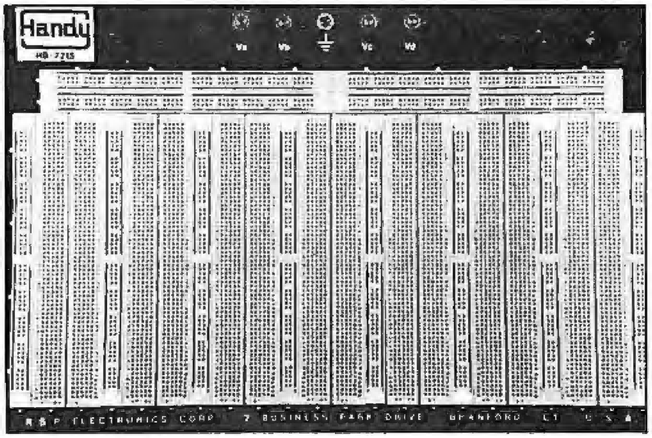
ADD-INS

Solderless Breadboard

The HB-7215 Titan solderless breadboard from Handy Products has enough space for you to build a complete computer. It features a 63 14-pin IC capacity of 48 distribution strips and 5680 plug-in tie points.

When your paper design is complete, you don't need soldering to insert ICs, diodes, transistors, DIP switches, LED/LCD displays, capacitors, resistors, and other components. Board markings code the component positions. You interconnect components with #22–24 AWG solid hookup wire, and you can test the board by plugging in your oscilloscope, power supply, frequency meter, signal generators, and so on.

The HB-7215 Titan is available for $129.95. Contact Handy Products, 7 Business Park Dr., POB 699, Branford, CT 06405, (800) 344-2639.
Inquiry 628.



The HB-7215 *Titan solderless breadboard.*

ATI-1000 AT-Compatible Motherboard

ATronics International's ATI-1000 motherboard is compatible with the IBM PC AT. It has up to 640K bytes of main memory expandable to 16 megabytes; 1 megabyte of on-board memory is optional. Its 64K bytes of system ROM/EPROM is expandable to 128K bytes.

Other hardware features include the Intel 80286 processor (the 80287 is optional), eight I/O slots, three programmable timers, a 6- to 8-MHz clock, seven-channel direct memory access, an on-board battery, and a speaker attachment.

Suggested retail price for the ATI-1000 is $1995. Contact ATronics International Inc., POB 296, Mount Eden, CA 94557-0296, (415) 538-2844.
Inquiry 629.

Multifunction Memory Card for Tandy 1000

The 4NI-1000 card from Micro Mainframe lets you add up to 512K bytes of memory to your Tandy 1000, provides DMA capability, and includes an RS-232C serial card. The 4NI-1000 also accepts optional real-time clock and mouse modules. This multifunction card uses only one of the Tandy 1000's expansion slots.

You can purchase the basic 4NI-1000 with 0K bytes for $259.95, with 128K bytes for $309.95, with 256K bytes for $469.95, or with 512K bytes of RAM for $649.95. Contact Micro Mainframe, 11285-E Sunrise Gold Circle, Rancho Cordova, CA 95670, (916) 635-3997.
Inquiry 630.

3 Megabytes of RAM on the IBM PC AT

Emulex's Mega Memory board provides up to 3 megabytes of RAM for the IBM PC AT. It fits into any of the AT's 16-bit slots. The board has a total of six banks, representing 12 rows, that you can populate with 64K- or 256K-byte chips depending on your AT's configuration.

Mega Memory comes standard with two software packages: Wait-Less Printing, a print spooler, and Insta-Drive, a RAM-disk emulator.

List price for Mega Memory ranges from $395 for 0K bytes of RAM to $5495 for 3 megabytes. Contact Emulex Corp., 3545 Harbor Blvd., POB 6725, Costa Mesa, CA 92626, (714) 662-5600.
Inquiry 631.

Controller for Floppy- and Hard-Disk Drives

The Xebec S1220 single-board controller eliminates the need for separate floppy- and hard-disk controllers. It plugs into a full-length I/O slot in the IBM PC, XT, and compatibles. The unit will support up to two 5¼-inch floppy-disk drives or two 5¼-inch fixed-disk drives. It has a drive transfer rate of 5 megabits per second.

The S1220 has a microprocessor-based architecture, full-sector buffer, and automatic seek and position verification. Its programmable features include sector interleave, sector size, and auto-initialize on power-up or restart for floppy and hard drives.

The S1220 Integrated Hard/Floppy Disk Controller costs $295. Contact Xebec, 3579 Highway 50 E, Carson City, NV 89701, (800) 982-3232.
Inquiry 632.

Color Computer Data-Acquisition System

The Data Gatherer from Green Mountain Micro is a 16-channel, 12-bit data-acquisition system with an on-board clock/calendar and parallel printer port. The system is designed for use with Tandy's TRS-80 Color Computer, TDP-100, or Color Computer 2.

A ROM-based operating system lets you program in Extended Color BASIC. The Data Gatherer is intended for economical testing and measurement, sensing, monitoring, robotics, laboratory control, and music synthesis.

The Data Gatherer sells for $330 assembled and $220 in kit form. The manual is available separately for $15. Complete with 64K-byte computer, the system costs $550. Contact Green Mountain Micro, Bathory Rd., Roxbury, VT 05669, (802) 485-6112.
Inquiry 633.

(continued)

SOFTWARE • APPLE

Graph Numeric Data on the Macintosh

With Engineering Tool Kit (ETK), you can use a Macintosh to record numeric engineering data, translate this data into graphics forms, and generate statistical reports. The types of graphs you can make include trend charts, scatter plots, and histograms (with optional best-fit curves). You can plot a maximum of 200 points and print out the statistics that go with those graphs.

Functions provided are multiple linear regression and analysis of variation reports (correlation coefficients, standard error of estimate, F-ratio, degrees of freedom, standard deviation, and other statistics). ETK also has a scientific calculator with logarithmic, arithmetic, and trigonometric computation capabilities.

The Engineering Tool Kit runs on either the 128K or 512K Mac with single or dual drives. Microsoft BASIC 2.0 is required. List price is $99. An Apple II version lists at $59. Contact SofTools, POB 8751, Boise, ID 83702, (208) 343-1437.
Inquiry **634**.

LISP Development Environment for Mac

Available as a complete workstation or a standalone software package, ExperLisp brings a LISP environment to the Macintosh 512K. The program, a complete implementation of LISP, provides access to the Mac toolbox, compiles directly to MC68000 machine code, and has three-dimensional and spherical graphics capabilities.

An ExperLisp Workstation includes the software and a Macintosh XL with up to 4 megabytes of RAM and a 10-megabyte hard-disk drive. Workstations configured with 2 megabytes of RAM cost less than $7000.

The software alone costs $495. You need an external disk drive to run it. Contact ExperTelligence Inc., 559 San Ysidro Rd., Santa Barbara, CA 93108, (805) 969-7874.
Inquiry **635**.

Demographics on a Disk

What's the ratio of women to men in Baltimore? How many Vietnam veterans live in New Hampshire? How many people voted against the winner of the 1980 Presidential election?

Answers to these questions, as well as other demographic data, are available from People in Places, an information program for the Macintosh. The package contains figures from the 1980 U.S. Census relating to population, income, employment, housing, businesses, and vital statistics. You can have information listed or displayed on maps or graphs. Data is presented for each state and region, urban counties and rural areas, and the Census Bureau's metropolitan statistical areas. Some subjects have comparative data from 1970 and 1960.

People in Places sells for $35. Contact Data & Information Software Co., Suite 1633, 235 Montgomery St., San Francisco, CA 94104, (415) 391-7670.
Inquiry **636**.

Talking Apple II

For less than $40, you can give voice to your BASIC programs on an Apple II. Speak Up is a voice-synthesizer package that requires no additional hardware and packs a text-to-speech converter into 7K bytes. You can embed the utility into your programs or use it alone to pronounce the text you type.

Speak Up has a suggested retail price of $39.95. For details, contact Educational Micro Inc., 1926 Hollywood Blvd., Hollywood, FL 33020-4524, (305) 920-2222 ext. 620.
Inquiry **637**.

Mac Communications Package

Dow Jones Information Services and Prentice Corporation have developed a complete communications package for the Macintosh. Called M125, the package includes Straight Talk, a POPCOM X100 modem, phone cables, and a modem-to-Mac cable.

Straight Talk communicates with Macs and provides access to Dow Jones News/Retrieval, The Source, CompuServe, and other services. It also supports MacWrite, MacPaint, and other Mac conventions.

The POPCOM modem has a feature that automatically sets modem switches, determines which cables to use, and locates the proper phone network. The modem also has an auto-voice feature.

M125 retails for $495. For more information, contact Prentice Corp., 266 Caspian Dr., POB 3544, Sunnyvale, CA 94088-3544.
Inquiry **638**.

Mac Cross-Compiler

Pterodactyl Software's PCMacBASIC cross-compiler creates Macintosh programs from BASIC source code using the Pascal Workshop and Mac Supplement on a Lisa. The programs run on a Mac or Mac XL. Two configuration tables in the Resource file, one for each machine type, control memory allocation and screen parameters. They can adjust for screen and memory size and compensate for rectangular pixels.

Features include multiple windows that update automatically, Dialog and Alert boxes configured in the Resource file, sequential or random disk files, and an extended CALL statement that accesses Pascal procedures and functions.

PCMacBASIC includes a run-time license and sells for $1000.

Pterodactyl has also released PC BASIC Compiler, which has a syntax compatible with BASICA on the IBM PC but also includes extensions. It generates assembly language and an EXEC file to automatically assemble and link. You can call Pascal, assembly-language, and Quickdraw subroutines from BASIC. The compiler is available for the Lisa in several versions. A protected compiler (unprotected run time for one machine) is $250. With a run-time license, the price is $750. A cross-compiler that runs on the Lisa and creates programs for the Mac costs $1000, including a run-time license.

Contact Pterodactyl Software, 200 Bolinas Rd. #27, POB 538, Fairfax, CA 94930, (415) 485-0714.
Inquiry **639**.

SOFTWARE • APPLE

Mockingboard Enhancements

Sweet Micro Systems has released three packages for its Mockingboard synthesizers. These programs let Mockingboard users create customized speech, speak in three European languages, and access these capabilities through BASIC.

Speech Development System (SDS) lets you add or delete phonemes and manipulate the six variables associated with each phoneme. These variables include inflection, rate of speech, amplitude, filter frequency, rate of articulation transition, and rate of inflection transition. SDS costs $39.95.

Foreign Language Rule Tables (FLRT) provides the basis for converting text into speech. The vendor has developed a set of rules that, when used with the Text to Speech Algorithm, enables the computer to speak in French, German, or British English. You can use these rules alone or incorporate them into programs that teach foreign languages or are used for translation purposes. FLRT, which can be used in conjunction with SDS, retails for $24.95.

Developers' Toolkit contains utility programs to facilitate development of music, sound, and speech software. Rule Editor lets you print the rule table on any printer. It works with Mockingboards B, C, and D. A new version of the Text to Speech Algorithm accesses a rule table located above the normal 48K-byte memory, giving you more room in which to place other program code. It also works with Mockingboards B through D. Ampermock is an ampersand utility designed to simplify incorporation of sound and speech in BASIC programs. It works with Mockingboards A through D. The toolkit, which retails for $29.95, contains five other programs.

Contact Sweet Micro Systems Inc., 50 Freeway Dr., Cranston, RI 02920, (401) 461-0530.
Inquiry 640.

SOFTWARE • CP/M/MS-DOS

Program for Programmers

FABS (Fast Access B-tree Structure) Plus is an assembly-language program module designed to maintain key files for quick data retrieval in large files. The package has an auxiliary program that lets you construct tightly packed index files directly from a data file; the program extracts keys from the nondeleted records, sorts them, and packs them into the B-tree.

FABS Plus does not suppo t paths to files when using MS-DOS 2.0. Files to be accessed must be in the current directory. The program reportedly has special commands that permit its use in a network or multiuser environment. Features include generic searches, multilevel sequencing, and support of duplicate keys (as well as ASCII or integer key types).

The vendor claims access times of less than 1 second on a floppy disk and less than ½ second on a hard disk.

Suggested retail price is $195. Contact Computer Control Systems Inc., 298 21st Terrace SE, Largo, FL 33541, (813) 586-1886.
Inquiry 641.

Development System Under RM/COBOL

C/Script II is designed to automate applications development under Ryan-McFarland's COBOL environment. You can use the system to specify all data, screen descriptions, and program-specific information. RM/COBOL source-code programs are produced through the use of maintainable skeleton files, a data dictionary, and three source-code generators.

You can access applications produced with C/Script II through the Variable Menu System. Menu options are arranged in a logical, hierarchical structure. A security system interactively monitors all terminals and allows reporting of operator activities. The package reportedly lets you enter an unlimited amount of code to customize generated programs.

C/Script II runs on all IBM PCs and compatibles and other MS-DOS or UNIX machines supporting RM/COBOL version 2. Prices range from $1540 to $5385, depending on environment. Contact C. S. Laboratories Inc., 459 North Dean Rd., Auburn, AL 36830, (800) 626-0381; in Alabama, (205) 821-1133.
Inquiry 642.

PIP Utility

A system utility for interfacing to microcomputer operating systems, XPIP combines functions of many operating-system commands with additional capabilities. Once you've selected a command and options, XPIP displays the correct command-line syntax before executing the command.

XPIP lets you display directories with file attributes, file size, and creation date and time sorted by name, extension, or size; search a set of files for the occurrence of a string; perform arithmetic in any base from 2 through 16; and execute a list of XPIP commands in a text file. You can have any file displayed, 128 bytes at a time, in hexadecimal and ASCII. XPIP uses English messages.

XPIP for MS-DOS or PC-DOS 1.1 or later requires 128K bytes of memory and at least one disk drive. XPIP for CP/M requires version 2.2 or later and at least 44K. Both versions cost $29.95. Contact System Facilities Inc., POB 7079, Charlottesville, VA 22906, (804) 977-5245.
Inquiry 643.

(continued)

SOFTWARE • IBM PC

Local Network on a Disk

LANLink is a software-driven local-area network (LAN) for IBM PCs and compatibles. Instead of requiring you to install network interface boards in your computer, LANLink uses RS-232C ports for all network communications. The logic that normally resides on boards is on LANLink's server and satellite disks.

The Software Link explained that it has programmed the 8250 universal asynchronous receiver/transmitter (UART) chip, standard on serial ports, to handle the same tasks assigned to controller chips on network boards. Using these ports, the company has realized a data-transfer rate of more than 115,000 bps.

The program is capable of linking multiple servers for hard-disk backup. It also provides R-LAN, a remote-access feature that lets you interact with the network through a modem in real time to work with files, programs, and peripherals.

LANLink runs on all PC-DOS machines and some MS-DOS compatibles. A starter kit that includes modules for both a server and a satellite is $495. Additional satellite modules cost $195. Contact The Software Link Inc., Suite 336, 8601 Dunwoody Place, Atlanta, GA 30338, (404) 998-0700.
Inquiry 644.

Expert-Systems Shell

An AI package designed for commercial users, TESS (The Expert System Shell) lets you build expert systems on an IBM PC or compatible. You don't need to know Prolog or LISP to create a TESS system; what you need are facts, rules, and probabilities.

TESS is a Bayesian-inference shell that can also offer some Prolog features. You can load large batches of rules into the shell from sequential files. The package is written in C.

The program includes modifiable windows and help facilities and comes with tutorials and descriptions of techniques used to make expert systems. Minimum hardware configuration is a PC with monochrome display, two 360K-byte disk drives, and 256K bytes of memory. TESS sells for £650. Contact Helix Expert Systems Ltd., 11 Ludgate Circus, London EC4M 7LQ, England; tel: 01-248 1734; Telex: 296119.

In North America, the package is marketed as Expert Edge and costs $795. Contact Human Edge Software Corp., 2445 Faber Place, Palo Alto, CA 94303, (415) 493-1593.
Inquiry 645.

GPIB Utility

Tektronix has developed a toolkit designed to simplify integration of an IBM PC into a GPIB instrument system. Called GURU (GPIB Users Resource Utility), the package consists of a GPIB interface board with self-test and diagnostics, a shielded GPIB cable, and a tutorial manual.

GURU's support software includes a tool that lets you generate a program for executing a prescribed test sequence without writing any code. You can call and use interactively a BASIC library of 16 subroutines for instrument selection and setup, range and tolerance tests, waveform acquisition and storage, and waveform graphs and statistics.

Tektronix plans to establish an application program library for GURU users.

GURU costs $600. Contact Tektronix Inc., Marketing Communications Dept., POB 1700, Beaverton, OR 97005, (800) 547-1512; in Oregon, (800) 452-1877.
Inquiry 646.

Debug dBASE

A utility program designed to help dBASE programmers debug code by locating control-statement errors, dFLOW graphically illustrates program loops, IF . . . ELSE conditionals, and case constructs. The package produces correctly indented listings for individual files and for entire applications systems. dFLOW also cross-references all modules in a full system and compiles a variable concordance.

dFLOW works with dBASE II and III on an IBM PC, PC XT, PC AT, and most compatibles. Suggested retail price is $129. Contact WallSoft Systems Inc., Suite 869, 233 Broadway, New York, NY 10279, (212) 406-7026.
Inquiry 647.

ATLAS Helper

Developed to help train engineers and technicians in the generation of ATLAS (Abbreviated Test Language for All Systems) code, ATLAS Tutor eliminates the need for a test station or compile facility. The menu-driven program-generation tool produces code that's in accordance with IEEE Standard 716.

The tutor leads you step-by-step through the statement-generation process. Each ATLAS statement you construct is stored in a user-defined file so that the statements are linked into a test program. Proper punctuation is inserted automatically.

Examples in the user's manual are organized by ATLAS verbs. The manual includes references to comments about the verbs and references to other structure elements.

ATLAS Tutor runs on an IBM PC or compatible with two disk drives (360K bytes per disk) or one floppy-disk drive and one hard-disk drive. The price is $400, which gets you the program and manual and a copy of the document "IEEE Standard 716 C/ATLAS Test Language." Contact Dubert International Inc., 8858 Glenhaven St., San Diego, CA 92123, (619) 277-4700.
Inquiry 648.

WHERE DO NEW PRODUCT ITEMS COME FROM?
The new products listed in this section of BYTE *are chosen from the thousands of press releases, letters, and telephone calls we receive each month from manufacturers, distributors, designers, and readers. The basic criteria for selection for publication are: (a) does a product match our readers' interests? and (b) is it new or is it simply a reintroduction of an old item? Because of the volume of submissions we must sort through every month, the items we publish are based on vendors' statements and are not individually verified. If you want your product to be considered for publication (at no charge), send full information about it, including its price and an address and telephone number where a reader can get further information, to* New Products Editor, BYTE, POB 372, Hancock, NH 03449.

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The new Eastman Kodak diskettes, for example, are one of these. So are IBM 5¼" diskettes. Same for DYSAN, Polaroid and many, many other familiar diskette brand names. Each of these diskettes is manufactured in whole or in part by another company!

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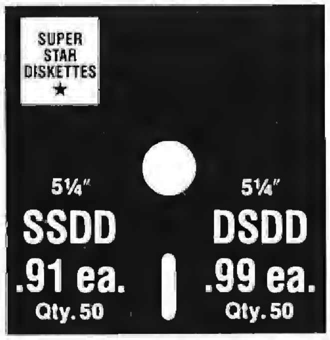

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We found that there are several manufacturers who don't give a hoot about the consumer market for their diskettes. They don't spend millions of dollars in advertising trying to get you, the computer user, to use their diskettes.

Instead, they concentrate their efforts on turning out the highest quality diskettes they can...because they sell them to the software publishers, computer manufacturers and other folks who (in turn) put their name on them...and sell them for much higher prices to you!

After all, when a software publisher or computer manufacturer or diskette marketer puts their name on a diskette, they want it to work time after time, everytime. (Especially software publishers who have the nasty habit of copy-protecting their originals!)

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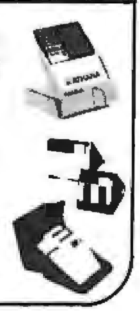

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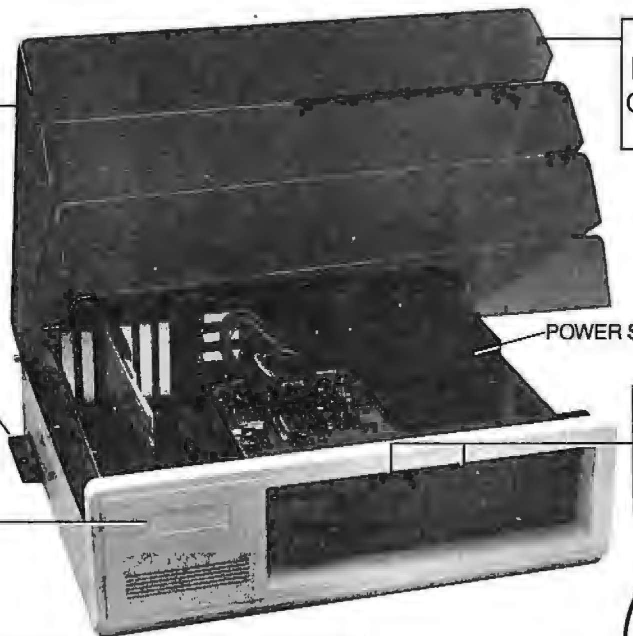

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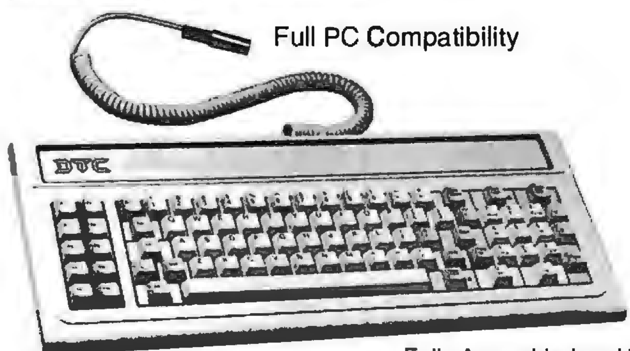

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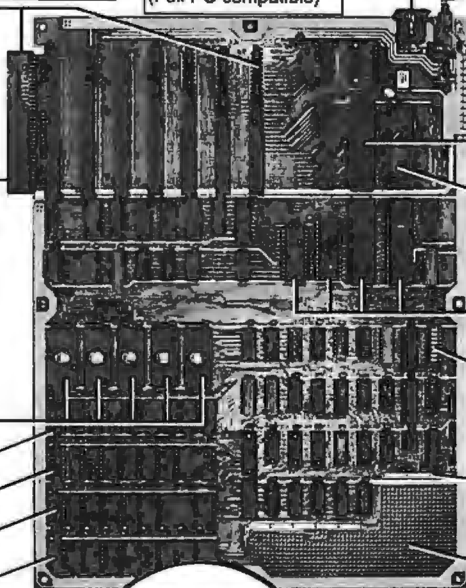

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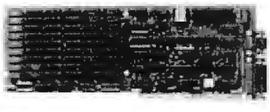

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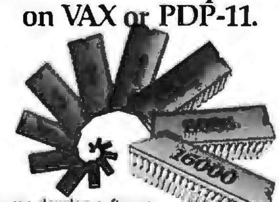

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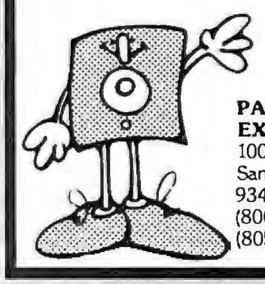

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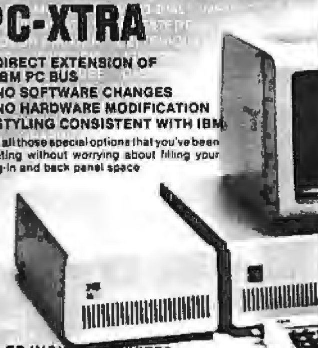

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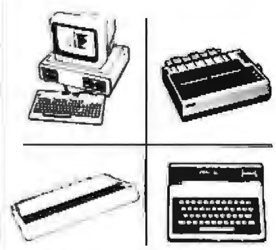

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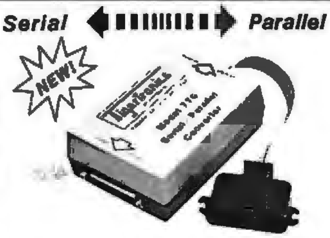

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Inquiry 227

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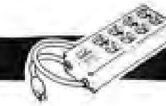

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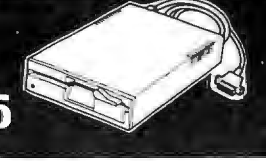

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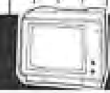

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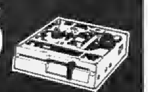

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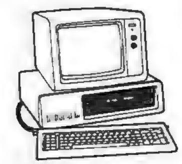

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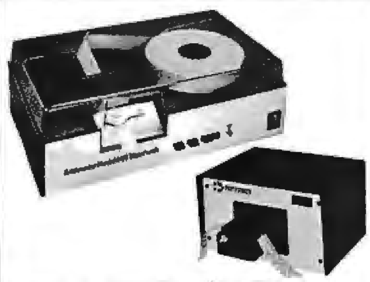

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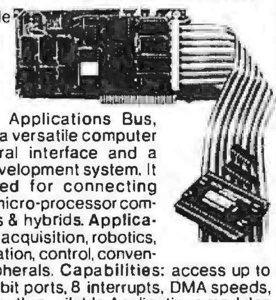

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TMS2564	8K x 8	450ns	5v	9.95
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MCM68766	8K x 8	350ns	5v	19.95
27128-45	16K x 8	250ns	5v	8.95
27128-30	16K x 8	300ns	5v	9.95
27128-25	16K x 8	250ns	5v	10.95
27256-25	32K x 8	250ns	14v	24.95

74LS00

74LS00	.23	74LS125	.48	74LS260	.58
74LS01	.24	74LS126	.48	74LS266	.54
74LS02	.24	74LS132	.58	74LS273	1.45
74LS03	.24	74LS133	.58	74LS275	3.30
74LS04	.23	74LS136	.38	74LS279	.48
74LS05	.24	74LS137	.98	74LS280	1.95
74LS08	.27	74LS138	.54	74LS283	.68
74LS09	.28	74LS139	.54	74LS290	.88
74LS10	.24	74LS145	1.15	74LS293	.88
74LS11	.34	74LS147	2.45	74LS295	.98
74LS12	.34	74LS148	1.30	74LS298	.88
74LS13	.44	74LS151	.54	74LS299	1.70
74LS14	.58	74LS153	.54	74LS323	3.45
74LS15	.34	74LS154	1.85	74LS324	1.70
74LS20	.24	74LS155	.68	74LS352	1.25
74LS21	.28	74LS156	.68	74LS353	1.25
74LS22	.24	74LS157	.64	74LS363	1.30
74LS26	.28	74LS158	.58	74LS364	1.90
74LS27	.28	74LS160	.68	74LS365	.48
74LS28	.34	74LS161	.64	74LS366	.48
74LS30	.24	74LS162	.68	74LS367	.44
74LS32	.28	74LS163	.64	74LS368	.44
74LS33	.54	74LS164	.68	74LS373	1.35
74LS37	.34	74LS165	.94	74LS374	1.35
74LS38	.34	74LS166	1.90	74LS377	1.35
74LS40	.24	74LS168	1.70	74LS378	1.13
74LS42	.48	74LS169	1.70	74LS378	1.30
74LS47	.74	74LS170	1.45	74LS385	1.85
74LS48	.74	74LS173	.68	74LS386	.44
74LS49	.74	74LS174	.54	74LS390	1.15
74LS51	.24	74LS175	.54	74LS393	1.15
74LS54	.28	74LS181	2.10	74LS395	1.15
74LS55	.28	74LS189	8.90	74LS399	1.45
74LS63	1.20	74LS190	.88	74LS424	2.90
74LS73	.38	74LS191	.88	74LS447	.36
74LS74	.34	74LS192	.78	74LS490	1.90
74LS75	.38	74LS193	.78	74LS624	3.95
74LS76	.38	74LS194	.68	74LS640	2.15
74LS78	.48	74LS195	.68	74LS645	2.15
74LS83	.59	74LS196	.78	74LS668	1.65
74LS85	.68	74LS197	.78	74LS669	1.85
74LS86	.38	74LS221	.88	74LS670	1.45
74LS90	.54	74LS240	.94	74LS674	9.60
74LS91	.88	74LS241	.98	74LS682	3.15
74LS92	.54	74LS242	.98	74LS683	3.15
74LS93	.54	74LS243	.98	74LS684	3.15
74LS95	.74	74LS244	1.25	74LS685	3.15
74LS96	.88	74LS245	1.45	74LS688	2.35
74LS107	.38	74LS247	.74	74LS689	3.15
74LS109	.38	74LS248	.98	74LS783	23.95
74LS112	.38	74LS249	.98	81LS95	1.45
74LS113	.38	74LS251	.58	81LS96	1.45
74LS114	.38	74LS253	.58	81LS97	1.45
74LS122	.44	74LS257	.58	81LS98	1.45
74LS123	.78	74LS258	.58	25LS2521	2.75
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		8286	6.45
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		8289	44.90
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8131	2.90
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8226	1.75
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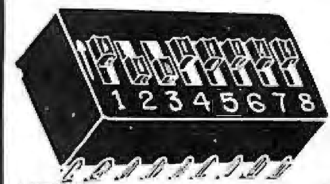
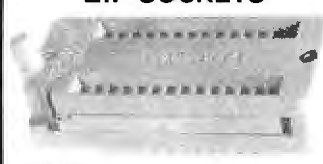
DIP SWITCHES



4 POSITION	.7
5 POSITION	.8
6 POSITION	.8
7 POSITION	.8
8 POSITION	.8

ZIF SOCKETS



14 pin ZIF	4.8
16 pin ZIF	4.8
24 pin ZIF	5.8
28 pin ZIF	6.8
40 pin ZIF	9.8

ZIF = (Zero Insertion Force)

IC SOCKETS

(1 to 99)

8 pin ST.	.12	8 pin WW	.5
14 pin ST.	.14	14 pin WW	.6
16 pin ST.	.16	16 pin WW	.6
18 pin ST	.19	18 pin WW	.9
20 pin ST.	.28	20 pin WW	1.0
22 pin ST.	.29	22 pin WW	1.3
24 pin ST.	.29	24 pin WW	1.4
28 pin ST.	.39	28 pin WW	1.6
40 pin ST.	.48	40 pin WW	1.9

ST = Soldertail WW = Wirewrap

CRYSTAL CLOCK OSCILLATORS

PART NO.	FREQUENCY	PRICE
1.000	1.0000 MHz	6.99
1.843	1.8432 MHz	6.99
2.000	2.0000 MHz	6.99
4.000	4.0000 MHz	6.99
8.000	8.0000 MHz	6.99
10.000	10.0000 MHz	6.99
16.000	16.0000 MHz	6.99
18.432	18.4320 MHz	6.99
19.660	19.6608 MHz	6.99
20.000	20.0000 MHz	6.99
32.000	32.0000 MHz	6.99

CRYSTALS

1.0000 MHz	2.69	8.0000 MHz	1.9
1.8432 MHz	2.69	10.0000 MHz	1.9
2.0000 MHz	1.95	10.7386 MHz	1.9
2.0972 MHz	1.95	12.0000 MHz	1.9
2.4576 MHz	1.95	14.3182 MHz	1.9
3.2768 MHz	1.95	15.0000 MHz	1.9
3.5795 MHz	1.95	16.0000 MHz	1.9
4.0000 MHz	1.95	17.4300 MHz	1.9
4.1943 MHz	1.95	18.0000 MHz	1.9
4.9160 MHz	1.95	18.4320 MHz	1.9
5.0000 MHz	1.95	19.6608 MHz	1.9
5.0688 MHz	1.95	20.0000 MHz	1.9
5.1850 MHz	1.95	22.1184 MHz	1.9
5.2429 MHz	1.95	32.0000 MHz	1.9
5.7143 MHz	1.95	36.0000 MHz	1.9
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78M05UC	.34	7824K	1.34
7805T	.74	7905K	1.44
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7812T	.74	7915K	1.44
7815T	.74	7942K	1.44
7824T	.74	78L05	.6
7905T	.84	78L12	.6
7908T	.84	78L15	.6
7912T	.84	79L05	.7
7915T	.84	79L12	.7
7924T	.84	79L15	.7
7805K	1.34	78H05K	9.9
7812K	1.34	78H12K	9.9
7815K	1.34	UA8S40	1.9

UC.T = TO-220 K = TO-3 L = TO-92

Inquiry 151

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2-way sensor detects noise or solid objects in its path. When front sensor contacts an obstacle or hears a loud noise (hand-clap), Peppy automatically turns to the left.
Uses 2 AA and 1 9V battery (not included).

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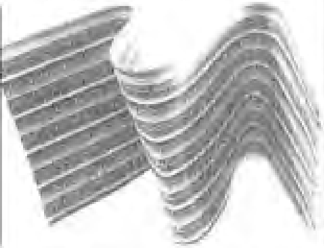

	Solid Color		Color Coded	
Size	1 ft.	10 ft.	1 ft.	10 ft.
10	.17	1.55	.78	7.20
16	.27	2.45	.95	8.70
20	.35	3.15	1.15	10.90
25	.45	4.00	1.22	11.50
26	.45	4.00	1.27	11.50
34	.60	5.35	1.55	14.40
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APPLE & IBM ACCESSORIES

APPLE ACCESSORIES

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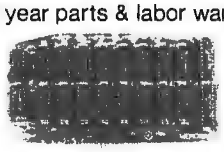

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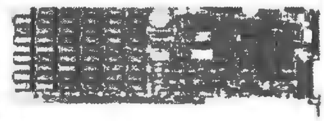

- 64K to 384K RAM
- Parallel Port
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- Clock Calendar
- Software Included
- 1-Year Warranty

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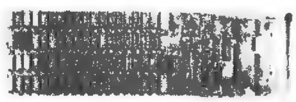
MEMORY CARD



- Expandable to 512K
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- Serial Port Available
- 1-Year Warranty

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MEMORY EXPANSION KIT

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DISKETTES 5¼"

ATHANA: (SOFT SECTOR w/HUB RING)
25 per package

SS/DD	29.75 or 1.19 ea.
DS/DD	34.75 or 1.39 ea.

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NO LABEL: (SOFT SECTOR w/HUB RING)
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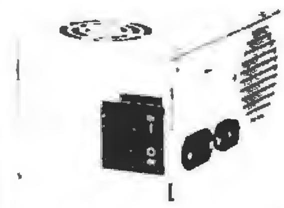
DS/DD	29.75 or 1.19 ea.

2-YEAR WARRANTY ON ALL BULK DISKETTES



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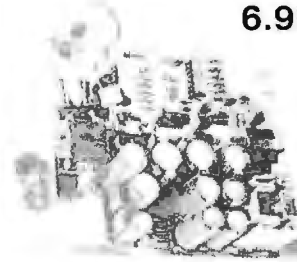
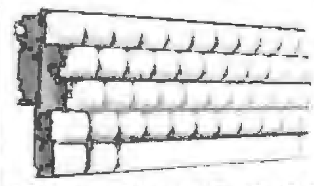


KEYBOARD (99/4)



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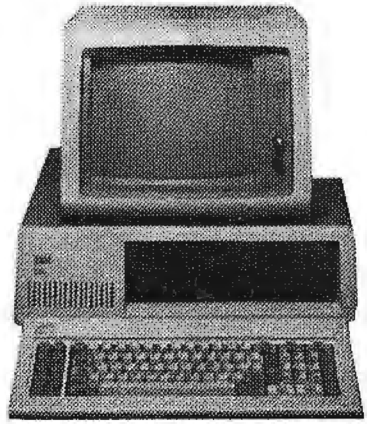

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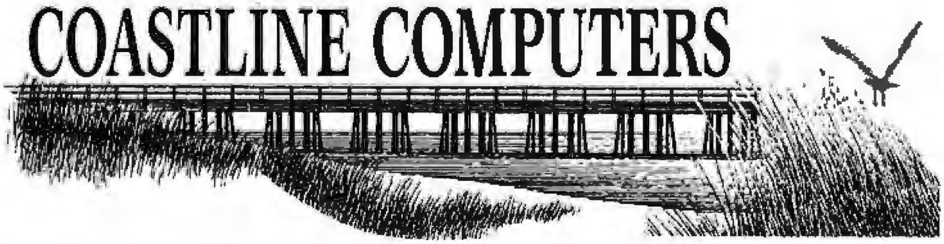

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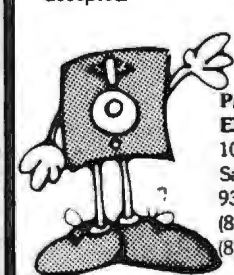

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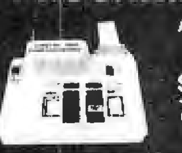

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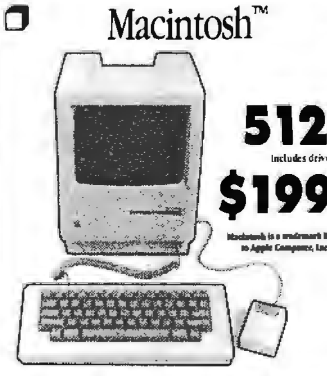

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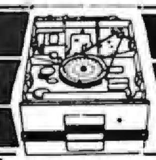

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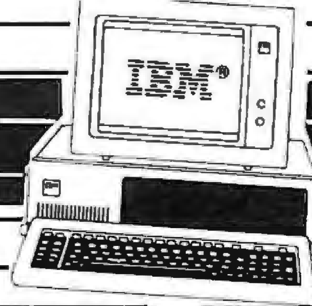

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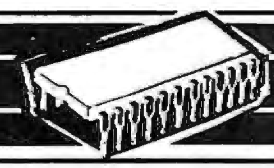

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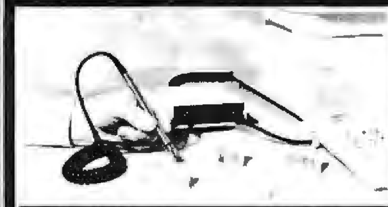

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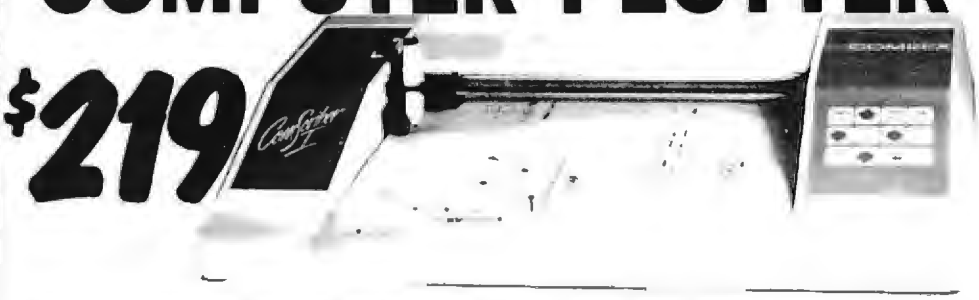

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Also available is a support package which includes demonstration software, interface cable, amulticolor pen assortment and a variety of paper and transparency material.

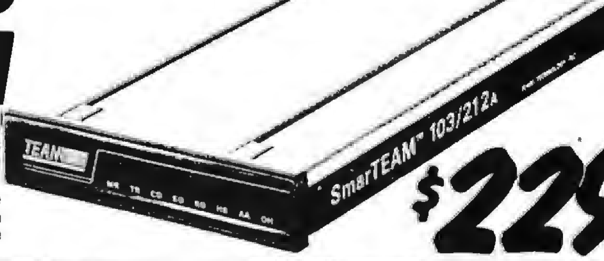
MONITORS

BMC 12A green phosphor 15 MHz composit video	BMC-12A	7895
BMC 12 high resolution. 20MHz	BMC-12EN	119 00
Amdek 300G 12 green phosphor	AMK-300G	12895
Amdek 300A 12 amber phos hi-resolution	AMK-300A	13895
Amdek 310A designed for IBM/PC amber	AMK-310A	15895
Zenith ZVM122 Amber Phosphor 12 40/80 column switch	ZTH-122	89.95
Zenith ZVM123 green phosphor 12" 40/80 column switch.	ZTH-Z123	89.95
NEC JB1201 green phosphor 18 MHz composit video	NEC-JB1201	15900
NEC JB1260 commercial grade composit	NEC-JB1260	119.00
Conrac9" open frame requires horz sync & 12v supply	CON-BW9	5900

COLOR

NEC JC1401D Medium/High 13" RGB	NEC-1401/X	25900
BMC AU9191U Color composit video with sound	BMC-9191	238 95
BMC 9191M RGB designed for use with the IBM computer	BMC-9191M	37900
NEC JC1203DM. RGB color monitor	NEC-1203	69900
NEC JC1215 color composit	NEC-JC1215	33900
Zenith ZVM135 RGB & composite suitable for IBM PC	ZTH-Z135	475 00
Amdek Color I, 13 composit video	AMK-100	299 00
Amdek Color II +, 13 RGB hi-resolution	AMK-200	41995
Amdek Color III +, 13 RGB, medium resolution	AMK-300	35995
Princeton HX-12 RGB IBM/PC compatible	PRN-HX12	478 95

1200 BAUD MODEM



The Team 212A offers all the features of the Hayes Smart Modem 1200 for a fraction of the price. Now is your opportunity to purchase a 1200 baud modem at the price of a 300 baud modem.

California Digital is so confident of your complete satisfaction that we will allow the return the Team 212A and apply the full credit towards the purchase of any other 1200 baud modem. TEM-SM1200

PRINTERS

MATRIX PRINTERS

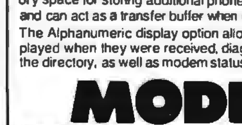
Star Gemini-10X 120 char/sec	STR-G10X	249 00
Star Gemini-15X. 100 char./sec 15" paper.	STR-G15X	365 00
Star Gemini Delta 10, 180 Char/sec	STR-D10	359 00
Toshiba P1351, 192 char/sec letter quality	TOS-1351	1495 00
Okidata 82A serial & parallel 9½" paper	OKI-82A	299 00
Okidata 92A parallel interface. 160 char/sec	OKI-92A	379 00
Okidata 83A & parallel 15" paper	OKI-83A	649 00
Okidata 84A & parallel 15" paper	OKI-84A	929 00
Epson RX-80 10" 120 Char/sec	EPS-RX80	239 00
Epson RX-80/FT friction & tractor	EPS-RX80FT	279 00
Epson FX80FT, 10" 160 char/sec with graphtrax	EPS-FX80	399 00
Epson FX100FT 15" 160 char/sec with graphtrax	EPS-FX100	599 00
Epson LQ1500, 15 correspondence quality	EPS-LQ1500	1079 00
Epson JX80 Color printer	EPS-JX80	579 00
Prowriter 8510 parallel 9½" paper	PRO-8510P	329 00
Prowriter II, parallel 15" paper, graphics	PRO-2P	599 00
Dataproducts B-600-3, band printer 600 LPM	DPS-B600	6985 00
Printronix P300 high speed printer 300 lines per minute	PTX-P300	3995 00
Printronix P600 ultrahigh speed 600 lines per minute	PTX-P600	5795 00

WORD PROCESSING PRINTERS

Starwriter F10 parallel. 40 char/sec	PRO-F10P	499 00
NEC8810 55 char/second. serial interface	NEC-8810	1659 00
NEC8830 55 char/sec. par'l interface	NEC-8830	1659 00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1599 00
NEC2050 designed for IBM/PC 20 char/sec par'l.	NEC-2050	689 00
Silver Reed EXP500, 14 char/sec. par'l interface	SRD-EXP500	319 00
Silver Reed EXP550 17 Char/sec par'l interface.	SRD-EXP550	429 00
Diablo 630 40 char/sec serial	DBL-630	1569 00
Diablo 620, proportional spacing, horz & vert tab 20 cps	DBL-620	769 00
Juki 6100, 18 char/sec	JUK-6100	399 00
Juki 6300, 40 char/sec	JUK-6300	699 00
Comrex CR2, 5k buffer, proportional spacing par'l	CRX-CR2P	395 00

PROMETHEUS ProModem 1200

$319



The Prometheus Promodem 1200 is best value that we have seen in a 300/1200 baud modem. This Hayes compatible modem features completely unattended operation, auto answer/auto dial and even includes "redial number when busy". Internal diagnostics makes the Promodem 1200 an easy modem to install. Help commands, real time clock and internal speaker add to the ease of use of this unit.

An optional processor accessory allows battery back up, extra memory space for storing additional phone numbers, messages received, and can act as a transfer buffer when exchanging programs.

The Alphanumeric display option allows messages saved to be displayed when they were received, diagnostic test results, numbers in the directory, as well as modem status.

EAGLE $895

The Eagle IIE/2 Computer features a 12" non-glare green phosphor CRT, typewriter style keyboard with separate numeric cluster. This unit provides two 5 1/4 drives for a combined storage capacity of 780 K/Byte. The computer contains a 4Mhz Z-80A, DMA disk interface, two RS-232C serial ports, Centronics printer interface, along with an auxiliary parallel port.

Software included consists of ULTRACALC electronic spreadsheet, SPELLBINDER word processor, CBASIC2, CP/M 2.2, and an exclusive Eagle menu driven utility package. These units are all "factory new" and are being offered far below their suggested price of $2495. This is your opportunity to purchase a complete CP/M system for only $895

Return of a Smash Hit Sellout DRAGON $99

Compatible with most Radio Shack Color Computer software. The world famous Dragon computer is now available in the United States. Manufactured by the Tano Corp under license of the British Broadcasting Company. The Dragon comes complete with 64K Byte of memory, serial modem port along with a Centronics printer interface. This unique microcomputer features Motorola's advanced 6809E microprocessor and comes standard with Microsoft Color Basic, data base manager, and a complete word processing package. The computer outputs color composite video along with R.F. video that allows the unit to be used in conjunction with any color television. This is the ideal low cost computer to be used with any dial up information system such as the Source, Western Union's EasyLink or any other time share service.

MODEMS

Team 1200 Hayes Compatible	TEM-SM1200	229 00
CTS 212AH 1200 baud, auto dial	CTS-212AH	299.00
Terminal software for CTS 212AH	CTS-212SFT	35 00
Prometheus 1200 super features	PRM-P1200	319 00
Prometheus 1200B internal PC	PRM-P1200B	279 00
Signalman Mark 12, 1200 baud Hayescompatible	SGL-MK12	23900
Signalman Mark 1, directconnect with terminalcable	SGL-MK1	7500
Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AO	42900
Hayes 1200B for use with the IBM/PC 1200 baud	HYS-1200B	39900
Hayes Smartmodem, 300 baudonly, auto answer autodial	HYS-103AO	229 00
Hayes Micromodem II 103 Apple direct connect	HYS-MM2	27900
Hayes Chronograph time & date	HYS-CHR232	19900
U.S. Robotics 212A 300/1200baud autodial/answer	USR-212A	43900
Penril 300/1200 industrial quality	PEN-12AD	495 00
Universal Data 103LP, line power, answer & originate	UDS-103LP	169 00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	219 00
Universal Data 212LP full 1200 baud duplex, line power	UDS-212LP	359 00
Novation J Cat, direct connect, auto answer	NOV-JCAT	115 00

TERMINALS

Freedom 100, split screen, detatchable keyboard	LIB-F100	495 00
Qume 102 green phosphor terminal	QUM-102	539 00
Ampex Dialogue 125 green screen.	APX-D125G	675.00
Ampex Dialouge 175 amber screen, two page, func keys	APX-D175A	719.00
Wyse 50, 14" green phosphor	WYS-50	595.00
Wyse 300. Eight color display, split screen	WYS-300	1159 00
Zenith 29 terminal, VT52 compatible detatchable keyboard.	ZTH-Z29	765 00
Televideo 910 Plus, block mode	TVI-910P	575 00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	759 00
Televideo 950, graphic char., split screen, 22 func	TVI-950	950 00
Televideo 970, 14" green, 132 column, European	TVI-970	1095 00

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California Digital

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F 10 DAISY WHEEL PRINTER

$499

LETTER QUALITY

The TEC F-10 Daisy Wheel printer is the perfect answer to a reasonablly priced 40 character word processing printer. While this printer is " extremely" similar to C.Itoh's F-10/40 Starwriter printer. Legal counsel for the C.Itoh Company have advised us that we should refrain from referring to the TEC printer as a Starwriter.

This 40 character per second printer auto installs with Wordstar and Perfect Writer. Features extensive built-in word processing functions that allow easy adaptability and reduced software complexity. Industry standard Centronics interface provides instant compatibility with all computers equiped with a parallel printer port. The TEC F-10 accepts paper up to 15 inches in width.

These printers were originally priced to sell at over $1400. Through a special arrangment California Digital has purchase these units from a major computer manufacturer and is offering these printers at a fraction of their original cost.

Options available include tractor feed, buffered memory and an assortment of printer cables for a variety of computers.

10 MEGABYTE WINCHESTER SPECIAL

California Digital has recently purchased several thousand 10 Megabyte Winchester disk drives. The manufacturer has asked us not to advertise their name. Please telephone for details

$319

$119

Your Choice

TEAC 55B 55F 48TPI·96TPI

	One	Two	Ten
Five Inch Double Sided Drives			
TEAC FD55B half height	119	115	109
TEAC FD55F 96 TPI, half ht.	119	115	109
CONTROL DATA 9409 PC	169	159	155
SHUGART SA455 Half Height	119	115	109
SHUGART SA465 ½ Ht. 96TPI	119	115	109
TANDON 100-2 full height	149	145	139
TANDON 101-4 96TPI full ht.	299	289	279
MITSUBISHI 4851 half height	139	135	129
MITSUBISHI 4853 96/TPI½ Ht.	155	149	139
MITSUBISHI 4854 8" elec.	295	285	275
QUME 142 half height	219	205	199
Eight Inch Single Sided Drives			
SHUGART 801R	159	159	154
SIEMENS FDD 100-8	119	115	109
TANDON 848E-1 Half Height	369	359	349
Eight Inch Double Sided Drives			
SHUGART SA851R	495	485	475
QUME 842 "QUME TRACK 8"	319	319	313
TANDON 848E-2 Half Height	459	447	435
REMEX RFD-4000	219	219	209
MITSUBISHI M2896-63 ½ Ht.	459	449	409

MEMORY

4164 DYNAMIC MEMORY 150ns

$1.35

Quantity 100

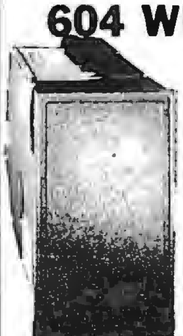
DYNAMIC MEMORY

		1-31	32 +	100 +
4164 150ns.64K 128 refresh	ICM-4164150	2.29	1.99	1.35
41256150ns.256K	ICM-41256150	8.95	8.50	7.25
4116 150ns. 16K	ICM-4116150	1.75	1.65	1.45
4116 200ns.16K	ICM-4116200	1.75	1.65	1.45
4128 for IBM/AT	ICM-4128150	8.95	8.75	8.35
DP8409 dynamic controller	ICT-8409	39.00	35.00	29.00
STATIC MEMORY				
21L02 200ns. 1K static	ICM-21L02200	1.49	1.29	1.15
21L02450ns. 1K static	ICM-21L02450	1.29	1.15	.99
2112 450ns.2K static	ICM-2112450	2.99	2.85	2.75
2114 300ns. 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns. 4K x 1	ICM-4044450	3.49	3.25	2.99
5257300ns.4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4 200ns. 2K x 8	ICM-6116200	3.95	3.85	3.70
6116 P3 150ns. 2K x 8	ICM-6116150	4.55	4.35	4.15
EPROMS				
2708 450ns. 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns. 2K x 8	ICE-2716	4.50	4.25	3.97
2716TMS 450ns. Tri-voltage	ICE-2716TMS	7.95	7.85	7.25
2732 450ns. 4K x 8	ICE-2732	4.50	3.75	3.56
2764 350ns. 8K x 8	ICE-2764	5.95	5.75	6.25
27128 350ns. 16K x 8	ICE-27128	7.95	7.35	6.95

Shugart

604 WINCHESTER

$99



These 6.7 Megabyte drives are new units recently released by the Shugart division of Xerox. The Shugart 604 is fully 506 industry compatible. Each drive is tested before shipment and is supplied with a 90 day warranty. SHU-604

Five Inch Winchester Hard Disk Drives		
FUJITSU M2235AS 27 Meg.	899	859
RODIME RO-208 53 Meg.	1589	1493
MAXTOR XT10140 140 Meg.	3895	3785
SHUGART 712 13 Meg. ½ Ht	495	465
SHUGART 604 6.7 Meg.	99	89
TANDON 502 10 Meg.	419	395
TANDON 503 19 Meg.	695	675
SEAGATE 225 25 Meg.	695	625

VISA

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. • COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.

master charge

Inquiry 319

Inquiry 271

Inquiry 250

Inquiry 89

Inquiry 52

Inquiry 76

Inquiry 130

Inquiry 164

Inquiry 265

4164 64K DYNAMIC 200ns 9/14.95

41256 256K DYNAMIC 200ns 5.95

STATIC RAMS

2101	256x4	(450ns)	1.95
5101	256x4	(450ns)(cmos)	3.95
2102-1	1024x1	(450ns)	.89
2102L-4	1024x1	(450ns)(LP)	.99
2102L-2	1024x1	(250ns)(LP)	1.45
2125	1024x1	(45ns)	2.95
2111	256x4	(450ns)	2.49
2111L	256x4	(450ns)(LP)	2.95
2112	256x4	(450ns)	2.99
2114	1024x4	(450ns)	8/9.95
2114-25	1024x4	(250ns)	8/10.95
2114L-4	1024x4	(450ns)(LP)	8/12.95
2114L-3	1024x4	(300ns)(LP)	8/13.45
2114L-2	1024x4	(200ns)(LP)	8/13.95
2114L-15	1024x4	(150ns)(LP)	8/19.95
TC5514	1024x4	(650ns)(cmos)	4.95
2141	4096x1	(200ns)	2.95
2147	4096x1	(55ns)	4.95
2148	1024x4	(70ns)	4.95
TMS4044-4	4096x1	(450ns)	3.49
TMS4044-3	4096x1	(300ns)	3.99
TMS4044-2	4096x1	(200ns)	4.49
TMS40L44-2	4096x1	(200ns)(LP)	4.95
UPD410	4096x1	(100ns)	3.95
MK4118	1024x8	(250ns)	9.95
TMM2016-200	2048x8	(200ns)	3.25
TMM2016-150	2048x8	(150ns)	3.75
TMM2016-100	2048x8	(100ns)	4.75
HM6116-4	2048x8	(200ns)(cmos)	3.69
HM6116-3	2048x8	(150ns)(cmos)	3.95
HM6116-2	2048x8	(120ns)(cmos)	5.95
HM6116LP-4	2048x8	(200ns)(cmos)(LP)	3.95
HM6116LP-3	2048x8	(150ns)(cmos)(LP)	4.25
HM6116LP-2	2048x8	(120ns)(cmos)(LP)	6.95
TC5516	2048x8	(250ns)(cmos)	9.95
TMS4016	2048x8	(200ns)	6.95
Z-6132	4096x8	(300ns)(Qstat)	34.95
HM6264P-15	8192x8	(150ns)(cmos)	10.25
HM6264LP-15	8192x8	(150ns)(cmos)(LP)	10.95
HM6264LP-12	8192x8	(120ns)(cmos)(LP)	12.95

LP=Low power Qstat=Quasi-Static

DYNAMIC RAMS

TMS4027	4096x1	(250ns)	1.99
2107	4096x1	(200ns)	1.95
MM5280	4096x1	(300ns)	1.95
TMS4050	4096x1	(300ns)	1.95
UPD411	4096x1	(300ns)	1.95
TMS4060	4096x1	(300ns)	1.95
MK4108	8192x1	(200ns)	.49
MM5298	8192x1	(250ns)	.49
4116-300	16384x1	(300ns)	8/6.95
4116-250	16384x1	(250ns)	8/6.95
4116-200	16384x1	(200ns)	8/8.95
4116-150	16384x1	(150ns)	8/10.95
4116-120	16384x1	(120ns)	8/12.95
2118	16384x1	(150ns)(5v)	4.95
MK4332	32768x1	(200ns)	9.95
4164-200	65536x1	(200ns)(5v)	9/14.95
4164-150	65536x1	(150ns)(5v)	9/16.95
4164-120	65536x1	(120ns)(5v)	3.95
MCM6665	65536x1	(200ns)(5v)	4.95
TMS4164-20	65536x1	(200ns)(5V)	4.25
TMS4164-15	65536x1	(150ns)(5v)	4.95
4164-REFRESH	65536x1	(150ns)(5V)(REFRESH)	8.95
TMS4416-20	16384x4	(200ns)(5V)	8.95
TMS4416-15	16384x4	(150ns)(5v)	9.95
41128-150	131072x1	(150ns)(5v)	13.95
41256-200	262144x1	(200ns)(5v)	5.95
41256-150	262144x1	(150ns)(5v)	6.45

5v=Single 5 Volt Supply REFRESH=Pin 1 Refresh

EPROMS

1702	256x8	(1us)	4.50
2708	1024x8	(450ns)	3.95
2758	1024x8	(450ns)(5V)	5.95
2716-6	2048x8	(650ns)	2.95
2716	2048x8	(450ns)(5V)	3.95
2716-1	2048x8	(350ns)(5V)	4.95
TMS2516	2048x8	(450ns)(5V)	4.95
TMS2716	2048x8	(450ns)	7.95
TMS2532	4096x8	(450ns)(5V)	4.95
2732	4096x8	(450ns)(5V)	4.25
2732A-4	4096x8	(450ns)(5V)(21V PGM)	4.95
2732A-35	4096x8	(350ns)(5V)(21V PGM)	4.95
2732A	4096x8	(250ns)(5V)(21V PGM)	6.95
2732A-2	4096x8	(200ns)(5V)(21V PGM)	10.95
2764	8192x8	(450ns)(5V)	4.95
2764-250	8192x8	(250ns)(5V)	5.25
2764-200	8192x8	(200ns)(5V)	8.95
TMS2564	8192x8	(450ns)(5V)	10.95
MCM68764	8192x8	(450ns)(5V)(24 pin)	24.95
MCM68766	8192x8	(350ns)(5V)(24 pin)	42.95
27128-45	16384x8	(450ns)(5V)	7.50
27128-30	16384x8	(300ns)(5V)	7.75
27128	16384x8	(250ns)(5V)	7.95
27256	32768x8	(250ns)(5V)	19.95

5V=Single 5 Volt Supply 21V PGM=Program at 21 Volts

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4.032	2.95
5.0	2.95
5.0688	2.95
5.185	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
18.0	2.95
18.432	2.95
20.0	2.95
22.1184	2.95
24.0	2.95
32.0	2.95

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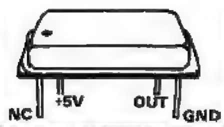
1.8432	7.95	10.0	7.95
2.0	7.95	12.0	7.95
2.4576	7.95	15.0	7.95
2.5	7.95	16.0	7.95
4.0	7.95	18.432	7.95
5.0688	7.95	20.0	7.95
6.0	7.95	24.0	7.95
6.144	7.95		



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XR2206	3.75
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2793	39.95
2795	39.95
2797	39.95
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UPD765	19.95
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MB8877	34.95
1691	7.95
2143	7.95

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MM58174	11.95
MSM5832	3.95

74LS00

74LS00	.24	74LS189	8.95
74LS01	.25	74LS190	.89
74LS02	.25	74LS191	.89
74LS03	.25	74LS192	.79
74LS04	.24	74LS193	.79
74LS05	.25	74LS194	.69
74LS08	.28	74LS195	.69
74LS09	.29	74LS196	.79
74LS10	.25	74LS197	.79
74LS11	.35	74LS221	.89
74LS12	.35	74LS240	.95
74LS13	.45	74LS241	.99
74LS14	.59	74LS242	.99
74LS15	.35	74LS243	.99
74LS20	.25	74LS244	1.29
74LS21	.29	74LS245	1.49
74LS22	.25	74LS247	.75
74LS26	.29	74LS248	.99
74LS27	.29	74LS249	.99
74LS28	.35	74LS251	.59
74LS30	.25	74LS253	.59
74LS32	.29	74LS257	.59
74LS33	.55	74LS258	.59
74LS37	.35	74LS259	2.75
74LS38	.35	74LS260	.59
74LS40	.25	74LS261	2.25
74LS42	.49	74LS266	.55
74LS47	.75	74LS273	1.49
74LS48	.75	74LS275	3.35
74LS49	.75	74LS279	.49
74LS51	.25	74LS280	1.98
74LS54	.29	74LS283	.69
74LS55	.29	74LS290	.89
74LS63	1.25	74LS293	.89
74LS73	.39	74LS295	.99
74LS74	.35	74LS298	.89
74LS75	.39	74LS299	1.75
74LS76	.39	74LS322	5.95
74LS78	.49	74LS323	3.50
74LS83	.60	74LS324	1.75
74LS85	.69	74LS348	2.50
74LS86	.39	74LS352	1.29
74LS90	.55	74LS353	1.29
74LS91	.89	74LS363	1.35
74LS92	.55	74LS364	1.95
74LS93	.55	74LS365	.49
74LS95	.75	74LS366	.49
74LS96	.89	74LS367	.45
74LS107	.39	74LS368	.45
74LS109	.39	74LS373	1.39
74LS112	.39	74LS374	1.39
74LS113	.39	74LS375	.95
74LS114	.39	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	3.90
74LS125	.49	74LS386	.45
74LS126	.49	74LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS396	1.89
74LS137	.99	74LS399	1.49
74LS138	.55	74LS424	3.95
74LS139	.55	74LS447	.95
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS540	1.95
74LS148	1.35	74LS541	1.95
74LS151	.55	74LS624	3.99
74LS153	.55	74LS640	2.20
74LS154	1.90	74LS645	2.20
74LS155	.69	74LS668	1.69
74LS156	.69	74LS669	1.89
74LS157	.65	74LS670	1.49
74LS158	.59	74LS674	14.95
74LS160	.69	74LS682	3.20
74LS161	.65	74LS683	3.20
74LS162	.69	74LS684	3.20
74LS163	.65	74LS685	3.20
74LS164	.69	74LS688	2.40
74LS165	.95	74LS689	3.20
74LS166	1.95	81LS95	1.49
74LS168	1.75	81LS96	1.49
74LS169	1.75	25LS2518	4.13
74LS170	1.49	25LS2521	2.80
74LS173	.69	25LS2538	3.74
74LS174	.55	25LS2569	2.80
74LS175	.55	26LS31	2.19
74LS181	2.15	26LS32	2.19

Z-80

2.5 MHz

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4.0 MHz

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Z80A-SIO/0	10.95
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6.0 MHz

Z80B-CPU	8.95
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6500

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6520	2.95
6522	5.49
6532	9.95
6545	9.95
6551	9.95

2.0 MHz

6502A	5.95
6520A	5.95
6522A	9.95
6532A	11.95
6545A	12.95
6551A	11.95

3.0 MHz

6502B	8.95

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IM6402	7.95
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UPD7201	19.95
INS8250	10.95

6800

68000-8	39.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809	8.95
6809E	8.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
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6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
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68488	19.95

6800=1 MHz

68B00	10.95
68B02	11.95
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68B09	11.95
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68B00=2 MHz

8000

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8035	5.95
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8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	13.95
8237-5	15.95
8238	4.49
8243	4.45
8250	10.95
8251	3.95
8251A	4.49
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8255-5	5.25
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8259-5	7.50
8271	79.95
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74S05	.35	74S151	.95	74S258	.95
74S08	.35	74S153	.95	74S260	.79
74S09	.40	74S157	.95	74S273	2.45
74S10	.35	74S158	.95	74S274	19.95
74S11	.35	74S161	1.95	74S275	19.95
74S15	.35	74S162	1.95	74S280	1.95
74S20	.35	74S163	1.95	74S283	3.29
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74S124	2.75	74S225	7.95	74S570	2.95
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7400

7400	.19	7483	.50	74172	5.95
7401	.19	7485	.59	74173	.75
7402	.19	7486	.35	74174	.89
7403	.19	7489	2.15	74175	.89
7404	.19	7490	.35	74176	.89
7405	.25	7491	.40	74177	.75
7406	.29	7492	.50	74178	1.15
7407	.29	7493	.35	74179	1.75
7408	.24	7494	.65	74180	.75
7409	.19	7495	.55	74181	2.25
7410	.19	7496	.70	74182	.75
7411	.25	7497	2.75	74184	2.00
7412	.30	74100	1.75	74185	2.00
7413	.35	74105	1.14	74189	2.99
7414	.49	74107	.30	74190	1.15
7416	.25	74109	.45	74191	1.15
7417	.25	74110	.45	74192	.79
7420	.19	74111	.55	74193	.79
7421	.35	74116	1.55	74194	.85
7422	.35	74120	1.20	74195	.85
7423	.29	74121	.29	74196	.79
7425	.29	74122	.45	74197	.75
7426	.29	74123	.49	74198	1.35
7427	.29	74125	.45	74199	1.35
7428	.45	74126	.45	74221	1.35
7430	.19	74128	.55	74246	1.35
7432	.29	74132	.45	74247	1.25
7433	.45	74136	.50	74248	1.85
7437	.29	74141	.65	74249	1.95
7438	.29	74142	2.95	74251	.75
7439	.79	74143	4.95	74259	2.25
7440	.19	74144	2.95	74265	1.35
7442	.49	74145	.60	74273	1.95
7443	.65	74147	1.75	74276	1.25
7444	.69	74148	1.20	74278	3.11
7445	.69	74150	1.35	74279	.75
7446	.69	74151	.55	74283	2.00
7447	.69	74152	.65	74284	3.75
7448	.69	74153	.55	74285	3.75
7450	.19	74154	1.25	74290	.95
7451	.23	74155	.75	74293	.75
7453	.23	74156	.65	74298	.85
7454	.23	74157	.55	74351	2.25
7460	.23	74159	1.65	74365	.65
7470	.35	74160	.85	74366	.65
7472	.29	74161	.69	74367	.65
7473	.34	74162	.85	74368	.65
7474	.33	74163	.69	74376	2.20
7475	.45	74164	.85	74390	1.75
7476	.35	74165	.85	74393	1.35
7480	.59	74166	1.00	74425	3.15
7481	1.10	74167	2.96	74426	.85
7482	.95	74170	1.65	74490	2.55

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4007	.29	4541	2.64
4008	.95	4543	1.19
4009	.39	4553	5.79
4010	.45	4555	.95
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4012	.25	4558	2.45
4013	.38	4560	4.25
4014	.79	4569	3.49
4015	.39	4581	1.95
4016	.39	4582	1.95
4017	.69	4584	.75
4018	.79	4585	.75
4019	.39	45151	12.95
4020	.75	4702	12.95
4021	.79	4724	1.50
4022	.79	74C00	.35
4023	.29	74C02	.35
4024	.65	74C04	.35
4025	.29	74C08	.35
4026	1.65	74C10	.35
4027	.45	74C14	.59
4028	.69	74C20	.35
4029	.79	74C30	.35
4030	.39	74C32	.39
4034	1.95	74C42	1.29
4035	.85	74C48	1.99
4040	.75	74C73	.65
4041	.75	74C74	.65
4042	.69	74C76	.80
4043	.85	74C83	1.95
4044	.79	74C85	1.95
4046	.85	74C86	.39
4047	.95	74C89	4.50
4048	.69	74C90	1.19
4049	.35	74C93	1.75
4050	.35	74C95	.99
4051	.79	74C150	5.75
4052	1.99	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4077	.59	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
4094	2.99	74C374	2.45
4098	2.49	74C901	.39
4099	1.95	74C902	.85
14409	12.95	74C903	.85
14410	12.95	74C905	10.95
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4512	.85	74C921	15.95
4514	1.25	74C922	4.49
4515	1.79	74C923	4.95
4516	1.55	74C925	5.95
4518	.89	74C926	7.95
4519	.39	74C927	7.95
4520	.79	74C928	7.95
4521	4.99	74C929	19.95
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74HC08	.59	74HC195	1.09
74HC10	.59	74HC238	1.35
74HC11	.59	74HC240	1.89
74HC14	.79	74HC241	1.89
74HC20	.59	74HC242	1.89
74HC27	.59	74HC243	1.89
74HC30	.59	74HC244	1.89
74HC32	.69	74HC245	1.89
74HC51	.59	74HC251	.89
74HC74	.75	74HC257	.85
74HC75	.85	74HC259	1.39
74HC85	1.35	74HC273	1.89
74HC86	.69	74HC299	4.99
74HC93	1.19	74HC367	.99
74HC125	1.19	74HC373	2.29
74HC132	1.19	74HC374	2.29
74HC138	.99	74HC393	1.39
74HC139	.99	74HC4017	1.99
74HC1S1	.89	74HC4020	1.39
74HC153	.89	74HC4024	1.59
74HC154	2.49	74HC4040	1.39
74HC157	.89	74HC4049	.89
74HC161	1.15	74HC4050	.89
74HC164	1.25	74HC4060	1.29
74HC166	2.95	74HC4511	2.39
74HC174	.99	74HC4538	2.29

74HCT00

74HCT: Direct, drop-in replacements for LS TTL and can be intermixed with 74LS in the same circuit.

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74HCT02	.69	74HCT193	1.39
74HCT04	.69	74HCT194	1.19
74HCT08	.69	74HCT195	1.29
74HCT10	.69	74HCT238	1.49
74HCT11	.69	74HCT240	2.19
74HCT14	.89	74HCT241	2.19
74HCT20	.69	74HCT242	2.19
74HCT27	.69	74HCT243	2.19
74HCT30	.69	74HCT244	2.19
74HCT32	.79	74HCT245	2.19
74HCT51	.69	74HCT251	1.09
74HCT74	.85	74HCT257	.99
74HCT75	.95	74HCT259	1.59
74HCT85	1.49	74HCT273	2.09
74HCT86	.79	74HCT299	5.25
74HCT93	1.29	74HCT367	1.09
74HCT125	1.29	74HCT373	2.49
74HCT132	1.29	74HCT374	2.49
74HCT138	1.15	74HCT393	1.59
74HCT139	1.15	74HCT4017	2.19
74HCT151	1.05	74HCT4020	1.59
74HCT153	1.05	74HCT4024	1.79
74HCT154	2.99	74HCT4040	1.59
74HCT157	.99	74HCT4049	.99
74HCT161	1.29	74HCT4050	.99
74HCT164	1.39	74HCT4060	1.49
74HCT166	3.05	74HCT4511	2.69
74HCT174	1.09	74HCT4538	2.59

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PR-125T	x	25	17,000	$349.00
PR-320T	x	42	17,000	$595.00

VOLTAGE REGULATORS

TO-220 CASE PACKAGE

7805T	.75	7905T	.85
7808T	.75	7908T	.85
7812T	.75	7912T	.85
7815T	.75	7915T	.85
7824T	.75	7924T	.85

TO-3 CASE PACKAGE

7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49

TO-92 CASE PACKAGE

78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79

OTHER VOLTAGE REGS

78M05C	5volt	½amp	TO-220	.35
LM323K	5volt	3amp	TO-3	4.95
LM338K	Adj.	5amp	TO-3	3.95
78H05K	5volt	5amp	TO-3	9.95
78H12K	12volt	5amp	TO-3	9.95
78P05K	5volt	10amp	TO-3	14.95
UA78S40	FAIRCHILD		DIP	1.95

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LM307	.45	NE590	2.50
LM308	.69	NE592	.98
LM308H	1.15	LM709	.59
LM309H	1.95	LM710	.75
LM309K	1.25	LM711	.79
LM310	1.75	LM723	.49
LM311	.64	LM723H	.55
LM311H	.89	LM733	.98
LM312H	1.75	LM741	.35
LM317K	3.95	LM741N-14	.35
LM317T	1.19	LM741H	.40
LM318	1.49	LM747	.69
LM318H	1.59	LM748	.59
LM319H	1.90	LM1014	1.19
LM319	1.25	LM1303	1.95
LM320	see7900	LM1310	1.49
LM322	1.65	MC1330	1.69
LM323K	4.95	MC1349	1.89
LM324	.59	MC1350	1.19
LM329	.65	MC1358	1.69
LM331	3.95	MC1372	6.95
LM334	1.19	LM1414	1.59
LM335	1.40	LM1458	.59
LM336	1.75	LM1488	.69
LM337T	1.95	LM1489	.69
LM337K	3.95	LM1496	.85
LM338K	3.95	LM1558H	3.10
LM339	.99	LM1800	2.37
LM340	see7800	LM1812	8.25
LM348	.99	LM1830	3.50
LM350K	4.95	LM1871	5.49
LM350T	4.60	LM1872	5.49
LM358	.69	LM1877	3.52
LM359	1.79	LM1889	1.95
LM376	3.75	LM1896	1.75
LM377	1.95	ULN2003	1.29
LM378	2.50	XR2206	3.75
LM379	4.50	LM2877	2.05
LM380	.89	LM2878	2.25
LM380N-8	1.10	LM2900	.85
LM381	1.60	LM2901	1.00
LM382	1.60	MPQ2907	1.95
LM383	1.95	LM2917	2.95
LM384	1.95	MC3487	2.95
LM386	.89	LM3900	.59
LM387	1.40	LM3905	1.25
LM389	1.35	LM3909	.98
LM390	1.95	LM3911	2.25
LM392	.69	LM3914	3.95
LM393	1.29	LM3915	3.95
LM394H	4.60	LM3916	3.95
LM399H	5.00	MC4024	3.95
NE531	2.95	MC4044	4.50
NE555	.34	RC4136	1.25
NE556	.65	RC4151	3.95
NE558	1.50	LM4250	1.75
NE564	2.95	LM4500	3.25
LM565	.99	RC4558	.69
LM566	1.49	LM13600	1.49
LM567	.89	LM13700	1.45

H=TO-5 CAN, K=TO-3, T=TO-220

RCA

CA3023	2.75	CA3083	1.55
CA3039	1.29	CA3086	.80
CA3046	1.25	CA3089	2.99
CA3059	2.90	CA3096	3.49
CA3060	2.90	CA3130	1.30
CA3065	1.75	CA3140	1.15
CA3080	1.10	CA3146	1.85
CA3081	1.65	CA3160	1.19
CA3082	1.65	CA3183	.99

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75108	1.49	75453	.38
75110	1.95	75454	.39
75150	1.95	75477	1.29
75154	1.95	75491	.79
75160	4.95	75492	.79
75188	1.25	75493	.89
75189	1.25	75494	.89

BI FET

TL066	.99	LF347	2.19
TL071	.79	LF351	.60
TL072	1.19	LF353	1.00
TL074	2.19	LF355	1.10
TL081	.79	LF356	1.10
TL082	1.19	LF357	1.40
TL083	1.19	LF411	1.29
TL084	2.19	LF412	1.99

TRANSISTORS

2N918	.50	2N3772	1.85
MPS918	.25	2N3903	.25
2N2102	.75	2N3904	.10
2N2218	.50	2N3906	.10
2N2218A	.50	2N4122	.25
2N2219	.50	2N4123	.25
2N2219A	.50	2N4249	.25
2N2222	.25	2N4304	.75
PN2222	.10	2N4401	.25
MPS2369	.25	2N4402	.25
2N2484	.25	2N4403	.25
2N2905	.50	2N4857	1.00
2N2907	.25	PN4916	.25
PN2907	.13	2N5086	.25
2N3055	.79	PN5129	.25
3055T	.69	PN5139	.25
2N3393	.30	2N5209	.25
2N3414	.25	2N6028	.35
2N3563	.40	2N6043	1.75
2N3565	.40	2N6045	1.75
PN3565	.25	MPS-A05	.25
MPS3638	.25	MPS-A06	.25
MPS3640	.25	MPS-A13	.40
PN3643	.25	MPS-A55	.25
PN3644	.25	MPU-131	.99
MPS3704	.15	TIP29	.65
MPS3706	.15	TIP31	.75
		TIP32	.79

IC SOCKETS

	1-99	100
8 PIN ST	.13	.11
14 PIN ST	.15	.12
16 PIN ST	.17	.13
18 PIN ST	.20	.18
20 PIN ST	.29	.27
22 PIN ST	.30	.27
24 PIN ST	.30	.27
28 PIN ST	.40	.32
40 PIN ST	.49	.39
64 PIN ST	4.25	CALL

ST=SOLDERTAIL

8 PIN WW	.59	.49
14 PIN WW	.69	.52
16 PIN WW	.69	.58
18 PIN WW	.99	.90
20 PIN WW	1.09	.98
22 PIN WW	1.39	1.28
24 PIN WW	1.49	1.35
28 PIN WW	1.69	1.49
40 PIN WW	1.99	1.80

WW=WIREWRAP

INTERFACE

8T26	1.59
8T28	1.98
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
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DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

INTERSIL

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ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

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ADC0809	4.49
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9601	.75
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4N35	1.25	ILQ-74	2.75
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Inquiry 231

U·N·C·L·A·S·S·I·F·I·E·D A·D·S

WANTED: Apple IIe public-domain software or information on programs to help teach non-English-speaking six-year-old Korean boy English, math, or any basic learning material. David Harbour, Route 4, Box 49, Ava, MO 65608, (417) 683-5201.

WANTED: Inner-city school needs donation of IBM, Apple, or compatibles plus peripherals in exchange for tax-deductible donation verification. Donation will enable students to receive hands-on experience otherwise not available. Rama Lahori, Chicago Vocational High School, 2100 East 87th St., Chicago, IL 60617, (312) 978-1600.

WANTED: Nonprofit agency needs word-processing equipment to expose Austrian older youth to the media and develop employable skills. Tax-deductible. The Institute for Cultural Affairs, Lilienbrunngasse 15/8, Wien, Austria, tel: (433-222) 24-69-234.

WANTED: College computer club looking for tax-deductible donation of computer with word-processing. Florence V. Ward, John Jay College Computer Club, 445 West 59th St., New York, NY 10019.

WANTED: Donation of disk-based computer system (IBM PC, IBM-compatible, or CP/M) with programming tools (assembler, compiler, etc.) for effort to help blind people understand programming and to develop learning tools for them. Piotr Bednarski, ul. Ryemonta 10m92, 01-842, Warsaw, Poland.

NEEDED: Hardware reference manual and operator's manual for Intel's Intellec 8/MOD 80 system (no longer available). Will pay postage. R. Hu, 1467 Bortolotti Crescent, Gloucester, Ontario K1B 5C1, Canada.

NEEDED: Information, schematics, etc., for Infoton I-100 terminal manufactured about 1979. Also same for Vector Graphic S-100 Z80 Rev. 3 board. Jim Wolfe, POB 6601, Torrance, CA 90504, (213) 376-2931.

WANTED: If you have had problems (corrected or not) with your Pixel computer or if your service contract has not been honored, send details to S. E. Rudlin, 4600 Grove Ave., Richmond, VA 23226.

FOR SALE: Columbia VP portable, amber screen, 128K to 512K, extras: $1600. Also, TRS-80 Model 100, 24K, brand new, modem, cable, AC adapter: $500. Dan Gammon, (301) 946-7370.

FOR SALE: 8K RAM module for Radio Shack PC-2 or Sharp PC-1500 pocket computer; asking $50. Need 16K RAM module with battery backup for the Radio Shack PC-2 or Sharp PC-1500. Also, would like to form users group for pocket computers. Robert Lerner, 23 Mayed Dr., Suffern, NY 10901.

WANTED: One AIM 65 micro, two (or more) MTU 32K Banker boards, one MTU card cage (or backplane only), one MMS Inc. Mach-9 6809 adapter for AIM, and one 2031 (or 4040) Commodore IEEE disk drive. Don Lewis, 606 Hazel Ave., Folsom, PA 19033, (215) 622-5495 or 586-5212.

FOR SALE: BYTE, all volume 3; volume 2, numbers 2, 5, 6, 7, 9–12; volume 4, numbers 1–4, 6, and 9; and issue 14 (October 1976). Also Commodore PET 8K with original keyboard and ROM. Best offer. Prefer local buyer. Shigeki Misawa, 37 Penwood Dr., New Providence, NJ 07974, (201) 464-1359.

FOR SALE: 1979 through 1984 of BYTE, *Creative Computing*, *Microcomputing*, *Interface Age*, and *Personal Computing*. Will sell volumes or single copies. Wanted: BYTE, October and November 1977 issues. Jim Reeb, 8392 East Inspiration Dr., Parker, CO 80134.

FOR SALE: Sweet Talker computer speech synthesizer, cabinet, built-in speaker, power supply, and ribbon cable for parallel interface, plus schematics and documentation: $95. Mike Hagerman, 1704 Mars Ave., Loves Park, IL 61111, (815) 633-3382.

WANTED: Help in finding a BBS public-domain or individually written program for an Atari 800 with Microperipheral modem, model UM-1, one disk drive, and 820 printer. Jim Klein, 48 102nd Ave. NW, Coon Rapids, MN 55433.

WANTED: Schematics and parts list for an Ithaca Audio (Intersystems), EPROM burner board, part number IA-1200. Need same information for the front-panel board. Paul Detzel, 22635 Southwest 65th Way, Boca Raton, FL 33428, (305) 487-4222.

FOR SALE: Hewlett-Packard 86A with 12-inch monitor, 5¼-inch disk drive, auto-dial modem, 82905B printer, I/O, ADV, and more. All manuals. Retail value $4900. Best offer. Winston Chung, 702 Harvey Rd., Claymont, DE 19703, (302) 792-2921.

WANTED: International computer hobbyists to correspond with in English, French, and German. Exchange information on microcomputer applications, engineering, robotics, R/C electric model planes, travel, national cultures, etc. Bob Saxer, 704 East Cedar Ave., St. Charles, IL 60174.

FOR SALE: CompuPro IEEE-696 CP/M system. Enclosure power supply and 21-slot motherboard, 6-MHz Z80, AMD 9511 floating-point board, dual Qume 842 disk drives and power supply, and more: $1800. TeleVideo 910+ terminal: $300. David A. Danello, POB 784, Dahlgren, VA 22448, (703) 775-4915 or (814) 643-3387.

WANTED: New Zealand University student would like to correspond with others who have an interest in Apple II computers and the expansions and languages available for them. Sean Fennell, 15 Buckley Rd., Epsom, Aukland 3, New Zealand.

FOR SALE: IBM film ribbons, stock number 1136108, for Selectric typewriters. Clear spool, not gray cartridge. Expired in 1976–1977; all 24 only $20. Fred Robinson, 7580 Honeysuckle, Orchard Lake, MI 48033.

FOR SALE: SD Systems RAM Disk-256, never used: $500. D. Boone, POB 330, Valley Mills, TX 76689.

FOR SALE: Never used 1983 Cromemco System HD3, DPU, 256K bytes of RAM, 20-megabyte hard disk, TU-Art, Cromix 68000, C-language compiler: $10,000 or best offer. Dr. Jeppesen, POB 270, Oak View, CA 93022.

FOR SALE: Fidelity Electronics Elite A/S Chess Challenger, USCF rating 1850, upgradable to latest model, like new: $300. Also, Novag Constellation chess computer, USCF rating 1800+, perfect condition: $150. John A. Henderson, 526 South Division St. #9, Ann Arbor, MI 48194, (313) 995-4106.

FOR SALE: CompuPro 85/88 S-100 system, complete and working. Includes 15-slot Integrand chassis, 128K-byte RAM, PMMI modem, two Shugart 851s, Wyse 100 terminal, and more. Asking $3000. David Langmann, 2900 Connecticut Ave. NW, Washington, DC 20008, (202) 232-7999.

WANTED: High-school student seeks correspondence with people interested in computer graphics and simulation in Pascal, C, and assembly language. Mariusz Jarzebowski, al. Wilanowska 364 m 81, 02-655, Warsaw, Poland.

FOR SALE: Computer Continuum A/D, D/A board with box, Timex computer, various Z80 and Timex books: $150 or best offer. Rob Forbes, POB 4826, Boulder, CO 80306.

FOR SALE: IBM 160K-byte disk drive (TM100-1): $95. BIOS ROM and 8088 from IBM PC: $45. Joe Gunter, RR 2, Box 823, Lot 125, Pompano Beach, FL 33067, (305) 421-6301.

WANTED: Manual for IMSAI S-100 board. Will pay all copy and mail expenses. Steven McClain, 10428 Mull Ave., Riverside, CA 92505, (714) 354-6979.

WANTED: California Computer Systems boards for an S-100 bus as follows: Z80 processor board 2820-00001 and floppy-disk controller board 2411-0001 rev. B. Lee D. Miller, 932 North Lakeshore Dr., Lincoln, NE 68528, (402) 435-3864.

FOR SALE: Sanyo 12-inch green monitor, new: $85. Smith-Corona TP-1 daisy-wheel printer (like new) with serial interface, two extra ribbons: $250. Network hardware to connect up to eight Commodore 64s to single disk and printer: $125. Other equipment available. Mike Schary, 110 Bel Air Lane, Fairfield, CT 06430, (203) 333-6034.

UNCLASSIFIED ADS MUST *be noncommercial, from readers who have computer equipment to buy, sell, or trade on a onetime basis. All requests for donated computer equipment must be from nonprofit organizations. Programs to be exchanged must be written by the individual or be in the public domain. Ads must be typed double-spaced, contain 50 words or less, and include full name and address. This is a free service; ads are printed as space permits.* BYTE *reserves the right to reject any unclassified ad that does not meet these criteria. When you submit your ad* (BYTE, *Unclassified Ads,* POB 372, *Hancock,* NH 03449), *allow at least four months for it to appear.*

FOR SALE: Micromint MPX-16 single-board computer system, MPX-17 IBM keyboard interface, and MPX-30 BIOS EPROM set for PC-DOS/hardware, unused in box: $900. Lee W. Sorensen, 6555 Lawndale Lane, Maple Grove, MN 55369, (612) 420-2425.

FOR SALE: Apple II+ with GE good resolution 12-inch TV/RF modulator, shift modification, 64K RAM total, Apple disk drive, working well. Price: 60 percent of cost. Newt Steers, (301) 320-5820.

FOR SALE: New Apple-compatible disk drives, Teac (red) half-height, direct drive, one-year warranty: $195 or best offer. Saturn 32K card: $75 or best offer. Hayes Micromodem II: $175 or best offer. Also, need inexpensive Apple IIe. W. Ostlund, 140 Oakview, Pittsburgh, PA 15218, (412) 242-5688.

FOR SALE: Xebec model S1410 hard-disk controller with manual, new, never powered up: $295. Philip Nunn, 201 Netherfield, Comstock Park, MI 49321, (616) 784-5732.

FOR SALE: Atari 800 with 48K, 850 interface module, cassette player, paddles, joysticks, *Analog* and *Antic* magazines, over 25 books. Send SASE for complete list. Robin Japins, POB 472, Olathe, KS 66061-0472.

FOR SALE: OSM ZEuS-4 multiuser computer with 6.3-megabyte hard disk and 8-inch floppy-disk drive, Heath terminal, manuals, and more: $4500. R. P. Perkins, M.D., OB/GYN, 2211 Lomas Blvd. NE, Albuquerque, NM 87106, (505) 277-4158.

FOR SALE: North Star Horizon 18-megabyte hard disk, complete with North Star and Soroc terminals: $4200 or best offer. B. Tooley, (806) 655-7121.

FOR SALE: LA34 terminal, tractor option included, mint condition: $400. Robert Lund, 34 Lorna Dr., Auburn, MA 01501, (617) 832-2611.

WANTED: Apple II+, IIe, or IIc computer. Include list of peripherals and cards. Indicate age, condition, asking price. Ken Hamel, Route 5, Box 162, Watertown, WI 53094.

FOR SALE: Hewlett-Packard HP 85a computer with 32K bytes of RAM, I/O ROM, case, and more. Must sell, make offer. John M. Uber, 1154 North Howard St., Akron, OH 44310, (216) 923-2074.

FOR SALE: Seattle Computer RAM+ expansion board for the IBM PC: $100 (RS-232, 256K maximum, no memory included). Dane Laun, 14052 Southwest Stampher Rd., Lake Oswego, OR 97034.

FOR SALE: Netronics 64K S-100 memory board with 16K: $100. One Vector 11-slot S-100 motherboard: $100. One solid-state music I/O board, two parallel/two serial, partially populated: $50. Ron Rogers, Apt. 2028, 6525 South Gessner, Houston, TX 77036, (713) 541-3208.

FOR SALE: DEC PDP-8A-500 classic configuration. Dual 8-inch single-density floppy drives with controller, CPU card, MM card, two 8K core boards, DKC8A option card, serial card, plotter controller card, VT50AA terminal, manuals, and more. Working. $600 plus shipping or best offer for part or all. Don Taylor, 12270 Southwest Center St. #63, Beaverton, OR 97005, (503) 627-0231.

WANTED: BYTE issues 1 through 12, and pre-1984 issues of *Microsystems*. Send list with prices. Barney Flusche, 98-825A Iho Place, Aiea, HI 96701, (808) 488-3259, evenings.

WANTED: Anyone wishing to trade public-domain software for the Apple II series. Send name, address, and a list of programs. Enclose SASE. Jason Pilnock, 5930 South 5th St., Pocatello, ID 83204.

WANTED: Computer science student seeks information for project concerning computer music synthesis and computer/synthesizer interfacing. Also, looking for others interested in starting a computer music group. Jeffrey Ring, 519 Shook, San Antonio, TX 78212, (512) 737-2387, evenings and weekends.

WANTED: Spectravideo owner seeks correspondence with other SV owners. R. Fortune, 46 West 17 St., New York, NY 10011.

FOR SALE: Cromemco C-10 SP with two 390K disk drives, Novation J-CAT, and more: $1000. Ronald Gans, 350 West 55th St. #2-E, New York, NY 10019, (212) 957-8361.

FOR SALE: TI TM990 board-level computer, 16-bit 9900-based, 8-slot card cage, 100M and 101MA CPU boards, 64K memory, 303 floppy controller, much digital and analog I/O, manuals, and more. Will sacrifice. Dwight Aussieker, Varna, IL 61375, (309) 463-2318.

B·O·M·B

BYTE's Ongoing Monitor Box

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March BOMB *Results*

THE BEST BARGAINS

Steve Ciarcia wins first place in the March issue for the first of several home-control projects from Ciarcia's Circuit Cellar. Aptly entitled "Build the Touch-Tone Interactive Message System," this article tells you how your answering machine can do a whole lot more. In second place is Computing at Chaos Manor; and this month Jerry Pournelle composed it while "On the Road: Hackercon and COMDEX." John Markoff and Ezra Shapiro's "Public-Domain Gems" wins third in the lineup. Fourth place goes to Richard S. Shuford, author of "Two Flat-Display Technologies." And winner of the $100 prize is Laine Stump, for his fifth-place theme article, "The Kit Solution." His was the first nonstaff-written article to appear in the BOMB. So Peter Rice, whose article "Arithmetic on Your PC" placed sixth, wins the second-place bonus of $50. Congratulations.

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5) When TIPS says: "Enter Subscriber Number"
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Enter [1] [#] [6] [5] [#] [#]

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7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

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8) End session by entering [*] [*] [9] [1] [#] [#]

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Fair	3	7	11	15	19	23	27	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	95	99
Poor	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100

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