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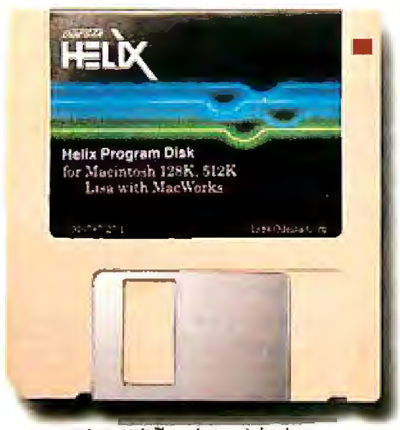

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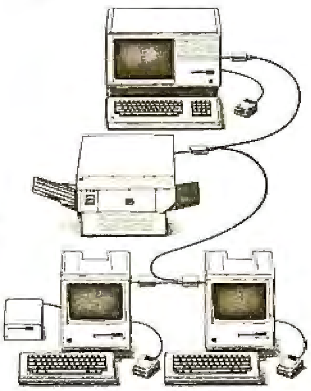

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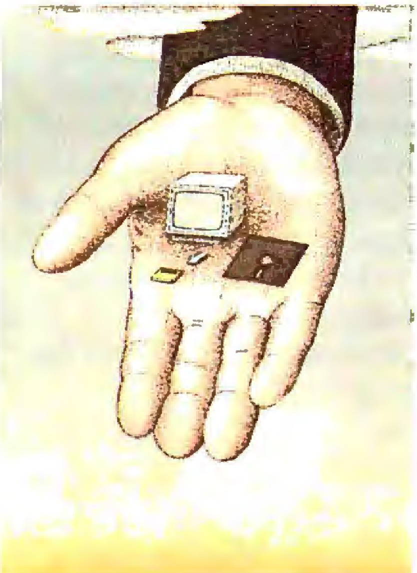

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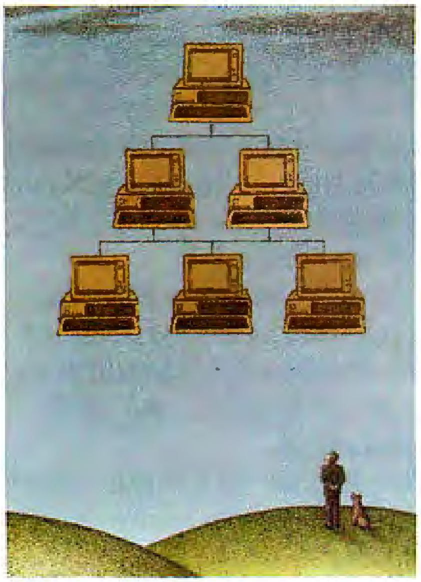

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REVIEWS

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BYTE May

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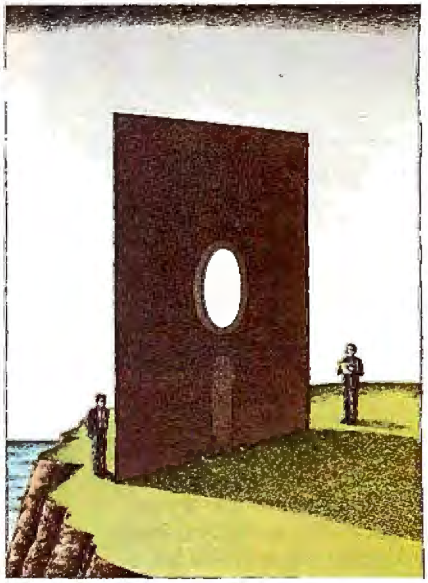

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BYTE'S READER POLL

Each month, several hundred BYTE readers vote in the reader poll called the BOMB (BYTE's Ongoing Monitor Box). We've done little to call attention to the poll but wish to do so now to urge increased participation. We take the BOMB results seriously. Besides awarding modest prizes to the writers whose articles win the most votes, we try to interpret the BOMB results in a way that will help us develop and choose articles that win the applause of BYTE readers.

Admittedly, several hundred votes from a circulation of 400,000 are neither a random sample nor a large one. We want to encourage you to vote on this month's articles to increase both the size and the significance of the BOMB results and to help us keep BYTE attuned to your needs.

The great majority of you have never voted in the BOMB and probably have never noticed the numbered list of articles published at the back of the magazine between the Unclassified Ads and the Reader Service index. The numbers on the list identify the articles for voting purposes. The ballot itself is one page further along, on the Reader Service card. Beneath the area where you circle Reader Service numbers to obtain information about advertised products, a smaller set of numbers lets you circle numbers to rate this month's articles. The ballot asks you to rate each article as excellent, good, fair, or poor. We assign weights to all these ratings to identify the best-liked articles.

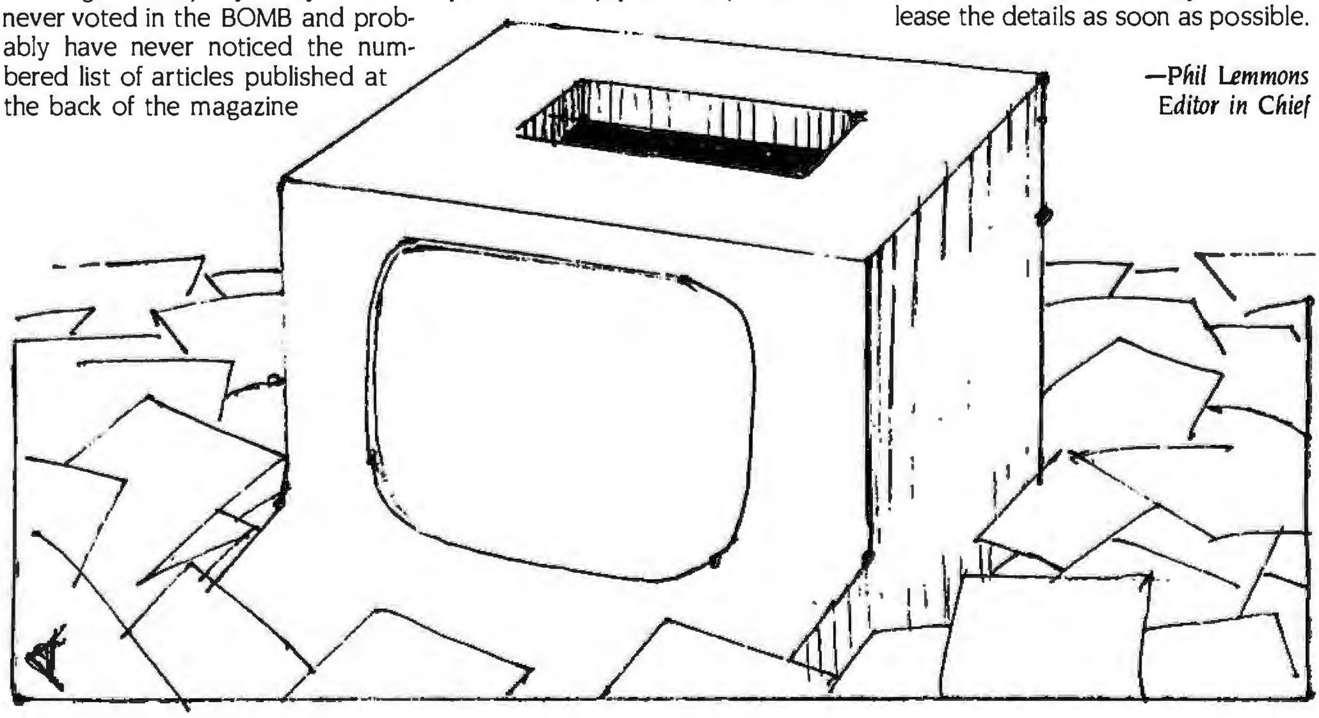
Steve Ciarcia and Jerry Pournelle are, of course, frequent winners of the BOMB, as are articles about major new personal computers. We do sometimes have surprises. A survey of statistical software scored very well, as did two articles examining the state of Soviet computers and electronics—Ruth Heuertz's look at Soviet microprocessors (April 1984) and Leo Bores's account of the Soviet Apple clone, AGAT (November 1984). We didn't realize how broad the appeal of statistics would be or how powerful people's curiosity about Soviet products, topics which lack the most important criterion of interest turned up in our reader research—emphasis on new technology.

Results that surprise us might not surprise you. Voting in the BOMB is the best way to keep us abreast of your interests and needs. We urge you to take a minute each month to make your opinion heard. We'll be listening when you do.

THE LONG-AWAITED BYTE INDEX

Finally. An index to the 1983 and 1984 issues of BYTE is now available. For a hard copy of this 48-page document, please send us $1 and we'll send you a copy postpaid. The index will also be available electronically. We'll release the details as soon as possible.

—Phil Lemmons
Editor in Chief



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

New Laser Printers May Outperform Canon's Engine

Two new printers from Konica and NEC may offer some advantages over the Canon LBP-CX engine used in Apple's and Hewlett-Packard's laser printers. The TMC Co., Wayne, PA, the U.S. distributor for Konica's LP-3010, says the newer laser printer is faster, will cost less to operate, and lasts longer than Canon's LBP-CX, but it is priced the same and offers the same 300-dot-per-inch (dpi) resolution.

While Canon suggests that the LBP-CX be used to print up to 3000 pages per month at a speed of 8 pages per minute, TMC says the LP-3010 can handle 10,000 copies per month at 10 pages per minute. The LP-3010 uses a $200 drum/toner cartridge the company says will last for 15,000 pages, while the LBP-CX's $99 cartridge must be replaced after 3000 copies. And while Canon suggests that the LBP-CX be "overhauled" at 100,000 pages, TMC says the LP-3010 will last for 600,000 pages.

TMC says that several OEMs have placed orders for the LP-3010 and will announce products early this summer; pricing for a low-end printer based on Konica's engine should start at about $3500. With more advanced capabilities, including full-page bit-mapped graphics, a Konica-based laser printer would be priced competitively with Apple's $6995 LaserWriter, TMC claims.

NEC Information Systems plans to begin shipping its own 8-page-per-minute, 300-dpi laser-class printer in late summer. NEC's printer uses an LED array rather than a laser. Because it is not based on copier technology, NEC claims the printer will last longer and require less service than laser printers. NEC's offering will feature three built-in fonts; two cartridges can add up to eight more fonts. NEC's 55-pound printer occupies only half the footprint of the heavier Canon-based printers. With a 64K-byte printer buffer and both serial and parallel ports, NEC's LED-array printer will sell for less than $3000. NEC is also considering unveiling one or more laser printers in the fall or winter.

A 300-dpi laser printer from Fujitsu is the basis of an even more advanced combination printer/scanner/copier that Corporate Data Sciences planned to unveil in April. Eight pages per minute can be digitized at 300 dpi. The image can then be stored or manipulated by a personal computer and printed. The unit will also work as a standard copying machine. The printer/scanner/copier will be priced at about $24,000; the 16-page-per-minute laser printer alone will sell for about $15,000. CDS says its laser-printer controller can also address higher-resolution laser printers, up to 1000 dpi, and it plans to offer a printer engine using a 480-dpi laser printer expected next year from Fujitsu.

DEC Revamps Rainbow to Match New PC Strategy

Stating that "stand-alone personal computing in the office is a thing of the past," Digital Equipment Corp. announced the Rainbow 190, designed to operate as a workstation for other DEC computers. With a 10-megabyte hard-disk drive, 640K bytes of memory, MS-DOS, and Rainbow Office Workstation software, the Rainbow 190 costs $6495. Also newly available for the Rainbow is the $595 WPS-PLUS word-processing program, already available on the VAX and ALL-IN-1 systems. DEC also announced a $295 DECnet interface for the Rainbow.

Fairchild Unveils First Single-Chip 212A 1200-bps Modem

Fairchild announced a single-chip 1200-bps modem that supports the Bell 212A standard. The Fairchild uA212A modem includes all signal-processing functions on a single chip, unlike previous applications that required several chips. To build a working modem, however, several other devices are required: A general-purpose microprocessor must handle dialing, handshaking protocols, and control functions, while other circuitry must handle RS-232C and telephone interfaces and ring detection. The chip should be available by June for $82.67 in quantities of 100.

(continued)

Firms Show Chinese-Language Word Processors

Two companies are developing Chinese-language word processors for the 512K-byte IBM PC using a standard American keyboard. Chinese Computer Communications, Lansing, MI, is showing PC 2001, which uses the company's own Pinxxiee input method: the company hasn't yet set a shipping date but hopes to price the software at about $795.

Asiagraphics Corp., Port Jefferson, NY, expected to begin shipping its Asiagraphics System in April for $995. This product employs a "descriptor" input method, using one of three Chinese phonetic systems (pinyin, Wade-Giles, or Bopomofo). Asiagraphics also plans Korean and Japanese versions and hopes to allow use of the IBM graphics adapter as well as the Hercules graphics card now supported.

IBM Puts Series/1 on a Chip, in an IBM PC Box

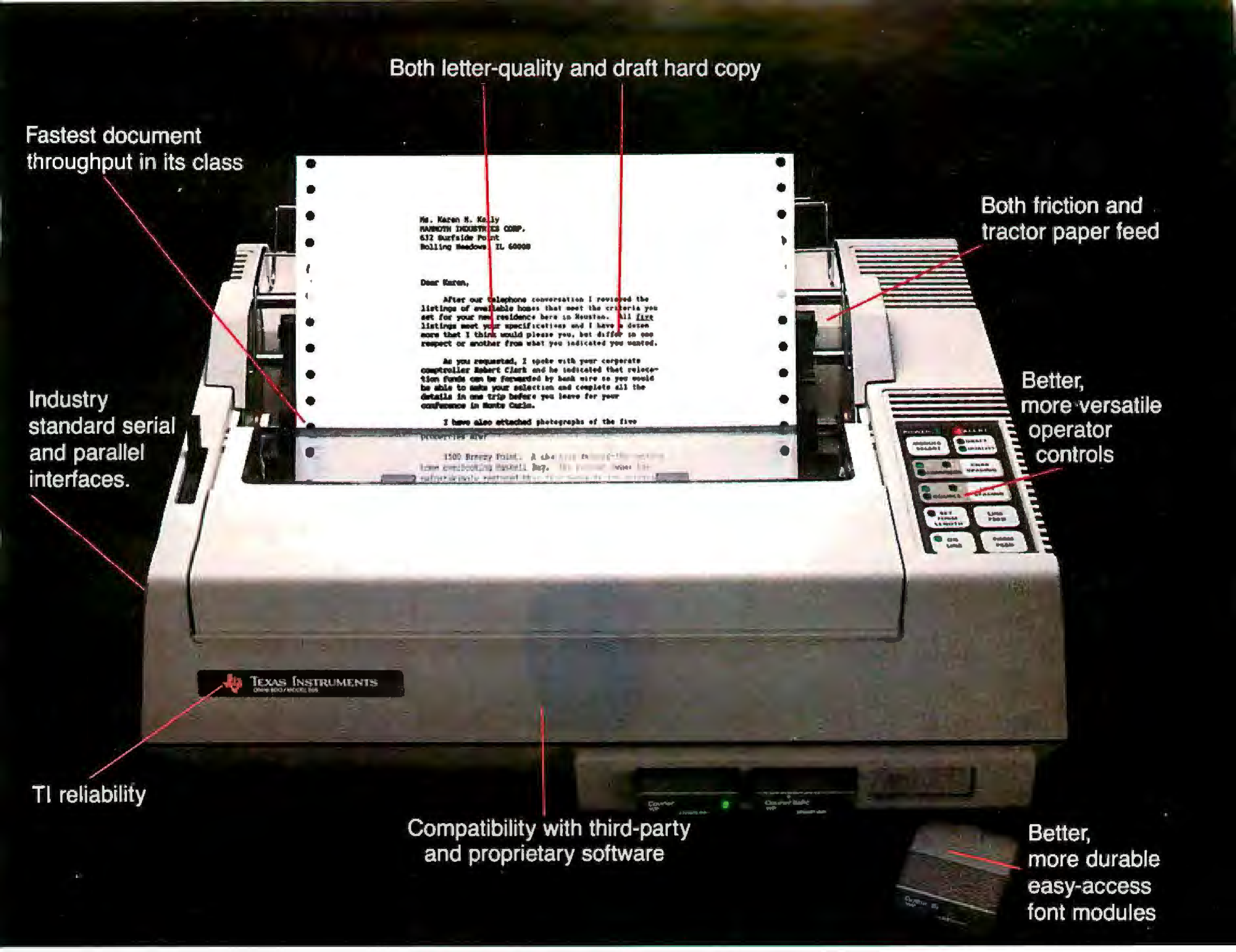
IBM has put its Series/1 computer architecture onto a single proprietary 16-bit microprocessor and announced versions of the IBM PC XT and AT that include the Series/1 chip and related circuits on two IBM PC expansion cards. The Series/1 5170 Model 495 is an IBM PC AT with the Series/1 expansion cards, a monochrome adapter and monitor, a 20-megabyte hard disk, and a 1.2-megabyte floppy-disk drive. It is priced at $9420. The Model 4950, based on the IBM PC XT, includes a 10-megabyte hard disk and one 320K-byte floppy-disk drive for $8130. IBM will stress the new system's usefulness as a file server in a network environment.

Morrow Upgrades Pivot: Fully IBM-Compatible

Morrow Designs has redesigned its Pivot portable computer to add a 25-line display and to make it more compatible with the IBM PC. The new Pivot, which Morrow hoped to begin shipping this month, will feature a backlit 25-line by 80-character liquid-crystal display, serial and parallel ports, two 5¼-inch disk drives, 256K bytes of RAM (expandable to 640K), rechargeable batteries, MS-DOS, and NewWord. Optional internal expansions will include an RGB/composite video output adapter and a 300/1200-bps modem. An optional expansion chassis is also planned. Morrow plans to price the two-drive machine at about $2995; it had already dropped the price of the 16-line Pivot to $1995 in March.

NANOBYTES

Optionware Inc. introduced OptionWord+, a $100 word-processing template for Lotus 1-2-3 . . . . **AT&T** introduced its long-expected UNIX personal computer. For details, see page 98 . . . . **Intel** has sued **NEC**, charging that NEC's V20 and V30 microprocessors violate Intel's copyright for the microcode used in the 8088 and 8086 . . . . **Apple** has developed a version of Smalltalk that runs on the Macintosh XL. Because it doesn't run on a standard Macintosh, Apple is selling it only on a limited basis, mostly to universities. . . . **Microsoft** has released a new version of Multiplan for the IBM PC. Multiplan 2.0 supports keyboard macros and has faster recalculation and a larger virtual spreadsheet (256- by 4096-cell). . . . For the Macintosh, **Microsoft** announced a run-time Microsoft BASIC interpreter, which software developers can distribute with programs they sell . . . . **Microsoft** also announced Excel, a sophisticated spreadsheet for the Macintosh (see page 44) . . . . **Summa Technologies** announced a site license-fee program under which buyers can make unlimited copies of a program for use by company employees—including personal use—for as little as $9800 . . . . **Prometheus**, Fremont, CA, now offers a version of its ProModem 300/1200-bps modem for the Macintosh. With ProCom-M telecommunications software and a cable, it's $549 . . . . **Prometheus** also planned to introduce a compact 300-bps modem for the Apple IIc for less than $200. The modem will provide an extra serial port and uses the IIc's power signal . . . . **Manzana**, Isla Vista, CA, is selling a double-sided 3½-inch disk drive for the IBM PC. The external 720K-byte drive is $625 . . . . **Advanced Micro Devices** expected to begin shipping samples of the 20-MHz 29PL141 microcode-programmable controller this month . . . . **Nestar Systems Inc.** announced a six-port HUB for its baseband LAN system that allows it to interface to a broadband network . . . . **Roger Wagner Publishing**, San Diego, CA, is developing a MacWrite-like word processor for the Apple IIc and IIe. MouseWrite takes advantage of the MouseText ROM included in the IIc and newer IIe models . . . . **Intel** announced OpenNET, a local-area-network (LAN) product line that incorporates Microsoft's Networks (MS-NET) software.



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Cryptographic Message Sending

Thank you for Charles Kluepfel's article, "Implementing Cryptographic Algorithms on Microcomputers" (October 1984, page 126). This is an area in which I have an interest and would like to see more articles in the future, especially on the practical aspects of making and using a large-scale (widely used) public-key cryptography (PKC) system.

An assumption that some people make is that the telephone system is a perfect "channel," that is, that all information put into one end will reach its destination and come out the other end. This is not necessarily true. It is definitely not true when a store-and-forward system such as an electronic-mail or electronic bulletin-board system is used. Since many messages sent in a PKC system will be longer than the maximum number of digits that can be encoded, the message will have to be broken into segments, each segment being encoded and sent separately. This raises the possibility of a third party (with or without the telephone company's approval) intercepting and preventing one or more segments from reaching the intended recipient, while letting other segments pass through. Even without the ability to decode the intercepted segments, a third party could do great damage to both the sender and recipient due to the recipient's assuming that the entire message was received, when in fact it was not. Under some conditions, damage could also be done by rearranging the order of the segments, if the recipient was to assume that they were sent in the same order as received. (Admittedly, such situations would be rare.)

The telephone company should not be thought of as a "channel," but rather as a third party that can usually be trusted to deliver *some* of the segments of the message. It is up to the sender and recipient to ensure that all segments arrive and are put into their proper order before taking action on the basis of a message received.

A possible method of achieving this would be to include in each segment a four- or five-character (or more) code, randomly chosen and different for each segment within a message. These random characters would be inserted into the plain text before the segment was encoded with the recipient's public key. Then the last segment sent would contain a repetition of all of these codes in their correct order. The recipient could check to make sure each segment had arrived and was in its proper order. Any segments containing codes not repeated in the final segment would be discarded.

Briefly covered in the article was the topic of a sender using his own private key to provide a "signature" to a message. For ordinary messages, only the last segment (containing the repeated random codes from all the other segments) need be signed. However, if an electronic contract is desired, all segments of the message should be encoded with both the sender's private key and the recipient's public one. This is to prevent the recipient from altering a segment (while keeping the same random code) and then claiming his copy to be the true contract. This means that in order to prove a contract, the recipient would have to provide a copy of each segment exactly as it was received from the modem and a copy of each segment after it was completely decoded into plain text. The arbitrator of a contract dispute need only encode the plain-text segment with the recipient's public key and "decode" the "segment as received" with the sender's public key. Comparing the two resulting segments should show them to be exactly alike, thus proving that the segment came from the sender that the recipient claims sent it. The recipient need not disclose his private key to the arbitrator.

Actually, the first segment of every message, ordinary or contract, should be encoded only with the recipient's public key and should contain information of who the sender is, so that the recipient can apply the right key to decode any signed segments. Otherwise, that information would have to be sent in plain text (horror!). Also, in order to prevent the recipient from reusing the sender's signed last segment (containing the repeated random codes) to send a falsely signed message to someone else, the sender should include identification of the intended recipient in the plain text of all signed segments. It wouldn't hurt to include the date and time as well.

Paul S. Burney
Portland, OR

Charles Kluepfel replies:
To protect against nonreception of segments of the message, the scheme need not be as complex as Mr. Burney suggests. The sequence code that he suggests at the beginning of each segment can be merely 00001, 00002, etc., without the need for a key as the last segment. This insertion is, as he states, before encryption, and the nature of this code prevents the presence of these or any known message contents from making the code breakable. Indeed, as the code used for message sending (as opposed to signature forming) is public, anyone trying to intercept code can himself encode 00001, etc. It does not aid the interceptor and thus can be safely used by the legitimate parties.

As for the portion regarding electronic signatures, encoding by the sender's private key is sufficient so that the recipient cannot alter the message. The use of the recipient's public key would not be of any further benefit. The recipient cannot produce a new message that is encoded by the sender's private key, that is, one that is decodable by the sender's public key. What must be guarded against, rather, is that the sender might claim to have sent further segments, modifying the intent of the message. The only way to guard against any disagreement is to have the entire document signed by both parties. Since signing is

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encoding by the private key, each party must do encoding by private key of all segments. It can be by each separately encoding the plain text, or by the plain text being encoded by one, and the resulting text further encoded by the recipient's private code. Of course the sender must then get a copy of this further-encoded text to later prove the recipient agreed to it. The sender's private and recipient's public encoding does not assure a contract, only that the sender sent it.

To assure any segment came from the sender, it would have to be encoded in the sender's private key. Including the recipient's name in the one (or few) signed segment(s) in no way prevents forgery of unsigned segments.

More on Binary Trees

I quite agree with John Snyder's remark, in his response to Lawrence Leinweber's letter ("Binary Trees Explained," September 1984, page 22), that there is no "proper solution" in software to a given problem.

On the other hand, with regard to his "A-trees," I'm sure that he finds them simple. After all, he wrote the article ("Indexing Open-Ended Tree Structures," May 1984, page 406). Algorithms by definition are simple, once you've successfully implemented them. Otherwise, you would never have gotten that far.

Any given data structure is as simple as its presentation, which brings me to my next point. Mr. Leinweber's C routine for tree searching managed to obscure what ought to be an obvious data structure. It would have been far more effective to present one of D. E. Knuth's diagrams from section 2.3 of *The Art of Computer Programming, Volume 1: Fundamental Algorithms* (Reading, MA: Addison-Wesley, 1974).

Frankly, I'm still not sure whether Mr. Leinweber's routines were meant to search a generalized tree implemented as a binary tree or simply a binary tree. I refuse to spend more than five minutes deciphering a five-line text in any language that I supposedly understand.

Finally, Dr. Snyder, since when are binary trees sometimes called B-trees? Binary-tree nodes have at most two children (and possibly none) and by no means fulfill the well-defined properties of a B-tree (see the section on trees in Niklaus Wirth's *Algorithms Plus Data Structures Equals Programs*; Englewood Cliffs, NJ: Prentice-Hall, 1976). I've always assumed that the "B" stands

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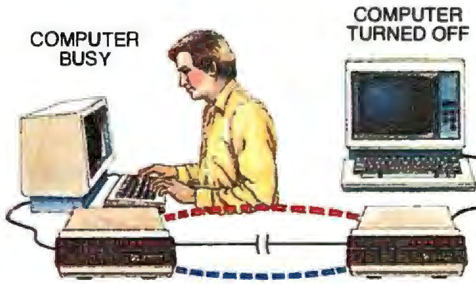

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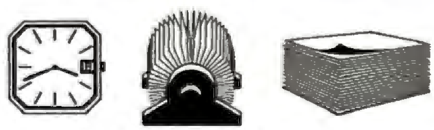
ProModem 1200 is Hayes compatible but that's where the resemblance ends. Our standard $495 modem includes a real-time clock/calendar. Hayes charges hundreds more for a Smart Modem with a time-base. Nor do they have electronic mail capability at any price.



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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for "balanced," which is what makes them so popular. They never degenerate into a linear linked list, which is what a binary tree is prone to do under certain input conditions (keys arriving in a well-ordered sequence).

C is a horrible language for clarifying ideas. What's wrong with English or, better still, pictures?

I. Caron
Kibbutz Ga'ash
Israel 60950

The Macintosh Debate Goes On

For years I have wanted a computer of my own; the type of work I do literally demands one. What had kept me from buying one had been a growing awareness of the fact that, while I was previously a slave to the thousands of bits of data I was entering into my file cabinet manually, none of the personal computers I had been considering would do more than put me hopelessly behind because I would be spending all of my time learning how to use the machine. Seven months ago I bought the Apple Macintosh, and my methods for using the information I collect in my work have changed dramatically. Indeed, for the past few months I have been imagining countless ways of using this data in ways I could have never hoped to use it if I did not have the Macintosh.

Which brings me to the essence of this letter. So much has been written about the Macintosh in various parts of your January issue that I find it difficult to address just one of the points that have been made. The three letters appearing on pages 26 to 32 seem befitting testimonials to the positivism most Macintosh owners express; Bill Benzon's article on MacPaint as a thought-process tool is, clearly, the most provocative piece I have seen written on any computer/application; and Steve Wozniak's description of his experiences at the University of California at Berkeley, coupled with the naive comments of Jerry Pournelle, serve to solidify my disdain for the conventional wisdom of the computer world. What is even more amusing is that I work for a company that perpetuates this conventional wisdom by choosing to ignore completely the existence of the technology embodied in the Macintosh and deciding to introduce a line of software only for IBM PCs.

I am not saying here that the Macintosh is the perfect machine. Surely, what we have in it is only a promise of what could

(continued)

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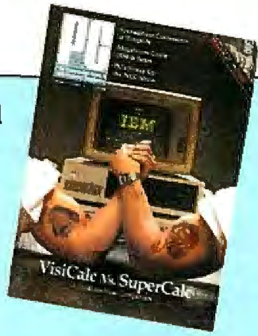

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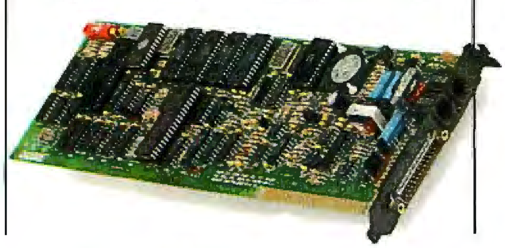

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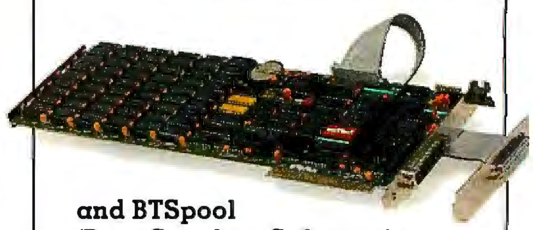

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be done with the computer if only all of those "me, too" marketers who want a financial ride on IBM's coattails could understand that the merry-go-round has to stop some time. It is, futhermore, an indictment of American business at large of its failure to identify and satisfy its customers' changing needs—a phenomenon that is known in marketing as "Harley-Davidson Syndrome." There isn't a month that goes by that someone somewhere doesn't introduce another word processor for the IBM machine, while over here in the Macintosh world, Microsoft is about to introduce the *only* alternative to MacWrite.

History has shown us many times what happens to those "madmen" who introduce new concepts. Invariably they were either burned at the stake as heretics or at least exiled to some uncivilized land where their unconventional wisdom could do no detriment. Strangely enough, their tenets have, somehow, managed to pervade our everyday lives. In some senses I often wonder why we don't continue to think of the world as flat.

STEVEN G. BAIRD
Baton Rouge, LA

Both detractors and defenders of the Macintosh have been surprisingly undiscerning regarding the performance of the Sony microfloppies. Clearly one spends considerable time listening to the Sony play tunes. So Jerry Pournelle concludes the drives are "painfully slow" (August 1984 BYTE, page 316). A guy confesses anonymously to John Dvorak (*InfoWorld*, November 26, 1984) that he has changed his mind about the Mac: "The big flaw is clearly the slow, small Sonys and the big overhead on starting and ending use of any serious programs." A Mac defender in your Letters section, Selden Deemer, concedes that the Mac is not without its faults: "Among the worst of these is the perpetuation of a disk-drive controller that lacks direct memory access. . . .The drives are maddeningly slow" (November 1984, page 18). Indeed, the Mac would be fatally crippled if this were true.

In fact, it ain't so. From MBASIC, the standard BYTE disk benchmark shows the Mac writing the standard 64K-byte sequential file in 25.2 seconds, reading same in 23. In both cases this is twice as quickly as the IBM PC under MS-DOS. By using the FIELD statement to PUT and GET four 16K-byte strings to a relative file, reducing BASIC overhead, one gets even closer to the hardware potential of the Mac/Sonys: 64K bytes of data are written in 6 seconds, read in 5 seconds. That is faster than the IBM PC XT runs the standard benchmark using the fixed drive (about 8 seconds each way). Finally, using the DiskCopy utility included with the Finder update, one reads 100K bytes in 4 to 5 seconds, writes 100K bytes in 7 to 8 seconds. That is not slow. Hasn't anyone noticed?

Clearly, it is software overhead, not hardware limitations, that accounts for the long waits while the Mac sings.

WILLIAM MILLER
Cleveland Hts., OH

The many arguments in the Macintosh debate, which has become a leitmotiv on your pages, seem to focus not on the niftiness of the Macintosh's special features but rather on their significance. Bill Benzon's article, "The Visual Mind and the Macintosh" (January, page 113), eloquently related the importance of the Macintosh to the role of visual images in creative thinking and persuasive communication.

But why should visual thinking and visual communication suddenly seem so important in the first place? Another perspective on the significance of the Mac is to see it in relation to the increasingly visual nature of all communication in recent history.

A middle-class burgher in, say, 17th-century Amsterdam probably saw three or four hundred artificial images (paintings, drawings, engravings, and so on) in a lifetime. In this world of television, advertising, and personalized T-shirts, we process that many images in a day! The phrase "Age of Information" usually connotes the invention and spread of the computer since World War II, but this period also witnessed the emergence of today's huge graphics and advertising industries. In 1971 (when Alan Kay was designing Smalltalk), there were 697,000 artists in the U.S., according to the Bureau of Labor Statistics. Ten years later, there were 1,055,000 artists, including 223,000 designers and 106,000 photographers. Today even the smallest company has a graphic logo and a "corporate identification" program—a practice almost unheard of 30 years ago.

Articles and books whose subject is the "information age" often make the point that the ever-increasing volume of information generated in the world is inevitable; the real issue, though, is how to give it useful shape and dimension. Visual communications does precisely that: It shapes information, gives it character, and streamlines it for faster travel to its target audience. Design is the art of taking a message and giving it impact through typography, composition, and both abstract as well as representational drawing and coloring.

As the information environment becomes ever fuller and noisier, the stakes are continually raised for those who want their message to carry above the din, which means new tools and techniques are needed to communicate effectively. In treating all information as visual information and greatly simplifying methods of combining verbal and visual information, the Macintosh is in harmony with the broad lines of evolution in human communication. (I've had mine for two weeks, and already my mouse finger is getting stronger.)

JIM HOEKEMA
Salt Lake City, UT

SUPPORT IS WHERE YOU FIND IT

I would like to comment on the letters concerning lack of Apple support ("No Support from Apple," February, page 18) and how I dealt with this problem since purchasing a IIc in June 1984.

The Apple IIc is being marketed as the somewhat portable version of the IIe with over 95 percent of IIe software running on the IIc. Therefore, any manual covering Applesoft as implemented on the IIe should be about 95 percent applicable to the IIc. This I quickly found to be true. For assembly-language programming, advanced BASIC programming, and a description of the Apple II family firmware (up to the IIe), Paul Irwin's *Apple Programmer's Handbook* (Indianapolis, IN: Howard W. Sams & Co., 1984) is exceptional. Major computer publications have described Apple's ProDOS, summarizing its many DOS 3.3 similarities and new features such as its UNIX-like nested hierarchical directory structure, RAM-disk support for the extra 64K bytes of memory, etc. The best summaries (nearly 100 percent coverage of features and commands) have appeared in BYTE ("ProDOS" by Rob Moore, February 1984, page 252) and *Apple Orchard* ("Introducing ProDOS" by Morgan P. Caffrey, January 1984, page 12). The former mentions all ProDOS-related publications by Apple. A thorough non-Apple description of ProDOS, combining the best segments of *BASIC Programming with ProDOS* and the *ProDOS Technical Reference Manual*, is given in John Campbell's *Inside Apple's ProDOS* (Reston, VA: Reston Publishing Co., 1984). Although the text is informative, the book has several typographical errors. A small paperback entitled *An Introduction to the Apple IIc* documents the serial-port and mouse-port pin outputs, among others, in its appendixes.

All the substitute texts mentioned above served very well until late October 1984, when several New York dealers received the *entire* complement of Apple documentation. A one-stop source for documentation has been the McGraw-Hill Bookstore, 1221 Avenue of the Americas, New York, NY 10020. Here I purchased the *Apple IIc Reference Manual*, *ProDOS Technical Reference Manual*, and *BASIC Programming with ProDOS*. Note that the *ProDOS Technical Reference Manual* is part of the "WorkBench" series of documents in loose-leaf format that can only be purchased separately and whose unusual page size fits best in Apple's "WorkBench" binder ($8). All the substitute texts purchased originally continue to be useful except Mr. Campbell's book, now completely redundant.

Thus, it would seem that the availability of Apple documentation continues to be a problem, but however late, the documentation did appear. The *IIc Reference* and the *ProDOS Technical* manuals have a few typographical errors that must not be considered lightly, since the text deals mostly with system software. I have programmed in BASIC quite extensively on an IBM PC XT, using PC-DOS 2.1 quite frequently. Although IBM manuals have been much more available, they have been consistently difficult to read, and as a physician-in-training with severe time constraints, I find that the clarity of Apple's presentation and the structure of ProDOS still puts Apple on top on my list. Its difficulties have mainly been eased by the availability of excellent documentation by third parties, a condition which has always been part of Apple's continued success.

MARVIN E. GOZUM, M.D.
Brooklyn, NY

After reading of some problems encountered by your readers in obtaining Apple technical manuals, I thought my own experience might be of interest.

After purchasing my IIe I wanted to purchase the technical reference manual but was surprised to learn that it was not available from my dealer. I checked around and learned that most dealers in this area did not stock the manual. After some digging, I learned that the dealers do not stock the manuals because they

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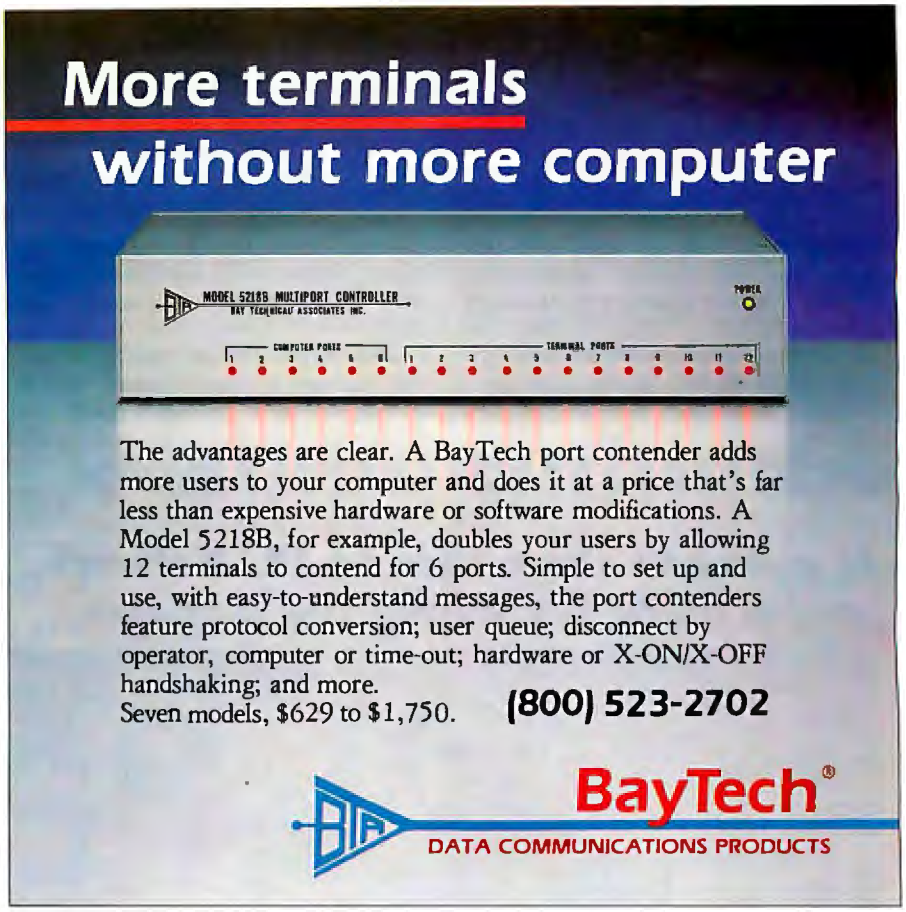

are considered very low dollar items that are "not worth the bother." Apple understandably requires dealers to purchase the manuals in lots of five. Evidently, the prevalent feeling among dealers is that the manuals will not be hot-selling items, and they do not want to deal with them. Two dealers told me this directly.

Fortunately, I was able to locate a store that regularly stocks all manuals but occasionally runs out due to demand. According to them, they have had no problems or unusual delays in getting the manuals from Apple. I now have *BASIC Programming with ProDOS*, *ProDOS Users Kit*, and the *Apple IIe Reference Manual*, all supposedly rare books but obtained with very little effort. Right after I purchased *BASIC Programming with ProDOS*, two dealers told me it was not yet available from Apple, and one dealer told me it was too much trouble to order.

I have found the manuals to be excellent—among the best I have seen. It may not be the same in all areas, but I believe that the problem lies more in the failure of dealers to provide for customer needs rather than insufficient support from Apple.

STEVE A. MUNCY
Dallas, TX

I read with interest the three letters under the heading "No Support from Apple" in your February Letters section. Although I missed the letter to which they referred, I felt I had to tell my experience with getting manuals.

The manuals named in the three letters are all manuals that I've wanted, with the exception of the *Apple IIc Reference Manual* because I have a IIe. Anyway, I no more than asked if my local dealer could get these for me and I had them. I waited one week for both the *ProDOS Users Kit* and the Applesoft manuals, both volumes. I had to wait three weeks for the *ProDOS Technical Reference Manual*, and it didn't bother me a bit. I'm sure that when the time comes that I want another manual I'll have it in short order.

I have had no problem at all with getting information on the Apple. In fact, when I found out that there was an update for ProDOS, I asked my dealer if he had it. He said he didn't even know there was one, but two days later he called and said he had it. I stopped by and picked up a copy and was on my way in a total time expenditure of 10 minutes. Maybe I'm lucky to have this dealer, but I wanted your readers to know that not everyone has problems getting the information they want.

BRAD W. HANSEN
Apple Valley, MN

A RAM Disk for the Mac

In his letter (under the heading "Take Back Your Mac," February, page 22), Don Slaughter pleads for RAM-disk software for the 512K-byte Macintosh and hopes for a "reasonable price ($50 or less)."

A public-domain RAM disk is available and can be downloaded from CompuServe's MAUG area (you need to be knowledgeable in the use of "BinHex.Hex" to download it and "Rmover" to install it).

Assimilation Process (20833 Stevens Creek Blvd., Suite 101, Cupertino, CA 95014) has been advertising the

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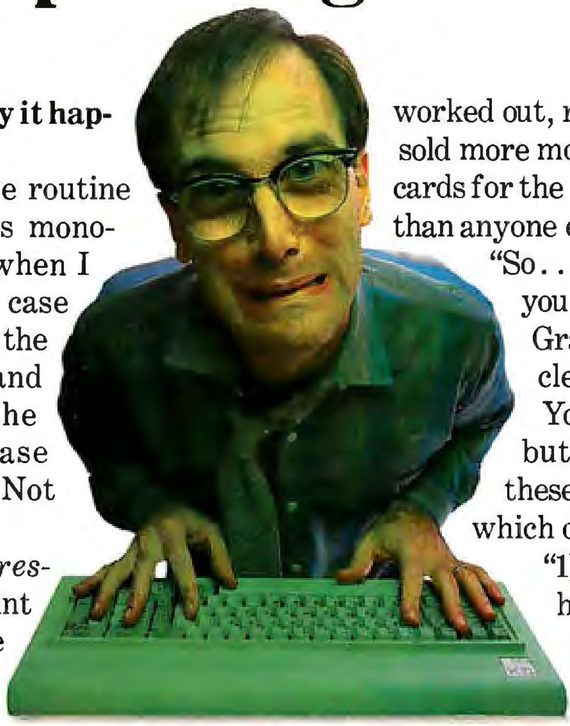
If you don't have a Hercules Graphics Card, you could end up looking like this:



"I know, because one day it happened to me...

"I was running some routine tests on a non-Hercules monochrome graphics card when I was struck by a severe case of *low resolutionitis*. I'm the president of Hercules and that's me exhibiting the symptoms of the disease in its advanced stages. Not a pretty sight, is it?

"What causes *low resolutionitis?* Experts point to ordinary monochrome graphics cards with coarse, hard-to-read graphics. A bad case of eyestrain may develop if action is not taken immediately.

"Fortunately for me, a Hercules Graphics Card was nearby. A quick change brought soothing 720 x 348 graphics. That's twice the resolution of ordinary 640 x 200 graphics cards.

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"Oh, and don't forget that a parallel printer port is standard on the Hercules Graphics Card, not an extra cost option.

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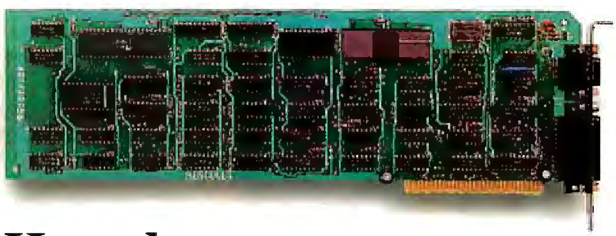
"Call **1-800-532-0600 Ext 408** for the name of the Hercules dealer nearest you and we'll rush you our free info kit.



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Mac•Memory•Disk for several months in both *MacWorld* and *A+*. This product sells for $29. I had no trouble getting copies through a local dealer, and it does everything Mr. Slaughter wants and more. The RAM disk can be set anywhere from about 30K to 300K, and any set of files can be automatically copied into it as part of the boot process.

Network Consulting Inc. (110-3700 Gilmore Way, Burnaby, BC V5G 4M1, Canada) has a $29.95 RAM-disk product in the beta-test stage that does a bit more than Mac•Memory•Disk.

DANIEL P. B. SMITH
Norwood, MA

Shortly after mailing my letter I learned that Assimilation Process of Cupertino, California, was planning to release RAM-disk software.

The Mac•Memory•Disk (as it is called) will only open a maximum of a 315K RAM disk on a 512K Mac, though it will open a RAM disk in excess of 700K on a Lisa running MacWorks with 1 megabyte of memory.

My experience in testing the speed of operation quickly showed that to obtain substantial speed gains in loading and exiting applications software on the Mac, the operating system of the Mac must be loaded into the RAM disk. It seems that most applications, on being double-clicked, must then do extensive accessing of the operating system to load.

But if the operating system is loaded into the RAM disk, this effectively leaves only about 100K left in the RAM disk (using the 512K Mac with 316K RAM disk) for the application software. MacPaint, when copied into such an environment, won't even open a disk file because there isn't enough room left on the disk for one.

MacWrite will create very small data files in that environment. Clearly, such an environment is adequate neither for business nor for software development. But Apple will not offer 1-megabyte caches for its products from now on except in the $4000-plus Macintosh XL (Lisa 2/10 with hard disk) or the $6995 laser printer. The evidence suggests that a relatively inexpensive 1-megabyte Mac (below $3500) will not be offered before January of 1986 (perhaps in the guise of using 1-megabit chips on a new main circuit board), if ever. My summary of these facts is that I am disappointed, and I think Apple has goofed.

DON SLAUGHTER
Seattle, WA

MODULA-2 REVISITED

I would like to correct some readers' misunderstandings and possibly add some fuel to the fire of the Pascal versus Modula-2 debate.

In my article on Modula-2 ("An Introduction to Modula-2," August 1984, BYTE page 195), I use the following example:

```
IF (oregano IN recipe[1])
  THEN
    IF (thyme IN recipe[1])
      THEN
        WriteString('Use oregano
          and thyme')
    END
  ELSE  WriteString('No  oregano');
END
```

(continued)

A few smart reasons to buy our smart modem:

Features	Ven-Tel 1200 PLUS	Hayes
1200 and 300 baud, auto-dial, auto-answer	Yes	Yes
Compatible with "AT" command set	Yes	Yes
Can be used with CROSSTALK-XVI or Smartcom II software	Yes	Yes
Regulated DC power pack for cool, reliable operation	Yes	**No**
Eight indicator lights to display modem status	Yes	Yes
Speaker to monitor call progress	Yes	Yes
Attractive, compact aluminum case	Yes	Yes
Two built-in phone connectors	Yes	**No**
Compatible with The Source and Dow Jones News Retrieval	Yes	Yes
Unattended remote test capability	Yes	**No**
Phone cable included	Yes	Yes
Availability	Now	
Price	**$499**	**$699**

The Ven-Tel 1200 PLUS offers high speed, reliable telecommunications for your personal computer or terminal. Whether you use information services or transfer data from computer to computer, the Ven-Tel 1200 PLUS is the best product around. Available at leading computer dealers and distributors nationwide.

Also from Ven-Tel: internal modems for the IBM and HP-150 Personal Computers with all of the features of the 1200 PLUS.

You choose. The Ven-Tel 1200 PLUS— the smartest choice in modems.

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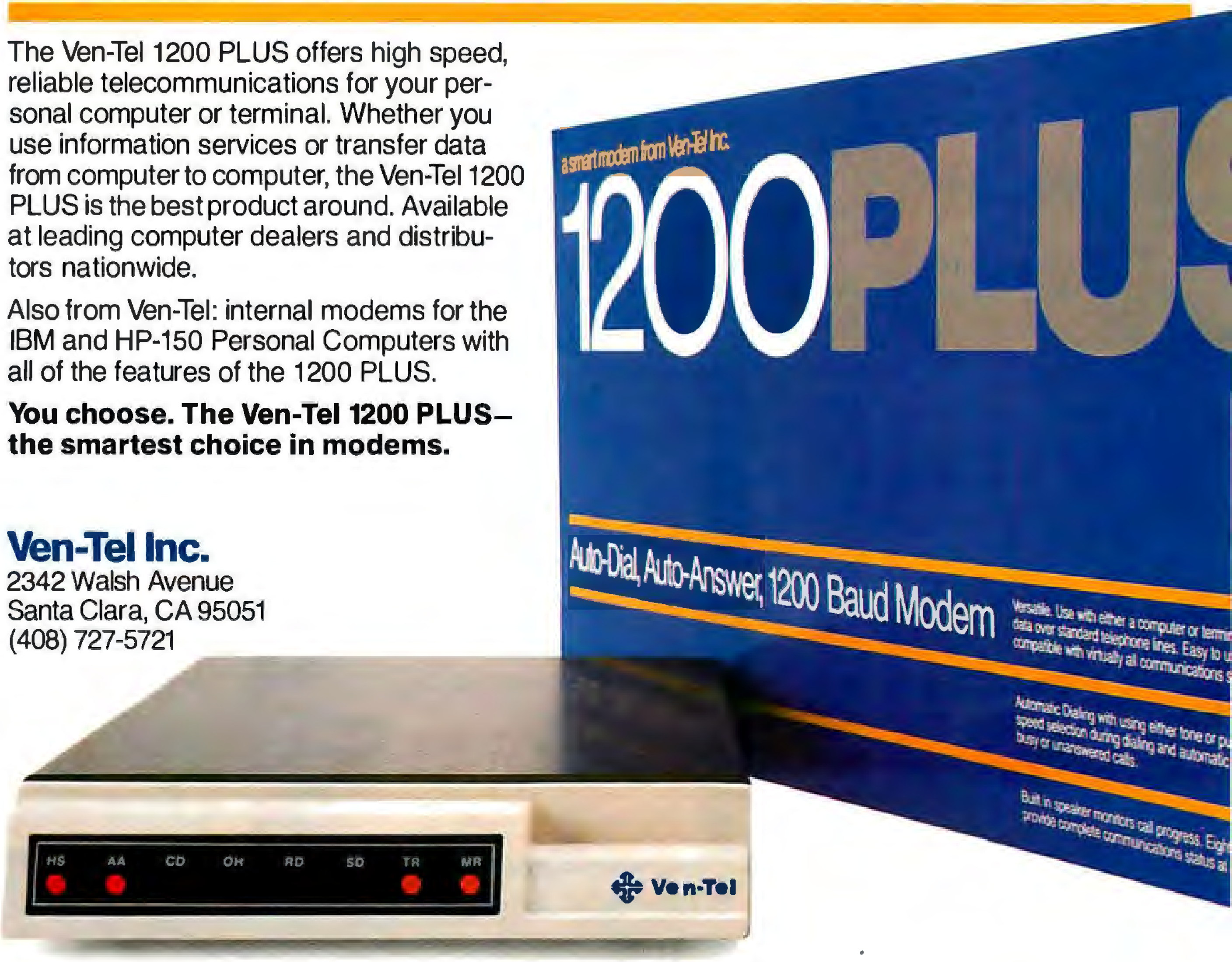
(408) 727-5721



Crosstalk is a trademark of Microstuf; Hayes and Smartcom II are trademarks of Hayes Microcomputer Products.

Inquiry 406

PRINTOUTS TH

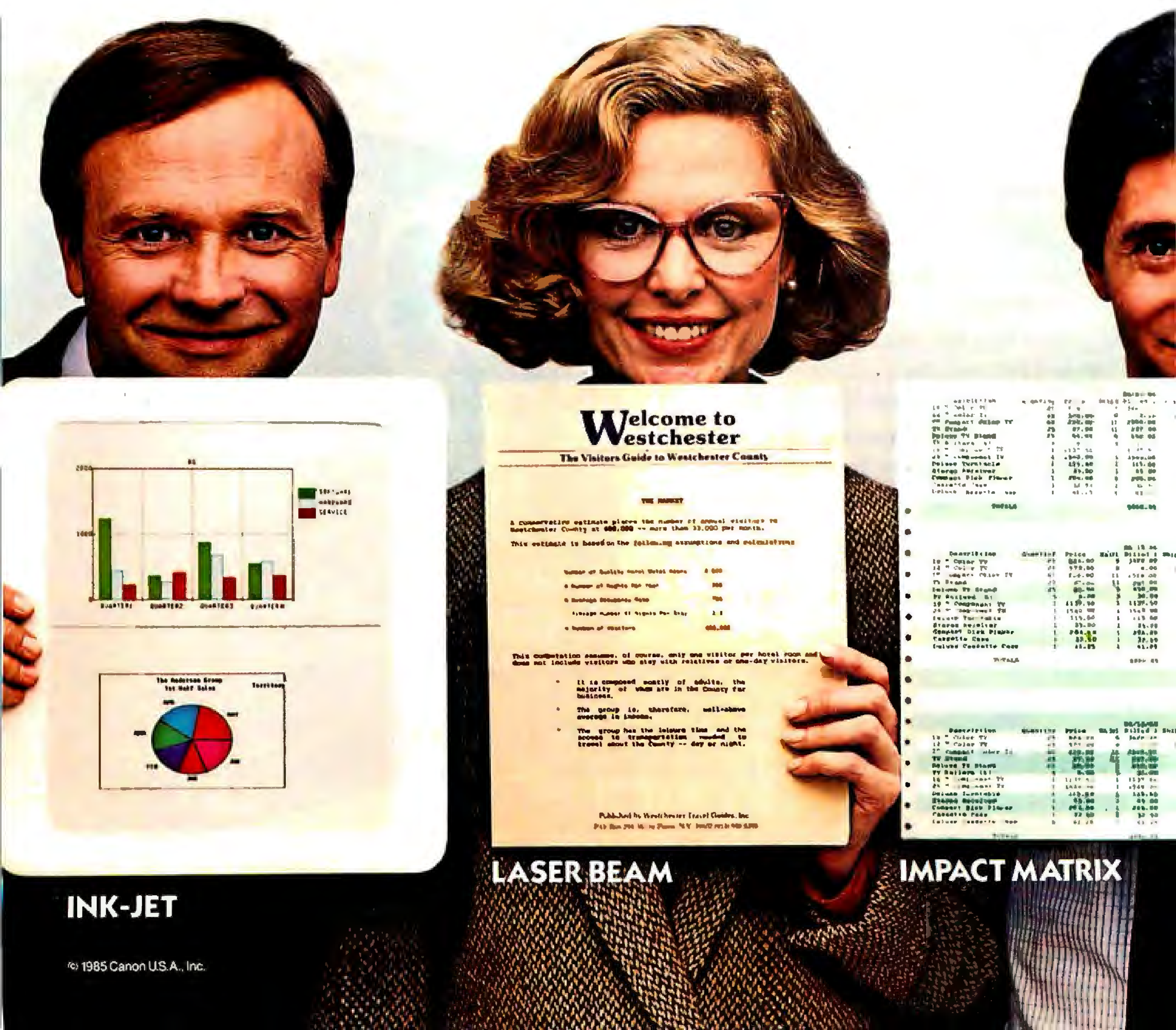
Take a close look at Canon's line ot printers. The first thing you'll notice is how good they make you look.

That's because Canon's experience in high-tech optics really shows. For instance, Canon was among the first to make a desktop Laser Beam Printer. At a price that's within any business's reach, the Canon Laser Printer can produce eight pages a minute with a quality that's more in common with a professional print shop than a personal computer.

Canon also developed the ingenious Bubble-Jet Printer technology, finally making it possible for a printer to not only work extremely quickly but also incredibly quietly.

Our Ink-Jet Printer can produce exceptionally sharp, high-resolution graphics in seven colors, even on transparencies. While the Thermal Transfer Printer has three kinds of print modes, including letter quality, at a very competitive price.

And the Canon Impact Matrix Series, for regular and extra-wide column paper, makes printing very fast, very economical.



LETTERS

Edmund Ramm offers this Pascal alternative in his recent letter ("Modula-2: Overrated?" February, page 30):

```
IF        (oregano IN recipe[1])
       AND
          (thyme IN recipe[1])
THEN
   WRITELN('Use oregano & thyme')
ELSE
   WRITELN('Use only thyme');
```

These two program fragments are not, in fact, equivalent; a point I was trying to make. The Modula-2 version is completely unambiguous and requires that one string be printed if both are included, a different string be printed if only thyme is included, and no action whatsoever if oregano is included but thyme is not. This three-case action requires a nested IF statement and can easily be misstated in Pascal, as I demonstrated on page 198 of my article. I hope that this clears up the misunderstanding.

Robert J. Paul
Watertown, MA

Icons Are Okay

In her letter regarding icons and the Macintosh, Ann Marchant states that the superiority of an alphabetic system to a pictographic system is "readily apparent" ("Icons Are Arcane," February, page 24), but she provides no evidence. We have recently done some experiments that bear on this issue (Muter and Johns, "Learning Logographies and Alphabetic Codes," *Human Learning*, in press) and we found that, under a reasonably wide range of conditions, pictographic writing systems were easier to learn to read than alphabetic writing systems.

Paul Muter
Psychology Department
University of Toronto
Toronto, Ontario M5S 1A1
Canada

An Alternative to Piracy

In a recent issue, one anonymous letter to the editor was attributed to a software pirate ("A Pirate Confesses," February, page 16). The pirate admitted displeasure with pirating software but stated it was necessary to do so.

The writer's central thesis was that software should be tried before it is purchased, since in no other way can the purchaser be sure that the software will perform as advertised or that it will work on

(continued)

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HOW TO CONTROL THE RISE AND FALL OF POWER.

Your small business computer can give you the power to raise your productivity. But first you have to control the power you give it. Because even the slightest dip or surge of electricity can result in a shocking surprise. An instant loss of important data or misinformation. Even worse, a total power line failure can create department devastation... a total system crash. You can't afford errors, delays and other problems. After all, you've invested in a computer to increase efficiency. But now there's a solution you can afford The Sola SPS. This economical, UL listed Standby Power System is designed to protect personal, micro and mini computers from AC line disturbances and failures. Sola SPS provides clean, regulated AC power to your computer when your power line experiences irregular voltage. Line dips or line surges are immediately converted to proper voltage. When the AC line is present, the SPS filters power to eliminate electrical noise. And when the AC line fails, the SPS goes into full action, providing precise AC power to the load from its internal battery. So the only noise you'll *hear* is the sound of performance. There's no maintenance. No installation. No kidding. Just plug it in and turn it on. Why let your productivity rise and fall with your power? The solution is as simple as SPS. The standby system that Sola stands behind.

A UNIT OF GENERAL SIGNAL GS

SOLA

Write for free literature. 1717 Busse Hwy., Elk Grove Village, IL 60007 (312) 439-2800 a particular hardware configuration.

The pirate then stated that no software vendors offered a guarantee that allowed return of software simply because the customer was dissatisfied. Therefore, such piracy is necessary.

We at T.N.T. Software sell all our software with a 30-day, money-back guarantee. We have done this for nearly two years. Customers can freely open our packaging, run our programs (not just demo versions), test all functions, and determine if our programs are suitable for their intended use. If the customer is dissatisfied for any reason—even if the program performs as advertised—the entire package may be returned within 30 days for a full refund of the purchase price.

Moreover, our dealers must give anyone who buys one of T.N.T. Software's programs the same or a better guarantee. That's part of our contract for all our dealers and distributors.

We find it hard to believe the pirate's statement that there are no other software companies or distributors with a policy equivalent to ours.

Yes, we do get some returns. Some types of programs are more prone to returns than others. Overall, our return rate is far less than 1 percent of sales.

We think our customers are far better served with our liberal return and nonrestrictive licensing policy than by services such as a toll-free phone number. We hope that the pirate and others will buy our software in the future.

Further, our prices are uncommonly low. Our company's success in the software market amply proves that copy protection, restrictive licensing arrangements, and other barbed-wire tactics are both unnecessary and counterproductive. We'd rather give the customer a break and treat the customer like a presumably honest person. Frankly, we wish other companies would adopt our stand, instead of wasting the customer's money by developing ever more tricky and "foolproof" protection schemes.

BRUCE W. TONKIN
PRESIDENT
T.N.T. SOFTWARE INC.
Round Lake, IL

WHAT MAKES SOFTWARE EXPENSIVE

I'm writing on a topic of deep interest to me and many of your readers: software prices.

One thing we've seen in the last year is a tremendous explosion of good software. We've also seen a number of companies go belly-up. Is the market so bad? No, it's never been better. Why are all these outfits in trouble? It's easy to blame it on piracy, interest rates, or investor confidence. It's appropriate to blame it on greed, poor planning, and an inadequate understanding of free-market theory.

When the first application programs for personal computers hit the streets, what were the projected sales? Five thousand? Ten thousand? Who would have expected them to be 2000 percent higher? The original pricing was set with development and promotion costs to be spread over a much smaller number of units than in fact were being sold. Did we see prices being slashed to account for the new economies of production? Or did we see them at-

(continued on page 458)

F·I·X·E·S A·N·D U·P·D·A·T·E·S

UPDATES

Busy, Busy BYTEnet Listings

The popularity of BYTEnet Listings has exceeded our wildest expectations. It has been busy virtually all day, every day, with calls to download listings of programs mentioned in BYTE.

We have added two more telephone lines to BYTEnet Listings to ease the congestion. The new number to call is (617) 861-9774. You should find it easier to get through to BYTEnet Listings.

If you find that BYTEnet Listings is busy, please don't call us at the BYTE offices to find out if the line is bad or if the system is down. It isn't bad or down, it's just busy. (Incidentally, BYTEnet Listings is closed to the public from 4 to 5 a.m. east-coast time every day; it is doing private network business and will reject your calls.)

Sola Makes Uninterruptible Power Supplies

In our January survey of uninterruptible power supplies, we inadvertently neglected to mention the many products available from Sola Electric. (See "Uninterruptible Power Supplies" by William Rynone, page 183.)

Sola Electric offers a full line of uninterruptible power supplies and power-conditioning equipment for microcomputers and minicomputers. A 20-page illustrated brochure details the electrical and performance specifications of the products. It describes the systems offered, contrasts power-protection alternatives, and explains the operation, design, and selection of uninterruptible power supplies. Request catalog number 696 from Sola Electric, 1717 Busse Rd., Elk Grove Village, IL 60007, (312) 439-2800 (marketing), (312) 228-1393 (technical services), or (312) 228-1250 (customer service).

Modifications to Printer Buffer

A few modifications to John Bono's printer-buffer project recently arrived from Dr. H. A. Tasman of Karlsruhe, West Germany. (See "Build a Printer Buffer," June 1984 BYTE, page 142.)

In figure 3b (page 452), the input BUSY flip-flop, IC10a, is set on the leading edge of the input STB, but the input byte is not clocked into the input register until the trailing edge of the input STB. However, in line 60 of listing 1 (page 453), OKAY:IN A,(STATUS) places BUSY in bit 0 of the A register and proceeds to IN A,(BYTEIN) if not 0.

"This procedure may work satisfactorily," writes Tasman, "if the host computer's parallel-port driver always produces an STB pulse that is shorter than the time needed for the instructions AND 01H and JP Z,NOCHAR, which, for a 1-MHz clock frequency, amounts to 17 microseconds."

Dr. Tasman found this condition to be unsatisfactory when he tried to use the printer buffer with a software parallel-port driver on his 4-MHz Z80 computer. In particular, he found that the STB pulse could surpass the clock-frequency limit when an interrupt occurs. If, for example, a character is read in before the STB is terminated, the input register will still be holding the previous character. If the STB extends beyond the input ACK pulse, the BUSY flip-flop will not reset and the character can be read in repeatedly.

Dr. Tasman suggests that you check the input STB before processing the character. Also, since the tri-state buffer, IC14, can put two more lines on the data bus with the STATUS command, you can connect the input STB (IC9 pin 11 through IC10 pin 1) to IC14 pin 10 and hook IC14 pin 9 to D3. To eliminate the STB problem, modify the software around line 60 to

```
OKAY:IN    A,(STATUS)
     BIT   0,A
     JR    Z,NOCHAR
     BIT   3,A
     JR    Z,OKAY
; GET CHARACTER
     IN    A,(BYTEIN)
```

BYTE'S BUGS

FreeSoft Address

Additional information about some products mentioned in "Public-Domain Gems" by John Markoff and Ezra Shapiro has come to light. (See the March BYTE, page 207.)

In the discussion about Red Ryder 3.0, a communications program for the Macintosh, the name and address of the author/distributor was inadvertently omitted. Earlier in the article, during the presentation on the Ultra utilities, the author was duly credited, but the address was incorrect. Both Red Ryder 3.0 and the Ultra utility programs are available from The FreeSoft Co., 10828 Lacklink, St. Louis, MO 63114.

Also mentioned in the article was Newkey, a program that lets you redefine the IBM PC keyboard. Newkey can be obtained for $39 from FAB Software, POB 12363, Birmingham, MI 48012.

We regret these errors.

A Bit Too Wide

An editing error in the February BYTE U.K. resulted in our creating a dream product rather than describing the real McCoy. (See "Realizing a Dream" by Dick Pountain, page 379.)

In the first and second columns on page 382, we say that ". . . a 32K-bit processor is necessary to efficiently manipulate objects . . ." and that "by employing some tricky design techniques, including a 64K-

(continued)

FIXES AND UPDATES

bit-wide memory bus . . ." We ask you to ignore the capital Ks as you read those sentences.

Mathematics Mistake

A pair of bugs appeared in listing 1 of Peter Rice's article "Arithmetic on Your PC." (See March, page 119.) The superscript ones (1s) in lines 13370 and 13380 on page 124 should have been minus signs.

We apologize for this error.

Caption in Error

A photo caption appearing in Jon Edwards's review, "Atari 800XL," misidentifies the screen display. (See March, page 268.) The photo actually shows a scene from Electronic Arts' Seven Cities of Gold.

Corrections for EPROM Programmer

In figure 2 (page 107) of the February Ciarcia Circuit Cellar, four corrections are necessary. (See "Build a Serial EPROM Programmer," page 104.)

Make a connection between the RESET line (pin 4) of IC8 and the line between pin 11 of IC7 and pin 2 of IC9.

On the lower right-hand corner, IC12 is a 74LS04, not a 74LS02.

The input to IC7, inverter b, should be labeled pin 3, not pin 13 as it was presented.

Finally, Q3 should be a 2N2905 and not a 2N905.

Also, when using 24-pin EPROMs, insert them into the ZIF socket so that the socket's pins 1 and 2 are empty.

BYTE'S BITS

Poke the IIe's Drive Delays in the Sixth Slot

Owen Sargent from Chicago, Illinois, has come up with a programming solution to the Apple IIe's drive shutoff and start-up delay. For the drive controller in slot 6:

POKE 49386,0	assigns drive 1
POKE 49387,0	assigns drive 2
POKE 48385,0	turns assigned motor on
POKE 49384,0	turns assigned motor off

Please note that any DOS command that causes the motor to switch on will shut it down after execution. If you wish to keep your motor running, insert POKE 49385 immediately after the DOS command.

Mr. Sargent came across this solution in Don Worth and Pieter Lechner's *Beneath Apple DOS* (Quality Software, Chatsworth, CA: 1981, page 6-2) and Apple's *Reference Manual for the IIe Only* (Cupertino, CA: 1982, page 128).

"I have tested this in a read-print loop," says Sargent, "and keeping the motor on increases speeds by 25 percent."

Computer Art Contest for Kids

West Publishing seeks entries for its First Annual Computer Art Contest for Kids. The theme is "Computers and the Imagination." It is hoped that children will use computers both as subjects and tools.

Both computer graphics and traditional art forms are acceptable. Computer graphics can be programmed by a child or created with a graphics tablet. The contest is open to students in kindergarten through high school. Winners will be announced at the World Conference on Computers for Education, July 29 through August 2, in Norfolk, Virginia. Winners will receive prizes from $50 to $300. The Grand and First Prize winners' schools will receive prizes of $300 and $100. The first 500 entrants and the winners will receive a commemorative T-shirt.

Contest entries must be postmarked no later than June 1, 1985, and mailed to Ann Kellogg, West Publishing Co., 4th floor, 201 Castro St., Mountain View, CA 94041. For further information, complete rules, and an official entry blank, call (800) 532-9378; in California, (415) 969-1283.

Alternative Address

In the November 1984 Fixes and Updates, we mentioned the services offered by Video Vision Associates, makers of laserdisc software. (See "Laserdiscs Here Today and With Us Tomorrow," page 33.) We supplied a Huntington Beach, California, address for the firm. While this address is correct, interested readers have had some difficulty reaching the office.

If you have encountered such problems, try contacting Video Vision Associates at its home office: 7 Waverly Place, Madison, NJ 07940, (201) 377-0302. ■

Inquiry 89

Three of today's most popular computer accessories.

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Do you ever get the feeling that computers are treated with more respect than people?

Everyone talks about technology.

But what about the people who have to use it?

Quite clearly, they're having problems.

Industry publications like PC Magazine have written about those problems.

And now, more than twenty states are currently preparing special computer legislation to force some changes.

You are not a machine.

Computers are designed by engineers.

They usually know a lot about technology but very little about people.

Which is why so many computers often are technically impressive yet strangely unnatural to use.

Computer-induced problems (%)	
Eyestrain	55%
Back pain	43%
Headaches	30%
Shoulder	25%
Hand/wrist	18%
Neck pain	15%

(Source: "Ergonomic Principles in Office Automation" Pub. 1983 by E.I.S. AB, Sweden.)

The result has been a whole range of computer-induced problems ranging from stress and fatigue to blurred vision.

In Sweden, they have an attitude the world is just catching up with.

It's this:

That the machine is the servant of man.

Not the other way around.

That excellent ergonomic design isn't a privilege.

It's a right.

That ergonomics isn't just a noble gesture.

It's good business.

Because computers are only as fast and as accurate as the people who operate them.

If they suffer, so does business.

This attitude has made Ericsson No. 1 in Europe twice over:

First, as the giant of European telecommunications.

Then again as Europe's biggest workstation company by far.

(You couldn't ask for a better marriage of technology for the future.)

Here is one example of how Ericsson got there.

It's the first of a range of computers being introduced in the U.S.A.

The Ericsson PC. It's Ergo-Intelligent.™

Ericsson has spent $300 million finding ways to make people and computers work better together.

Here are some of the results.

Ergo-Screen.™

Aspirin gets rid of a headache.

Ergonomics gets rid of the cause.

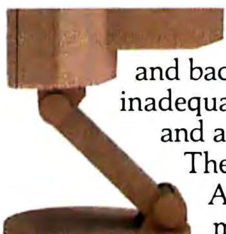
The Ericsson PC has a non-glare screen with restful amber characters on a specially developed, low-fatigue background color.

Even the shape of the characters was specially developed to allow easier recognition of difficult letters like O and Q.

On the monochrome monitor, the resolution is double that of IBM's, so clarity is remarkable.

You can even have text and graphics on the same screen.

Ergo-Arm.™



Thousands of people get neck and back pain from inadequate screen height and angle adjustment.

The Ericsson Ergo-Arm lets you move your screen exactly where you want it.

Ergo-Touch.™

Ericsson keys are full-size, and the layout is ergonomically planned for greater speed and accuracy.

Yet the keyboard is 20% more compact and less than half the weight of IBM's.

Even the cord is adjustable to suit left- or right-handers.

Ergo-Color.™

Even the color of the case is ergonomically selected to be restful on the eye over many hours.

Ergo-Space.™

The system unit is one-third smaller than IBM's.

It even fits under your desk in a special vertical rack.

So your desktop is your own again.

IBM Compatible.

Many companies claim to be compatible.

Some are. Some are stretching the truth.

The Ericsson PC boasts the highest compatibility rating there is.

It's operationally compatible.

You can take advantage of thousands of PC-compatible programs already available.

In fact, with the best-selling software, program and data disks are interchangeable with those of the IBM PC.

Service. Not excuses.

Ericsson wouldn't give you anything less than on-site or carry-in service. The choice is yours.

3 Free Offers.

Ericsson will send you revealing literature on ergonomics.

Also a detailed brochure on the Ericsson PC.

And arrange a hands-on test if you ask for it.

Call toll-free 1-800-FOR-ERGO.

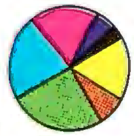
ERICSSON

IBM is a trademark of International Business Machines Corp.

INTRODUCING NEAR LETTER QUALITY AND THROUGHPUT SPEEDS OTHER PRINTERS CAN'T COME NEAR.

The new C.Itoh ProWriter™ 8510S-LQ Near Letter Quality printer is a whole new field of one.

It's priced at just $549. But it gives you near letter quality printing for beautifully sharp characters like printers costing hundreds of dollars more.



Ours

Theirs

And in a text and graphics speed test against its closest competition, namely the Epson® FX-80 and the Okidata Microline 92, the new and faster C.Itoh 8510S-LQ out printed them all.

The stopwatch proved that the 8510S-LQ, at throughput speeds of 100 full lines per minute, printed text up to 35% faster than the competition. And it created bar graphs and pie charts up to 54% faster.

Of course, speed in itself does not keep a printer in a class by itself. Reliability does. That's something no C.Itoh printer has ever lacked. No other printers are more thoroughly tested or proven on the job. Which is why C.Itoh printers continue to be the world's best sellers, with 1.7 million sold last year alone.

For more information on the new and faster C.Itoh 8510S-LQ or wider carriage 1550S-LQ Near Letter Quality printers just see your C.Itoh dealer. Or call us toll free at 1-800-423-0300.

Or write C.Itoh Digital Products, Inc., 19750 South Vermont Avenue, Suite 220, Torrance, CA 90502.

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Printers

Inquiry 60 for Dealers. Inquiry 61 for End-Users.

Kaypro 2000 Features Detachable Keyboard

The Kaypro 2000 is an 11-pound battery-powered portable computer with a detachable 75-key keyboard. Standard are a single 720K-byte floppy-disk drive, one RS-232C serial port, a real-time clock/calendar, an 80-character by 25-line liquid-crystal display (LCD), bundled software, and 256K bytes of memory (expandable to 640K bytes using standard NMOS chips). Optionally, you can add an 8087 chip on the main board. An internal 300/1200-bps modem is also available.

Kaypro says that the unit's batteries will last approximately four hours in normal use. To conserve power, the unit automatically powers down when no activity occurs in one minute or when the cover is closed (without losing data or programs in RAM), and the disk drives are turned off when not actually reading or writing data. The Kaypro 2000 uses Phoenix's IBM PC-compatible ROM BIOS and can run virtually any program for the IBM Personal Computer. Graphics images are displayed with a resolution of 640 by 200 pixels.

The Kaypro 2000 measures about 12½ by 2⅝ by 11 inches when closed. An optional "base unit" for the Kaypro 2000 is planned. The base unit will allow use of additional floppy- and/or hard-disk drives, an external monitor, a parallel printer, and other IBM-compatible peripherals.

The Kaypro 2000 should be available in June for $1995. Contact Kaypro Corp., POB N, Del Mar, CA 92014, (619) 481-4300.
Inquiry 600.

The Kaypro 2000's keyboard is detachable.

Mac COBOL Has ANSI 74, Allows Access to Mac ROM

Micro Focus's Mac COBOL is the first version of COBOL for Apple's Macintosh. Mac COBOL includes an editor, a full ANSI 74 compiler, a 68000 object-code generator, and access to 386 of the Macintosh ROM routines. Any COBOL program written for Micro Focus's IBM PC compiler will run on the Macintosh without modification, although programmers can add features to take advantage of the Macintosh's user interface.

Micro Focus also plans to give Mac COBOL a debugging tool, a forms generator, a help facility, and access to all 512 of the Macintosh ROM routines. Buyers of Mac COBOL version 1.0 will receive an upgrade to the next version free of charge.

Mac COBOL is priced at $2000. Contact Micro Focus Inc., 2465 East Bayshore Rd., Palo Alto, CA 94303, (415) 856-4161.
Inquiry 601.

Graphics Software for HP Touchscreen and IBM PC

Hewlett-Packard has announced two families of software: one for its Touchscreen Personal Computer (formerly the HP 150) and the other for the IBM PC.

A majority of the programs for the Touchscreen Personal Computer are centered around business graphics and are designed to work with HP's line of plotters, and the InkJet and the LaserJet printers.

The Charting Gallery ($265) lets you make various charts. The Drawing Gallery ($345) is a MacDraw-type drawing program that can use the HP Mouse ($210). The Executive MemoMaker ($245) is supplied with a spelling checker, and it lets you incorporate graphics from the Charting and Drawing Galleries into text documents.

Most of the programs unveiled for the IBM PC are versions of programs already available for the Touchscreen PC. Among the releases are the MemoMaker word processor ($160) and the Personal Card File database ($160). Also offered is TextCharts ($200), which lets you create presentation-quality signs and transparencies on HP's plotters and printers.

For further information, contact your local Hewlett-Packard sales office.
Inquiry 602.

(continued)

Business-Pro Runs AT Software

Texas Instruments' Business-Pro can be configured to run IBM PC AT and TI's Professional Computer software. This 80286-based tool has 512K bytes of RAM expandable to 3.5 megabytes without consuming any of its eight full- or six half-size card slots or to 15 megabytes using card slots. Memory speed is 150 nanoseconds.

Storage options are 360K-byte or 1.2-megabyte floppy drives, a 60-megabyte tape backup, or 21-, 40-, or 72-megabyte hard disks.

The DOS is MS-DOS 3.0 for one person or XENIX for up to eight users. Languages supported are MS-BASIC, MS-Pascal, MS-FORTRAN, MS- and RM/COBOL, LISP, C, and assembly.

Networking is provided by EtherLink hardware, supported by NetWare/E-TI software. As a workstation, it'll serve up to 50 micros sharing 144 megabytes of storage, a tape backup, and three printers.

An 80287 coprocessor, a mouse, speech technology, and communications hardware and software are optional.

With a serial/parallel interface and a 1.2-megabyte floppy-disk drive, the base unit is $3995. A 21-megabyte Winchester drive increases the price to $5795. Other configurations will range from $4440 to $10,785. Network servers will be offered. Contact Texas Instruments Inc., Data Systems Group, POB 809063, Dallas, TX 75380-9063, (800) 527-3500.
Inquiry **603**.

The HOTMS 3000 *series is a system solution for test engineers.*

Systems Solution for Test, Measurement, Analysis

Honeywell's HOTMS 3000 Series, a systems solution for the test and measurement environment, is said to be easy to operate, capable of a wide variety of measurements, and able to produce on-site test results with its high-performance architecture and powerful data-analysis software. With an HOTMS 3000, a test engineer works with a complete data-acquisition system designed to manage all aspects of testing, such as the initial design, measurement, data analysis, and communications. The price for a fully configured HOTMS 3000 begins at $20,000; cost varies depending upon your application.

HOTMS 3000 is a modular series built around a multiprocessor-based microcomputer. The computer has a distributed bus architecture that uses four Motorola MC68000 microprocessors. It runs under Regulus, a UNIX-like operating system with real-time extensions. Regulus supports BASIC, Pascal, FORTRAN, and C.

The six system cards communicate across a VME bus in a multitasking environment. Three card slots are available for a communications card or for up to 8 megabytes of RAM.

Each HOTMS has a so-called mechanical support structure with a rack-mountable, tabletop enclosure and a 17-slot card cage. The card cage has a 9-slot computer card rack and an 8-slot signal-conditioning card rack. The signal-conditioning front end can handle a continuous system throughput of up to 160,000 samples per second. A series of analog and digital signal-conditioning cards offering a range of input and output options complements the data-collection bus.

Other features of the main housing are a 9-inch amber monitor and a built-in multifunction keypad. Each comes standard with a 5¼-inch floppy-disk drive and a choice of a second floppy drive and a 36- or 86-megabyte hard-disk drive. The power for all devices in the main unit is supplied by a 640-watt power supply that comes in a variety of voltages and frequencies. An external VT-200-style keyboard and a 13-inch external color monitor are optional.

Major system functionality is provided by Operator Interface Devices, which are supported by several user-interface programs. These programs provide a consistent set of menu interfaces to the system and a plug-in structure for software modules. The modules are offered as either integral parts of each HOTMS or as upgrade options.

For information on hardware and software options and system configurations, contact Honeywell Inc., Test Instruments Division, POB 5227, Denver, CO 80217-5227.
Inquiry **604**.

GRiDCase Family of Portables

GRiD Systems has introduced three IBM PC-compatible portables: the GRiDCase I, II, and III. Members of this family are nearly identical, differing mainly in display-screen apparatus. The GRiDCase III, for example, has a high-clarity gas-plasma display, while the low-end GRiDCase I uses an LCD. The GRiD-Case II features an enhanced LCD screen, according to the manufacturer.

GRiD claims that, unlike the Compass, the new GRiD-Case models are highly compatible with the IBM PC. The company cites the new line's ability to run Lotus 1-2-3 and Microsoft's Flight Simulator as proof of compatibility.

Each GRiDCase comes with a 720K-byte floppy-disk drive, an interface for an RGB monitor, and a standard-size typewriter keyboard. Options include

(continued)

an external 5¼-inch floppy-disk drive, an internal 1200-bps modem, and a battery pack that lasts from one to five hours, depending on which model is being used.

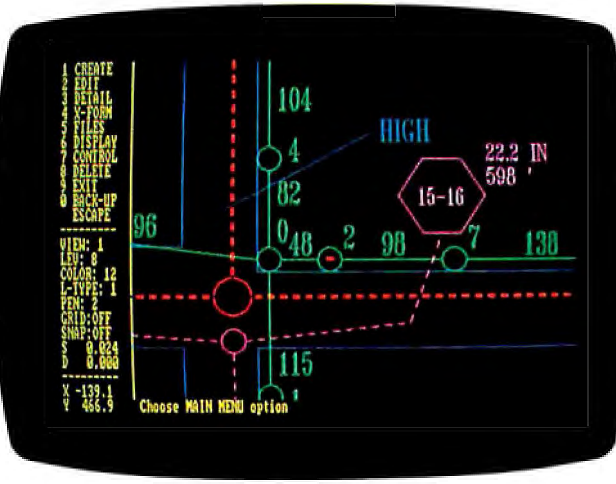
Prices range from approximately $3000 for the GRiDCase I to about $4500 for the GRiDCase III. Contact GRiD Systems Corp., 2535 Garcia Ave., Mountain View, CA 94043, (415) 961-4800.
Inquiry 605.

Integrated CAD System for IBM

CADKey, a two- and three-dimensional design and drafting tool for 512K-byte IBM PCs, PC XTs, and PC ATs, is said to be the only IBM PC-based system with true three-dimensional capabilities fully integrated with two-dimensional drafting abilities.

You can use CADKey to draw in three dimensions and to convert those images into two-dimensional drawings that conform to ANSI and ISO standards. Once you create a three-dimensional image, you can automatically view it from any angle. If you modify a design, CADKey automatically updates all views.

CADKey drawings appear as wireframe representations. For a solid appearance, hidden lines can be trimmed. All parts, families of parts, and drawings can be stored, automatically scaled to size, and retrieved from disk within the program. All entities making up an image can be manipulated individually or as a group, and any entity or group of entities can be altered at will. Entities to be transformed may be selected by cursor position, last created, type, level, and windowing, and you can use geometric relationships between entities for selection, construction, transformation, editing, and dimensioning.



Sample screen produced by CADKey.

Any part, section of a part, or group of parts can be rotated, scaled, or moved along any of three coordinate axes by user-selected angle, distance, or factor. Both numerical and interactive methods are supported, and zoom and pan features are provided.

CADKey uses English-language menus. Commands can be tailored to suit your needs. The program supports 640- by 420-dot resolution, 256 levels, and 16 colors and accepts input from a digitizer, mouse, function keys, and keyboard. Among its other features are quick selection and repaint, the ability to use disk space as virtual memory, and the ability to accommodate parts exceeding 10,000 entities.

CADKey is $1895. Contact Micro Control Systems Inc., 27 Hartford Turnpike, Vernon, CT 06066, (203) 647-0220.
Inquiry 606.

Laser Printer Produces Full-Page, High-Resolution Graphics

Corporate Data Sciences' CDS 2300, a $5695 laser printer, can store and print a full 8½- by 11-inch image with a resolution of 90,000 dots per square inch. It uses Canon's LBP-CX standard laser-printer engine, augmented with an 8-MHz 80186 processor, 1.28 megabytes of bit-mapped RAM for images, 128K bytes of system RAM, and 128K bytes of ROM.

In addition to several CDS fonts provided for use in the bit-mapped image mode, the CDS 2300 can emulate a Diablo 630 daisy-wheel printer, a Tektronix 4014 graphics terminal, and the ANSI X3.64 protocol. Once a bit-mapped image is loaded into the printer, copies can be produced at a rate of eight per minute. Both RS-232C serial and Centronics parallel interfaces are supplied.

CDS also sells a Graphics Display/Processor (GD/P), an intelligent graphics terminal for the IBM PC. The GD/P workstation costs $4995.

Also newly available from CDS is a graphics terminal called Whizzie (an abbreviated form of "what you see is what you get"). This $1995 terminal has a 17-inch display and an interface card for the IBM PC XT or AT, but it does not have the intelligence or the advanced capabilities of the GD/P. Like the GD/P, Whizzie displays a 1024- by 1024-pixel image exactly as the laser printer will produce it.

Contact Corporate Data Sciences Inc., Suite 102, 2560 Mission College Blvd., Santa Clara, CA 95054, (408) 980-9747.
Inquiry 607.

Cermetek Unveils 3-line, 1200-bps Multiplexer

Cermetek Microelectronics' 3X1200 Multiplexer lets three users communicate at 1200 bps over a single telephone line, reducing phone bills by as much as two-thirds. This statistical multiplexer uses the Hayes AT command set and can serve as a single-user 1200-bps modem. When two 3X1200s are connected by a phone line, users at any of the six RS-232C serial por s can communicate with any other port and share peripherals.

The 3X1200 supports switched multiplexing: Users can opt to communicate with any port at any time instead of being tied to a

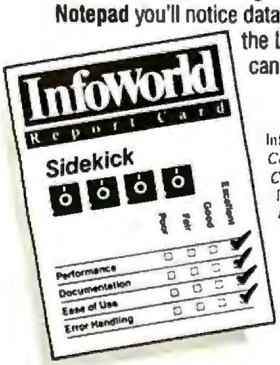
(continued)

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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Available at better dealers nationwide. Call (800) 556-2283 for the dealer nearest you. To order by Credit Card call (800) 255-8008, CA (800) 742-1133

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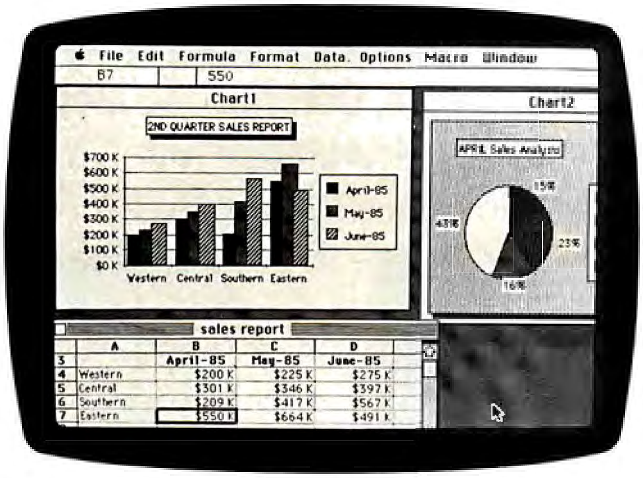
*Selected by *InfoWorld* as the most significant software product of the year.

Inquiry 457 for Dealers. Inquiry 458 for End-Users.

single channel. Its system software provides error checking and retransmission of garbled data. System parameters can be reset remotely, even though they are password-protected. The 3X1200 also keeps activity statistics on all ports.

The Cermetek 3X1200 is priced at $1395. Contact Cermetek Microelectronics Inc., 1308 Borregas Ave., POB 3565, Sunnyvale, CA 94088-3565, (408) 752-5000.
Inquiry 608.

Integrated Software for Macintosh



Excel is Microsoft's first integrated package.

Microsoft's first integrated package, Excel for the Macintosh, has spreadsheet and graphics capabilities, a spreadsheet-oriented database, and a macro facility for storing and recalling commonly used keystrokes. It supports the AppleTalk network and provides two-way file compatibility with Multiplan and Chart for the Macintosh, Lotus 1-2-3 for the IBM PC, and applications that support Microsoft's SYLK format.

The Excel spreadsheet provides you with a 256-column by 16,384-row work area. You can view and reference multiple spreadsheets, consolidate worksheets, enter multiple-variable problems or situations, and vary the borders, number formats, and font styles and size. You can assign names to cell references, numbers, and mathematical expressions and call four windows into a worksheet.

You can produce instant "what if" graphics with Excel's charting abilities, which are functionally identical to Microsoft's Chart for the Mac. Excel files can be read directly into Chart, and Excel can read Chart files. When you alter numbers in a spreadsheet window, charts in separate windows are instantly updated. For data comparisons, you can open more than one chart window for the same or different data. The charting facility also has 42 predesigned charts, the ability to relocate objects on screen, and your choice of font, range, scale, and patterns.

The database is an ancillary function of Excel's spreadsheet. With it, you can sort, extract, and display information in a variety of ways. The database lacks form- and report-design capabilities; however, Excel's formatting capabilities let you create reports. It does let you remove data for analysis in a different section of your work area.

Excel's suggested retail price is $395. It requires 512K bytes of memory and will work with the Macintosh XL. Contact Microsoft, 10700 Northrup Way, Bellevue, WA 98009, (206) 828-8080.
Inquiry 609.

Test, Measurement Tools

Hewlett-Packard's PC Instruments are peripheral devices that give you the ability to run test or measurement applications from the same computer you use to write reports. Modular tools that work with the HP Touchscreen and IBM's PC, PC XT, and PC AT computers, the PC Instruments line consists of eight units, several software packages, and accessories. A typical micro can support up to eight modules, and additional modules can be engaged with more interface cards.

Current members of the line are a digitizing oscilloscope, a digital multimeter, a function generator, a universal counter, a 16-channel digital I/O, a relay multiplexer, a dual-voltage D/A converter, and a relay actuator. Each is housed in a stackable plastic box with its own external power supply.

Key to PC Instruments, says Hewlett-Packard, is its system software. The software operates with a single HP PCIB interface card inside the computer, provides the user interface and instrument I/O drivers, and gives you control over instrument modules. It has data-conversion utilities and supports three data-conversion formats (BASIC, DIF, and stripped ASCII) that order acquired data for use with such programs as Lotus 1-2-3 and Statpak.

In its manual mode, the software displays an instrument's control panel on screen along with multiple windows. The windows let you monitor the status of several instruments, fiddle with instrument settings, and oversee the entire operation. The software supports the Touchscreen, an IBM PC mouse, and cursor keys. Instrument initialization parameters can be stored and recalled.

The progam mode lets you exercise control over each instrument through calls to the BASIC subroutine library. A pair of generic commands, Output and Measure, are used to program all the instruments.

Optional data-acquisition software lets you start logging and plotting data immediately. This menu-driven BASIC package has an engineering-graphics utility. Software libraries that permit the Touchscreen and IBMs to control up to 15 PC Instruments in a BASIC environment are available.

PC Instruments are priced between $650 and $1500. The PCIB interface and system software are $500. The optional I/O library is $300 for the Touchscreen and $400 for the IBM PC. Contact your local Hewlett-Packard dealer.
Inquiry 610.

(continued on page 464)

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

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.
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—Tools that will allow you to create animation or solve those difficult curve fitting problems.
and much, much more . . . . .

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NEW

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

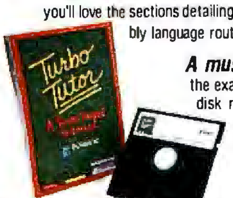
The perfect complement to Turbo Pascal. It contains: ***Turbo-Access***, a powerful implementation of the state-of-the-art B+tree ISAM technique; ***Turbo-Sort***, a super efficient implementation of the fastest data sorting algorithm, "Quicksort on disk". And much more.

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."

Get started right away: free database! Included on every Toolbox disk is the source code to a working data base which demonstrates how powerful and easy to use the Turbo-Access system really is. Modify it to suit your individual needs or just compile it and run.

Remember, no royalties!

From Start to Finish in 300 pages. Turbo Tutor is for everyone, from novice to expert. Even if you've never programmed before, Turbo Tutor will get you started right away. If you already have some experience with Pascal or another programming language, Turbo Tutor will take you step by step through topics like data structures and pointers. If you're an expert, you'll love the sections detailing subjects such as "how to use assembly language routines with your Turbo Pascal programs."



A must. You'll find the source code for all the examples in the book on the accompanying disk ready to compile. Turbo Tutor might be the only reference on Pascal and programming you'll ever need.

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I Use ___ PC-DOS ___ MS-DOS
___ CP/M 80 ___ CP/M 86

My computers' name/model is: ____________

The disk size I use is:
☐ 3½" ☐ 5¼" ☐ 8"

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PROKEY COMPATIBILITY	YES	YES
DISPLAY PROTECTION	NO	YES
ABILITY TO IMPORT DATA FROM SCREEN	NO	YES
PULL-DOWN MENU USER INTERFACE	NO	YES
CONTEXT-SENSITIVE ON-LINE HELP SYSTEM	NO	YES
DISPLAY-ONLY MACRO CREATION	NO	YES
ENTRY AND FORMAT CONTROL IN DATA FIELDS	NO	YES
COMMAND KEYS REDEFINABLE "ON THE FLY"	NO	YES
PRICE	129.95	69.95

Total ProKey compatibility. Every Prokey Macro file may be used by SuperKey *without change* so that you may capitalize on all the precious time you've invested.

Now your PC can keep a secret! SuperKey includes a resident file encryption system that uses your password to encrypt and decrypt files, even while running other programs. Two different encryption modes are offered:

1. **Direct overwrite encryption** (which leaves the file size unchanged) for complete protection. At no point is a second file that could be reconstructed by an intruder generated. Without your secret password, no one will ever be able to type out your confidential letters again!

2. **COM or EXE file encryption** which allows you to encrypt a binary file into an ASCII file, transmit it through a phone line as a text file and turn it back again into an executable file on the target machine (only of course if your correspondent knows the secret password!). Now, you will even be able to secretly exchange programs through Public Bulletin Board Systems or services such as CompuServe.

Totally memory resident at all times, gives SuperKey the ability to create, edit, save and even recall new or existing macro files anytime, even while running another program.

Pull down macro editor. Finally, a sensible way to create, edit, change and alter existing macro definitions. Even while using another application, a simple keystroke instantly opens a wordprocessor-like window where you're allowed to see, edit, delete, save and even attach names to an individual macro or file of macros, and much more.

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Inquiry 461 for Dealers. Inquiry 462 for End-Users.

Conducted by Steve Ciarcia

INTELLIGENT DISK DRIVE

Dear Steve,

How about an intelligent disk drive that will interface through an RS-232C port? It might be useful in solving format incompatibilities.

RUSS SHALL
Key West, FL

An intelligent disk drive with an RS-232C serial port is a good idea, and I will consider it for a future article.

Such products are already on the market. One such device, the SEEDI from Mariachi Oy (Puutarhakatu 17, SF-20100 Turku 10, Finland), interfaces an RS-232C serial port with an Apple II disk drive. It allows data to be taken or transferred without the need for the computer itself. The disk can then be put into an Apple II system and booted to retrieve the data.

Another unit is the FDS-200 Minifile from Greco Systems (372 Coogan Way, El Cajon, CA 92020). It, too, can be interfaced to an RS-232C port and will store data directly on a 5¼-inch floppy disk. It is an intelligent minifloppy-disk system that can store up to 179K bytes per disk.—Steve

COMPUTERS AND THE DISABLED

Dear Steve,

I am a student at the University of South Alabama who is working on a project to help a quadriplegic communicate. Here is the nature of the problem. We are hoping to translate jaw pressures to menu-selection responses. The menu could consist of words that could be sent to a speech synthesizer. I am using an IBM PC clone (a Columbia) and need suggestions as to what interface and other peripheral devices to acquire for a speech synthesizer. Your help in this matter is greatly appreciated.

RON LINDQUIST
Mobile, AL

Helping the disabled is one of the most rewarding areas for microcomputer experimenters. I wish you success.

You can acquire two basic types of speech synthesizers for the Columbia: a plug-in board or one that is connected through a serial or parallel port. The plug-in type ties up a slot, so this may be a consideration in your choice. Tecmar makes a speech board for PCs, as does MSI. Add-on types include two models from Votrax. Identical units are available assembled from Intex and in kit form from Micromint. Some of these units have speakers built in; others would require you to add your own.

Although you did not mention it specifically in your letter, I assume that your input device will be interfaced through the game adapter port. This would probably be the simplest and cheapest way to go. Simple microswitches could be used to initiate the selection process.

I hope that this is of some help. A lot of planning beforehand is much better than a lot of kludges later! I have listed the addresses of the referenced manufacturers for your convenience.

Micromint Inc.
561 Willow Ave.
Cedarhurst, NY 11516
(800) 645-3479

Street Electronics
1140 Mark Ave.
Carpinteria, CA 93013
(805) 684-4593

Tecmar
6225 Cochran Rd.,
Solon, OH 44139
(216) 349-0600

—Steve

STEREOSCOPIC GRAPHICS

Dear Steve,

Can you refer me to a source of mathematical formulas for generating true-perspective proportions from elevations and for reducing right-eye images to left-eye offsets for three-dimensional imagery? I have never seen a discussion of the mathematical relationships.

I can take a lead pencil and produce drawings that merge beautifully into three-dimensional images, even without a viewer, but I can't explain to my computer how to do it without the mathematical base, and it is crucial to a project I'm working on. Unfortunately, I'm more of an artist than I am a theoretical mathematician.

B. R. POGUE
Thatcher, AZ

Creative Computing *magazine ran a two-part article, "Stereo Graphics," by John D. Fowler in the January and February 1983 issues. It seems to be exactly what you are looking for. The article describes the math briefly and gives a program in TRS-80 Color Computer BASIC to produce some stereo pictures.*

Another article, which gets into the math of perspective drawing and rotation, is "Three Dimensional Apple Graphics" by Mark Pelczarski, in the February 1982 issue of Creative Computing.—Steve

TRANSORBS BETTER

Dear Steve,

In your article on power-line conditioning (December 1983), you recommended the use of MOVs (metal-oxide varistors) for transient voltage suppression. I believe I have located a better device for this—the Transorb by General Semiconductor.

I learned about this device while designing a burglar alarm, which my company sells. I tried zeners, then MOVs, to eliminate power glitches caused by the cycling of refrigerator motors, incandescent lamps, and the like. The zeners were useless because they didn't clamp with the high-voltage values. The MOVs were a little better, but the clamping voltage for a 15-V-rated device might still rise to 30 or 40 V under actual clamping currents.

I tried the Transorbs, and they worked perfectly. I now use them exclusively in all my products. They cost about 50 cents apiece, so they're less expensive than MOVs.

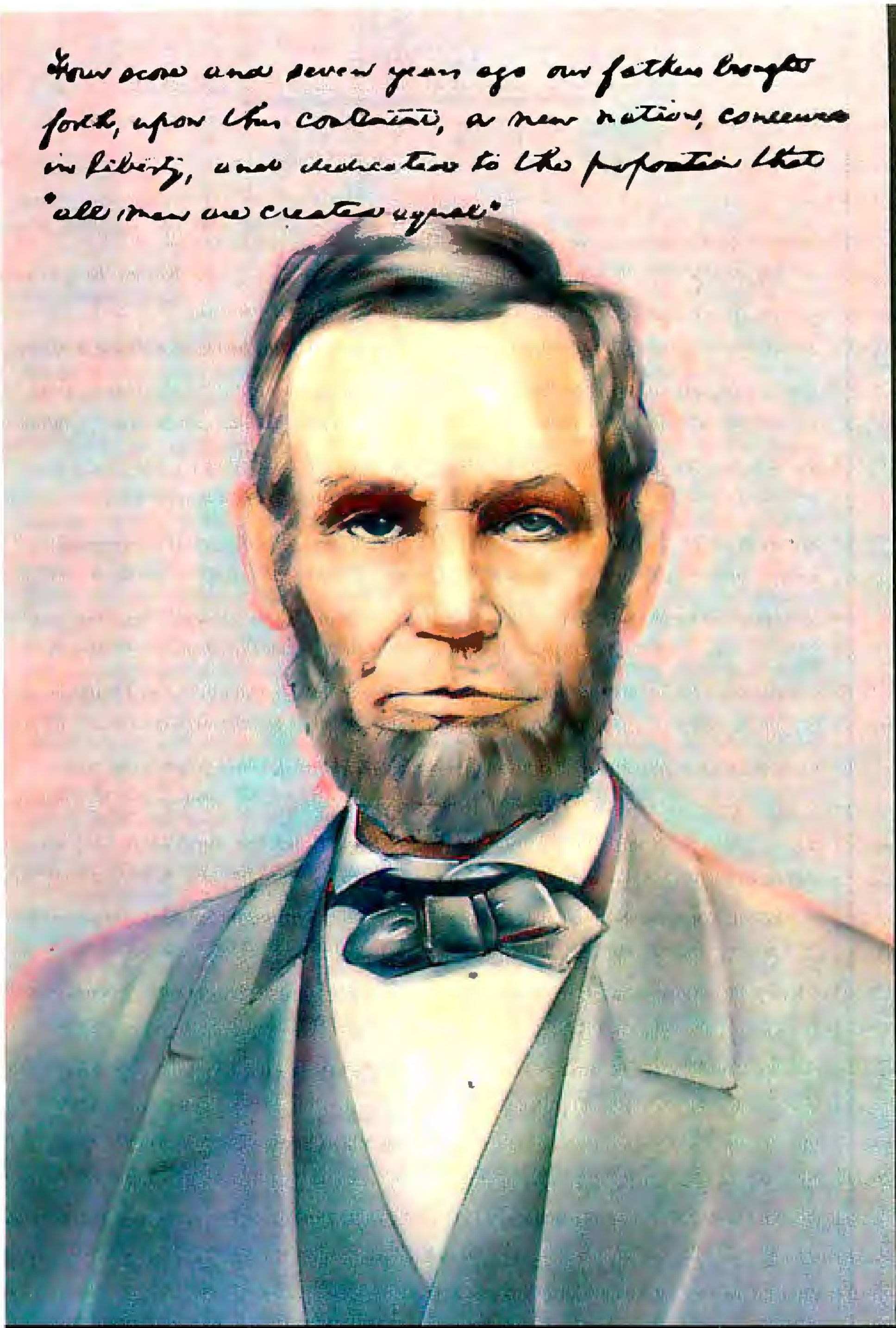
LOGAN CRESAP

SQUARE ROOTS

Dear Steve,

Recently, one of your readers complained that his computer could not deter-

(continued)



The picture in this ad is actually an 18" by 24" collector's item—an originally commissioned museum-quality print. This month, the Gettysburg print is yours, absolutely free, at most computer stores that carry Leading Edge Word Processing.

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Systems and Software Division
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They used small scraps of paper to record huge hunks of Truth; primitive tools to produce profound prose. But when the words finally went forth, they made indelible marks on all who read them.

The amazing thing is that these monumental processors of words, did it without the benefit of monumental help.

Like Leading Edge Word Processing: the easiest to use, yet most potent piece of software ever created to take full advantage of all the power inherent, but until now un-tapped, in today's most sophisticated personal computer. (Like the IBM® PC and the even faster and more powerful Leading Edge™ PC.)

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mine square roots accurately, even for arguments that were perfect squares. You solved his problem by testing each result to see if it was very nearly an integer: IF ABS(R−INT(R+0.5)) < (small value) THEN (something). This worked more or less well, depending upon (small value) and a particular computer.

It seems I am spoiled because the computer I use most, the TI-99/4A, *always* takes the square roots of perfect squares perfectly. Actually I stopped the test after I=500000 for: IF SQR(I*I)< > I THEN (we are in trouble).

Your solution was slightly bothersome because of the judgment required in selecting the small value. If it is too small, it rejects legitimate square roots; if it is too large, it accepts erroneous roots.

Naturally, I could not test any new ideas on the TI-99/4A, but I also have a Commodore 64 and other family members have other computers. On all of them, the square-root function could be made perfect with

```
B = SQR(a)
B = (B+A/B)/2
```

The tested domain was small as compared to my test of the TI-99/4A (to a half million).

Later, I found a way to cause the TI-99/4A to take poor square roots with

```
B = EXP(LOG(A)/2)
```

These could be made perfect with adding

```
B = (B+A/B)/2
```

Oddly, B = A↑(1/2) gives slightly different results from B = EXP(LOG(A)/2) when one would guess them to be identical.

I did discover a cute way to cure the symptom for any computer with guard digits. The TI-99/4A has 3 guard digits (it shows 10 digits out of 13 or 14), and the C64 has a single guard digit (it shows 9 digits out of 10):

```
B = SQR(A)
B = VAL(STR$(B))
```

This scheme is nice because it adjusts itself for a particular computer and for the relative magnitude of A and B.

WEBB SIMMONS
San Diego, CA

AIM-65 PERIPHERALS

Dear Steve,

To avoid the expense of a disk drive, I wish to connect a cassette recorder to my AIM-65 computer. Is there a BYTE article that shows how to accomplish this? Also, is there a circuit that can interface my AIM-65 to a video monitor?

KWAME AJANAKU
Grand Prairie, TX

A simple means of modifying a standard audio cassette recorder for direct digital recording appeared in the October 1978 BYTE. "A Simpler Digital Cassette Tape Interface," by Ralph W. Burhans, describes a simple circuit that should meet your requirements.

The output of a basic AIM-65 cannot be directly interfaced to a video monitor because it doesn't have a video generator. This is a circuit that takes ASCII data from the system bus and converts it to a string of bits to produce the dots that make up the characters on the screen. It also produces the horizontal and vertical sweep sync pulses to synchronize the character bits. Rockwell sells a CRT controller module for the AIM-65, part #RM65-5102, but if you'd rather build one yourself, read my Circuit Cellar article "Build the Term-Mite ST Smart Terminal" in the January 1984 BYTE. This circuit uses the National Semiconductor NS455A Terminal Management Processor, which provides all the signals necessary to drive a video monitor and produces an 80-column by 25-line display.—Steve

VIC-20 BAR-CODE READERS

Dear Steve,

Do you know of any bar-code readers for the VIC-20? If not, do you know of any books or magazine articles that explain how to build one?

COLIN C. KELLEY JR.
Piedmont, CA

I am not aware of any bar-code readers specifically designed for the VIC-20, but several readers on the market interface with an RS-232C serial port. Such a port can be added to the VIC-20, either through a commercial accessory or via an article in the May 1983 BYTE, "The Enhanced VIC-20, Part 4: Connecting Serial RS-232C Peripherals to the VIC's TTL Port" by Joel Swank.

Two bar-code readers that interface to an RS-232C serial port are

The D2 Series Mini Bar Code Reader
Skan-a-Matic Corp.
POB S, Route 5 West
Elbridge, NY 13060
(315) 689-3961

(continued)

SRD Corporation Model BCR-170
SRD USA Liaison Office
999 North Sepulveda Blvd.
Suite 314
El Segundo, CA 90245
(213) 417-5114
—Steve

32-Bit Computer Design

Dear Steve,

I want to design a 32-bit computer using the 32032 processor. I am in need of information on high-resolution graphics-board design, bit-slice and array microprocessors, interfacing 32- and 8-bit buses, high-resolution monitor design, and some good test equipment. Any information would be appreciated.

R. J. Iling
Port Coquitlam, British Columbia, Canada

Data on the 32032 can be obtained from National Semiconductor Corporation, POB 70818, Sunnyvale, CA 94086. This processor is quite new, but the company probably has application notes that will help in designing your system.

Texas Instruments Inc. (POB 401560, Dallas, TX 75240) features a line of bit-slice processors, and it also publishes the book Fundamentals of Microcomputer Design. *Contact TI at the above address for information on data sheets and application notes.*

Two Motorola application notes, AN-843: "Using the MC68000 and the MC6845 for a Color Graphics System" and AN-851: "Motorola MC6845 CRTC Simplifies Video Display Controllers" (available from Motorola Semiconductor Products Inc., POB 20912, Phoenix, AZ 85036), provide design details for a graphics-display system. Other video-display-controller chips are made by Texas Instruments and several other semiconductor manufacturers. (See my article "High-Resolution Sprite-Oriented Color Graphics" in the August 1982 BYTE.)

Test equipment can be obtained from a number of advertisers in BYTE. You will need at least a digital multimeter, a digital-signal generator, and a good oscilloscope to start.—Steve

What Means Compatible?

Dear Steve,

Would you please explain the term "IBM-compatible"? IBM clones are sprout-

(continued)

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AZTEC C86/PRO provides the power, portability, and professional features you need to develop sophisticated software for PC DOS, MS DOS AND CP/M-86 based microsystems. The system also supports the generation of ROM based software for 8088/8086, 80186, and 80286 processors. Options exist to cross develop ROM code for 65xx, 8080, 8085, and Z80 processors. Cross development systems are also available that target most micro computers. Call for information on AZTEC C86/PRO support for XENIX and TOPVIEW.

POWERFUL — AZTEC C86/PRO 3.2 outperforms Lattice 2.1 on the DHRYSTONE benchmark 2 to 1 for speed (17.8 secs vs 37.1) while using 65% less memory (5.8k vs 14k). The AZTEC C86/PRO system also compiles in 10% to 60% less time and supports fast, high volume I/O.

PORTABLE — MANX Software Systems provides real portability with a family of compatible AZTEC C software development systems for PC DOS, MS DOS, CP/M-86, Macintosh, CP/M-80, APPLE // +, //e, and //c (NIBBLE - 4 apple rating), TRSDOS (80-MICRO - 5 star rating), and Commodore C64 (the C64 system is only available as a cross compiler - call for details). AZTEC C86/PRO is compatible with UNIX and XENIX.

PROFESSIONAL — For professional features AZTEC C86/PRO is unparalleled.

- Full C Compiler (8088/8086 - 80186 - 80286)
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UPGRADE to AZTEC C86/PRO $310
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VAX - > 8086/80xxx cross $5000
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AZTEC C68K
— for the Macintosh

For power, portability, and professional features AZTEC C68K-c is the finest C software development system available for the Macintosh.

The AZTEC C68K-c system includes a 68000 macro assembler, a linkage editor, a source editor, a mouse based editor, a SHELL development environment, a library of UNIX I/O and utility routines, full access and support of the Macintosh TOOLBOX routines, debugging aides, utilities, make, diff, grep, TTY simulator with upload & download (source supplied), a RAM disk (for 512K Mac), a resource maker, and a **no royalty** license agreement. Programming examples are included. (Over 600 pages of documentation).

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.

AZTEC C68K-c (commercial system) $500
AZTEC C68K-p (personal system) $199
AZTEC C68K-p to AZTEC C68K-c upgrade $310

Mac C-tree database $149
Mac C-tree database with source $399
Lisa Kit (Pascal to AZTEC C68k object converter) .. $ 99

AZTEC C65
— for the APPLE //

"... The AZTEC C-system is one of the finest software packages I have seen..." NIBBLE review, July 1984.

The only commercial C development system available that runs native on the APPLE II+, IIc, and IIe, the AZTEC C65 development system includes a full floating point C compiler compatible with UNIX C and other MANX AZTEC C compilers, a 6502 relocating assembler, a linkage editor, a library utility, a SHELL development environment, a full screen editor, UNIX I/O and utility subroutines, simple graphics, and screen functions.

AZTEC C65 (Apple DOS 3.3) $199
AZTEC C65/PRO (Apple DOS + ProDos) $350
(call for availability)

AZTEC C II/PRO
— for CP/M-80

The first member of the AZTEC C family was the CP/M-80 AZTEC C compiler. It is "the standard" compiler for development on CP/M-80. The system includes the AZTEC C II C compiler, an 8080 assembler, a linkage editor, an object librarian, a full library of UNIX I/O and utility routines, CP/M-80 run time routines, the SMALL library (creates modules less than 3K in size), the fast linker for reduced development times, the ROM library, RMAC and M80 support, library source, support for DRI's SID/ZSID symbolic debugger; and more.

AZTEC C II/PRO $349
AZTEC CII/BAS $199
C-TREE Database with source $399
C-TREE Database in AZTEC object form $149

AZTEC C80
— for TRSDOS (Radio Shack Model III & 4)

"I've had a lot of experience with different C compilers, but the Aztec C80 Compiler and Professional Development System is the best I've seen." 80-Micro, December, 1984, John B. Harrell III

This sytem has most of the features of AZTEC C II for CP/M. It is perhaps the best software development system for the Radio Shack Model III and IV.

AZTEC C80 model 3 (no floating point) $149
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To order or for information call:

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(201) 530-7997 (NJ and outside U.S.A.). Or write: MANX SOFTWARE SYSTEMS, P.O. Box 55, Shrewsbury, N.J. 07701.

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SHIPPING INFORMATION - Standard U.S. shipment is UPS ground (no fee). In the U.S. one day shipment is $20, two days is $10. Canadian shipment is $10. Two days shipment outside the U.S. is by courier and is freight collect.

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(Bug Busters) call: 201-530-6557

ASK BYTE

ing up like weeds, and every manufacturer claims that his product is IBM-compatible. Some, though, qualify this statement and state that it does not run all the IBM software. Even you designed a 16-bit machine, and you also claim that it is IBM-compatible.

There is a considerable price difference between the real IBM and the clones, and I am contemplating whether I should go IBM or compatible.

HARRY RIESBECK
Nepean, Ontario, Canada

IBM compatibility is indeed an often misused term. In a general sense, any computer that can run Lotus 1-2-3 and Microsoft's Flight Simulator is said to be "IBM-compatible," since these programs make extensive use of keyboard, memory, and graphics features. Any machine capable of running MS-DOS is considered compatible, since MS-DOS and PC-DOS are compatible. However, to be 100 percent compatible, the ROM BIOS (read-only memory basic input/output system) routines must be identical. Since these routines, which oversee the operation of the hardware, are copyrighted by IBM, the only legal way to get them is to license them or develop them independently.

Many computers are bus-compatible with the IBM PC and will handle most of the accessory boards now on the market. Others have some minor quirks in the graphics routines, keyboard control functions, and use of interrupts.

Some PC clones on the market are 100 percent compatible with the IBM PC, and they do represent a better value. Check product reviews in the major computer magazines.—Steve ■

IN ASK BYTE, *Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to*

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POB 582
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Due to the high volume of inquiries, personal replies cannot be given. All letters and photographs become the property of Steve Ciarcia and cannot be returned. Be sure to include "Ask BYTE" in the address.

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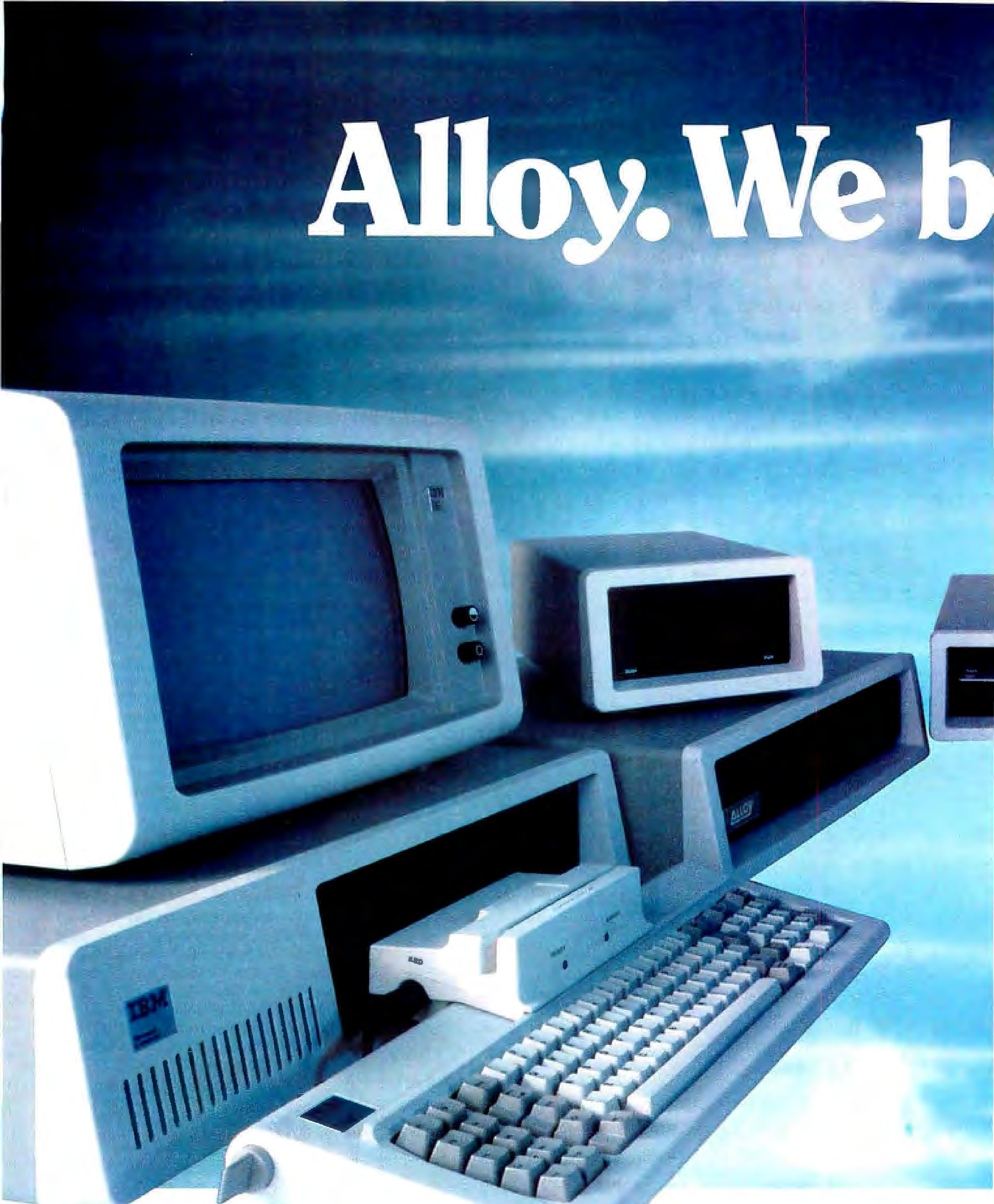
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● BBS FOR MEMBERS
Uploading and downloading are features of the 300-bps BBS called ABACUS-COM, operating 24 hours, 7 days a week at (805) 871-2725. It is for members of A Bakersfield Area Commodore User Society (ABACUS). The group meets on the second Wednesday of every month in Bakersfield, California. Contact Gene Smith, ABACUS, 2316 Sandy Lane, Bakersfield, CA 93306.

● FARMER'S CHOICE
Descriptions of agricultural software packages, electronic information services, and university contact information for farmers is available in a capsule form in the newsletter *Agricultural Computing*. Contact Doane Publishing, 11701 Borman Dr., St. Louis, MO 63146, (314) 569-2700.

● TECHNICAL SCHOLASTICS
An independent newsletter from a nonprofit organization about educational computing, *Academically Speaking . . .* is produced bimonthly for the benefit of computerists, teachers, and manufacturers. Contributions concerning hardware and software developments that affect curriculum and administration in postsecondary education are welcome. Contact William Buchholz, *Academically Speaking . . .*, Scholastech Inc., POB 1545, Cambridge, MA 02238.

● A HUNDREDFOLD
A newsletter for the TRS-80 Model 100, *Century*, contains hardware and software news and reviews, programs, and information that is also applicable to the NEC and Olivetti computers. It is published eight times a year; a subscription is $35. Contact *Century*, Peregrine International, Suite P-225, 323 South Franklin, Chicago, IL 60606-7095.

● ENGINEERS REVIEW
Engineering Software Exchange (ESE) is a monthly newsletter that promotes high standards in engineering-applications software. Reviewers critique programs based on the quality of documentation, degree of user-friendliness, interactive features, and the completeness of the software. A subscription is $60 annually. Contact Lidia LoPinto, CAE Consultants Inc., 41 Travers Ave., Yonkers, NY 10705.

● A WELCOMING
ASSEMBLY—The Milwaukee Area IBM Personal Computer Users Group meets at 7 p.m. twice a month. Members who use IBM PC and compatible computers can benefit from product demonstrations, instructional sessions, a monthly newsletter, and access to a library of public-domain software. Contact the IBM PC Users Group, POB 2121, Milwaukee, WI 53203-2121, (414) 679-9075.

● COMPUTERS FOR
HOOSIERS—The BBS of the Hoosier Users Group (HUG) is on line 24 hours a day at (317) 631-994A to serve users of the Texas Instruments 99/4A computer. The monthly newsletter, which is exchanged with other users groups, supplements monthly meetings. The group sponsors classes in BASIC and Extended BASIC. Special-interest groups and a library of public-domain software meet members' specific needs. Contact HUG, POB 2222, Indianapolis, IN 46206-2222.

● TELEWORKS
The *TeleCommuting Report*, a monthly newsletter published by Electronic Services Unlimited, tracks developments in the field of location-independent work. Because corporations are presently running pilot programs and researching the use of computers in homes or at satellite offices, reports of their results can aid small businesses as well as manufacturers. A subscription is $145. Contact Electronic Services Unlimited, 142 West 24th St., New York, NY 10011, (212) 206-8272.

● MAC STREET JOURNAL
The newsmagazine of the New York MacUsers' Group, *The Mac Street Journal*, is published monthly by and for the benefit of Mac users. Articles, reviews, and graphics are included as well as an order form for public-domain software and members' evaluations of software. Monthly meetings feature lectures, demonstrations, and special-interest group discussions. A bulletin board is maintained. Annual dues are $32. Contact New York MacUsers' Group, POB 6686, Yorkville Station, New York, NY 10128.

● BUG PREMIERS
The First Basis Users Group (1st BUG) meets on line and in New York City every month. Members maintain a BBS and produce a monthly newsletter and a semiannual directory of users of Basis 108, a 6502/Z80-based microcomputer. Contact John Flory, 1st BUG, 4 Tower Lane, Morristown, NJ 07960.

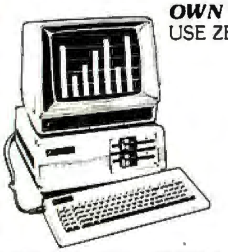
● FOR AGRICULTURALISTS
Farmers and agri-businesspeople who use computers in their operations can share ideas and public-domain software via a monthly newsletter called *The Computer Farmer*. Contact Kelly Klaas, Route 1, Box 4133, Twin Falls, ID 83301, (208) 733-4251.

● INDEPENDENT
EXPANSION—The Phoenix Chapter of the Independent Computer Consultants Association (ICCA) meets the second Tuesday of the month at 6 p.m. in Phoenix, Arizona. A newsletter is produced monthly; annual subscriptions are $10. ICCA is a nonprofit club for computer consultants and contract programmmers. Contact Mike Diross, ICCA, Phoenix Chapter, POB 32115, Phoenix, AZ 85064, (602) 892-3270.

● THE PUBLIC'S DOMAIN
A newsletter covering public-domain and user-supported

(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.



software for the IBM PC is devoted entirely to new disks, their reviews, and questions and answers concerning their exchange. *PC-SIG News* is produced by the PC Software Interest Group, which has also published *Directory of Public Domain (and User-Supported) Software for the IBM Personal Computer*. Contact the PC Software Interest Group, Suite 130, 1556 Halford Ave., Santa Clara, CA 95051.

● LOGO FOR THE TEACHER—*Microquests*, a monthly publication available from September through May for teachers of Logo, contains mathematical, scientific, and linguistic problems for children to solve. A subscription is $25 a year. Contact Martin-Bearden Inc., POB 337, Grapevine, TX 76051.

● MEDICS ON LINE
The Atlanta Medical Forum is available at (404) 351-9757 every hour of the day at 300 and 1200 bps. It is a user-supported private BBS for people interested in areas of health care that involve computers. The Bread Board System software allows message exchange and file transfer. A $15 annual donation is requested. Contact Dr. Floyd Garrett, Suite 424, 315 Boulevard NE, Atlanta, GA 30312.

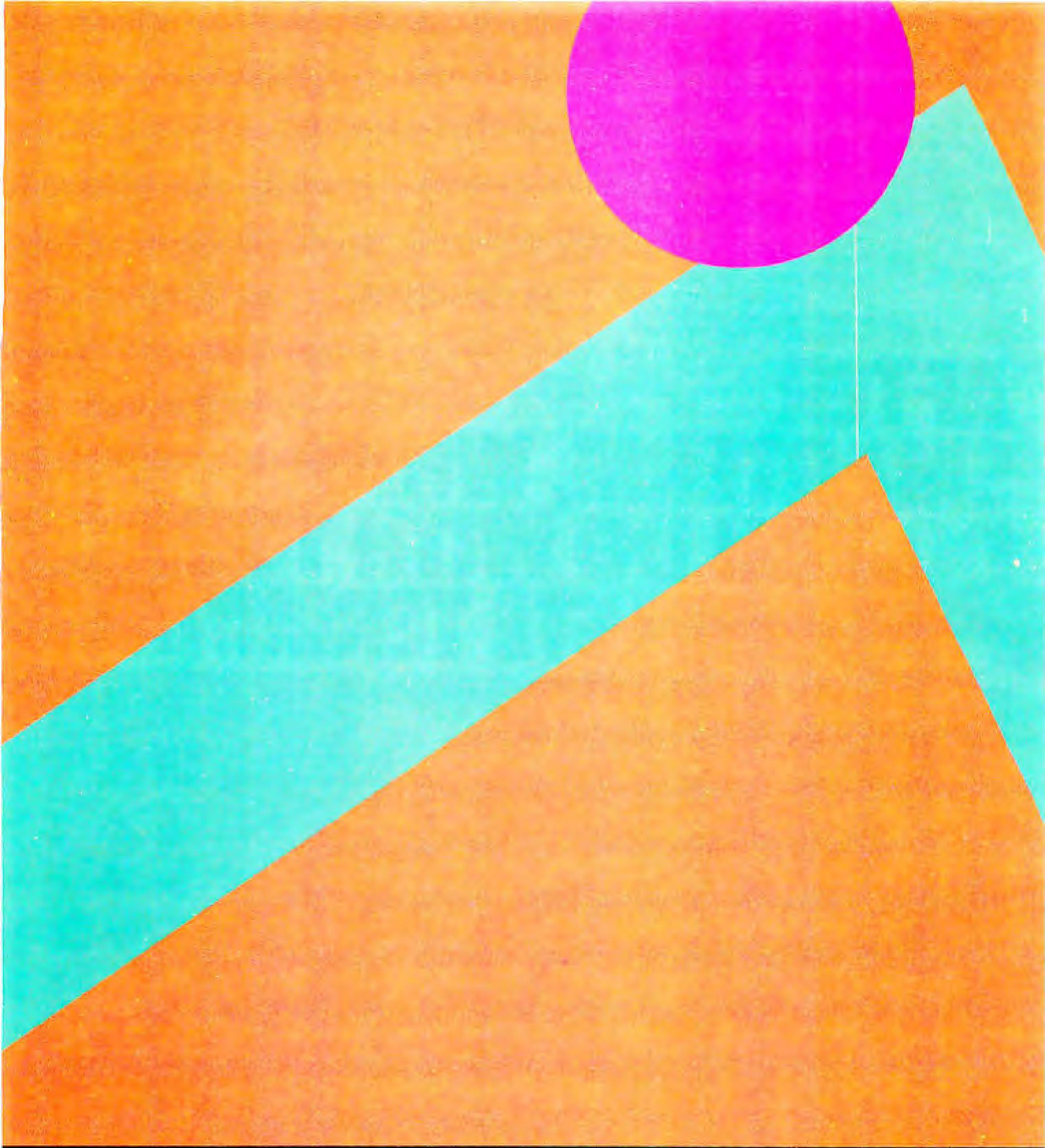
● LONE TEXAN EAGLE
The East Texas Eagle Users meet the second Thursday of every month. Interested persons can contact R. J. Dodson, 1809 Bell, Longview, TX 75602, (214) 758-2994.

● A NEW ADDITION
The Adam Users Group (AUG), though independent, benefits from Coleco's input on new products in the bimonthly newsletter, *AUGment*. The international group has scheduled an AUG BBS for telecommunications linkups using the Adam. A public-domain library is available to members. Annual dues are $12. Contact AUG, POB P, Lynbrook, NY 11563.

● GROUP FOR THE VALLEY—The Los Angeles area Valley PC Users Group meets on the second Thursday of each month in North Hollywood. It is a forum for sharing information among users of IBM PCs and compatible computers and provides a public-domain software library. Contact Carlo di Giovanni, 6161 Whitsett, North Hollywood, CA 91606, (818) 762-7566, or Robin Kaplan, The Information Group, 3414 Troy Dr., Los Angeles, CA 90068, (213) 851-2480.

● MINDSETTERS
The First Mindset Users Group welcomes members across the nation who share an interest in this MS-DOS micro with advanced graphics capabilities. Send an SASE to receive a sample newsletter. An annual subscription costs $15. Local members meet in the Bay Area on the second Monday of each month. Contact David Duberman, 355 15th Ave. #5, San Francisco, CA 94118, (415) 668-8352.

● ATTENTION CANADIANS
RAM (Regroupement des Amateurs de Micro-ordinateurs) contains five user subgroups for the IBM, Apple, TRS-80 Color Computer, Commodore 64, and CP/M-based computers. General and subgroup meetings are held each month. A BBS is maintained, and a newsletter written in French, *Organigramme*, is produced bimonthly. A public-domain and freeware library exists for each subgroup. Contact Ronald Léger, RAM, POB 21, St. Jean, Quebec J3B 6Z1, Canada. ■



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—PC Paintbrush	✓	✓				
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—Pinball	✓					
—Without software patch needed	✓					
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• Runs Lotus 1-2-3™ and Symphony™ in high resolution color:	✓		✓			
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THE APPLE
MACINTOSH BOOK
Cary Lu
Microsoft Press
Bellevue, WA: 1984
383 pages, $18.95

FIRE IN THE VALLEY:
THE MAKING OF THE
PERSONAL COMPUTER
Paul Freiberger and
Michael Swaine
Osborne/McGraw-Hill
Berkeley, CA: 1984
288 pages, $9.95

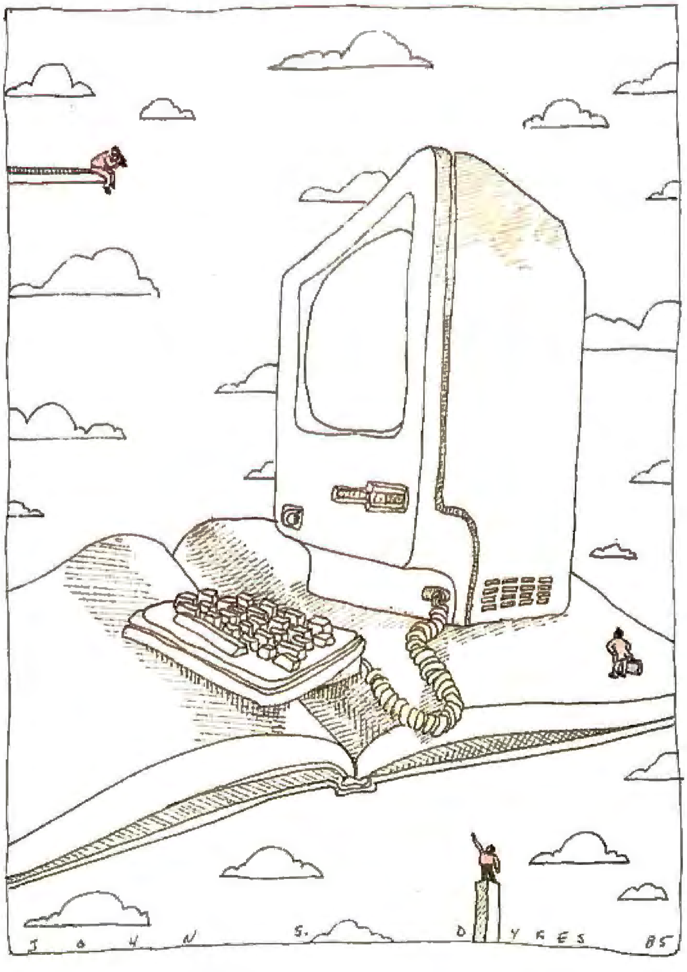
BENEATH
APPLE PRODOS
Don Worth and
Pieter Lechner
Quality Software
Chatsworth, CA: 1984
295 pages, $19.95

PRODUCTIVE SOFTWARE
TEST MANAGEMENT
Michael W. Evans
John Wiley & Sons
New York: 1984
232 pages, $32.95

THE APPLE MACINTOSH BOOK

Reviewed by Scott L. Norman

Cary Lu, in writing *The Apple Macintosh Book*, did not fall into the trap of creating an extended version of the Macintosh manuals. Instead, he produced a book that should be of broad interest to present and prospective owners of the Mac. To a lesser extent, it may also appeal to people who are generally interested in the improvement of the personal computer. Although the depth of coverage is occasionally shallow, the book lives up to the author's intention: to anticipate major questions and to furnish the tools for finding solutions rather than attempting to provide up-to-the-minute information on all relevant topics.



Because Lu's book was one of several commissioned by Microsoft Press while the Macintosh was still under development, it emphasizes the initial Microsoft programs: MacWrite, MacPaint, Multiplan, and Chart.

The book shares another, and more pleasing, characteristic with its competitors: the heavy use of graphics, in keeping with the computer's own style. The text is confined to half the width of a page, leaving plenty of room for screen printouts, sketches, and other marginalia. These are generally helpful, especially to people with little exposure to the Mac.

The Apple Macintosh Book is divided into four sections. Two chapters cover the philosophy of the visual interface, some of the strong points and limitations of the Mac, and the process of setting up the machine. Nine chapters emphasize basic machine operations.

The chapter "Fundamental Operations" is where Lu introduces the Mac desktop and the use of the mouse to manipulate windows and icons. It's well done, with plenty of illustrations of screens and menus and a liberal use of color to distinguish instructions to the user from a running commentary on what is happening.

DEALING WITH DISKS

In the 11th chapter, Lu describes the details of dealing with disks: initializing and erasing, copying, moving, renaming files, and so on. Although he is careful to describe how to go about things with a single-drive system, Lu emphasizes that two drives are almost mandatory for serious work. I think he's right, and prospective purchasers of the

(continued)

ILLUSTRATED BY JOHN S. DYKES

Mac would do well to keep this in mind.

Lu dispenses reasonable advice on how to distribute system files, application programs, and data files among disks. The goal, as all Mac users soon learn, is to maximize usable storage space while minimizing the amount of time spent preparing disks for use. The trick is in learning which files must go where.

The chapter on disk handling closes with a discussion of how information can be moved between programs by means of the Mac's Clipboard and Scrapbook files. This discussion is pretty brief, however; at its conclusion the author advises interested readers to jump ahead to the 20th chapter, "Macintosh Software Issues." This interesting section describes a bit of the philosophy behind the design of operating systems and user interfaces and then gets into how Mac application programs store and exchange data.

Lu also briefly discusses the use of alternative operating systems to alleviate the Mac software shortage—a rather desperate measure at the moment. It seems unlikely that the people for whom the book is primarily intended would have much interest in pursuing this topic right away.

The ability to direct files with the mouse, Clipboard, and other tools is one of the Mac's most appealing features, and the consistency of the machine's operation certainly encourages users to move data from one application to another. Lu does a good job of describing the three forms in which the Clipboard and Scrapbook can store information: formatted data files, ASCII (American Standard Code for Information Interchange) text files, and picture files for the QuickDraw routine in ROM (read-only memory). He goes on to discuss some of the limitations on data sharing and editing that are likely to arise.

Readers seeking a more general idea of what the Mac is all about should read the chapter on MacPaint. The author devotes subsequent chapters to specific types of software: word processors, spreadsheets, business graphics, and so on. This applications material is followed by 14 brief chapters on how things work. This is where you will find the material on software issues that I have already described. Lu provides some details about the video display, keyboard, mouse, and I/O (input/output) ports, and he offers advice about printers and modems.

In three rather philosophical chapters, Lu speculates about future Mac products and the future development of microcomputers. He provides a comparison of the Mac and the IBM Personal Computer that will make few converts. This section is uneven. The chapters on the screen, keyboard, and mouse contain little material that most readers would care to refer to more than once. The chapter on disks and drives has more substance, and the one on printers contains at least a suggestion of what is needed to use printers other than the Imagewriter.

The final section consists of five chapters, containing material that didn't fit anywhere else. They are as much fun to read as anything in the book; the potpourri includes

(continued)

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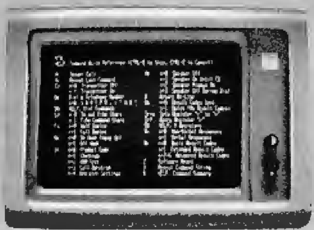

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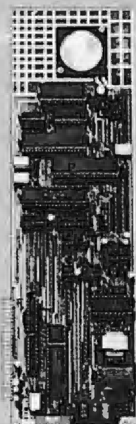

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thoughts on graphics, illustrations of the basic Macintosh fonts along with the names of their closest standard equivalents, and hints on moving specific types of files back and forth to popular application programs running on other machines. A 15-page glossary wraps things up.

Cary Lu, currently an editor at *High Technology* magazine, customarily takes a critical, level-headed approach to computers in his magazine writings; he maintains that approach in this book. It must have been difficult. The Macintosh is one of those high-tech objects that inspires high passions in its devotees and detractors, but Lu manages to keep things in perspective.

Scott L. Norman (8 Doris Rd., Framingham, MA 01701) *is department manager of solid-state science at* GTE *Laboratories in Waltham, Massachusetts.*

FIRE IN THE VALLEY: THE MAKING OF THE PERSONAL COMPUTER

Reviewed by Joel Pitt

It's easy to forget that in the not-too-distant past the concept of a personal computer seemed fantastic. *Fire in the Valley*, by Paul Freiberger and Michael Swaine, is a history of the brief revolutionary period during which personal computers became a reality.

Changes in the direction of the computer revolution and in the image of the computer—from remote behemoth to tool of humanity—have been shaped by the personalities and motivations of the people who first dreamed of, and then built, personal computers. "The newborn industry," the authors write, was a movement of "hobbyists fully conscious that they were bringing on a social, not just a technological, revolution."

Freiberger and Swaine have lived in the valley south of San Francisco and watched the industry grow from that vantage point. Both men served as editors at *InfoWorld*; Freiberger is now West Coast editor of *Popular Computing*; Swaine is editor in chief of *Dr. Dobb's Journal*. They don't ignore the contributions of hobbyists and professionals from other parts of the country, however, so their picture of the origin and development of the industry seems balanced and fair.

The chapter entitled "Tinder for the Fire" is a brief, general history of the computer and the transistor technology that permitted its miniaturization. The obligatory recitation of the evolution of the idea of the computer, starting with Charles Babbage's analytical engine, includes much that is old hat; however, the authors also discuss Intel's development of the first CPU (central processing unit) chip, the 4004, which is less well known. A brief account of David Ahl's failed attempt to interest Digital Equipment Corporation in selling computers for personal use underlines the conflict between the individual vision that drove the personal computer movement and the corporate computer world that "passed up the chance to

BOOK REVIEWS

bring computers into the home and onto the desk."

The birth and development of the MITS Altair computer is described in "The Voyage to Altair." We learn that the flashy cover photo on the January 1975 issue of *Popular Electronics*, which served to announce this first successful hobbyist computer kit to the world, was just a "photo of an empty metal box masquerading as a computer." The frantic race to bring the Altair into reality was a cliff-hanger. (What has come to be known as "vaporware"—products announced well before they're available—has an ancient and honorable role in the history of the microcomputer movement.) Fortunately, MITS was able to fill those metal boxes quickly enough so that the revolution was not brought to a halt just as it was getting off the ground.

But "The Voyage to Altair" is not only the story of the Altair computer. Many of the people who worked with the Altair went on to play major roles in the future of the personal computer. Freiberger and Swaine let us learn about them as we follow the history of MITS.

The next four chapters focus on the people, personalities, and est-inspired vision that drove IMSAI, the second major microcomputer manufacturer; the hobbyists and visionaries who flocked to and formed the Homebrew and other microcomputer clubs; the software developers who helped to make the microcomputer a usable tool; and the entrepreneurs who brought microcomputers and software to us in retail stores, computer shows, and magazines. We learn about the social vision that drove some people, the marketing vision that drove others, and the sense of discovery, play, and adventure that pervaded the movement. (The book is illustrated with 32 pages of photographs that help to put flesh on the players mentioned.)

The penultimate chapter, "American Pie," is devoted to Apple Computer and its founders, Steve Wozniak and Steve Jobs. And though the first six chapters of *Fire in the Valley* help refute Apple's occasional claim to have invented the personal computer, this chapter documents Apple's legitimate claim to a unique and critical role in bringing it to the people. The last chapter of the book, "Big Companies," covers the significant, though belated, entry of the major computer companies (which had passed up the opportunity to invent the personal computer) into the microcomputer business.

The story that Freiberger and Swaine have attempted to recount is rich with the excitement of discovery, serendipity, accidental association, businesses made and lost, and remarkable people. Because it is contemporary history, the authors were able to draw much of their information from interviews with many of the people involved. They have relied to a lesser degree on written sources. In the preface there's a long list of acknowledgments of the people they interviewed, but there is no bibliography.

Freiberger and Swaine's reliance on oral sources helps give their book a personal vitality; however, because of their dependence on interviews, the accuracy of their

(continued)

historical material may be open to question. It's not surprising to find that the intensely creative people who shaped the personal computer movement often had their own ideas about how things should be done and about their own rights and responsibilities. There were, of course, many disputes and, not surprisingly, differing accounts of what happened and why. It seems that the authors have made every attempt to be fair. It's not at all unlikely, however, that some of the many volatile personalities involved in the making of the microcomputer will take exception to a statement here or a date there.

Freiberger and Swaine have pulled together considerable information for *Fire in the Valley* and given it a sense of human vitality.

Joel Pitt (28 Cedar Ridge Rd., New Paltz, NY 12561) is a senior consultant with Woodbury Computer Associates and writes about microcomputer applications.

BENEATH APPLE PRODOS
Reviewed by Martin Kalman

From June 1978 to early 1984, the primary disk operating system (DOS) for the Apple II family was Apple DOS. Although early documentation was meager, this operating system was used to create the large body of software that has been an important factor in the popularity of these computers. Early in 1984, Apple Computer Inc. introduced a new operating system called ProDOS (Professional Disk Operating System) to rectify Apple DOS's shortcomings.

As with their earlier book, *Beneath Apple DOS*, Don Worth and Pieter Lechner attempt to document an operating system, with a particular emphasis on those topics that have been omitted or covered superficially in the Apple manuals. In the beginning, the authors state that *Beneath Apple ProDOS* is intended to serve as a companion to the manuals provided by Apple. They go on to enumerate the deficiencies of Apple DOS and point out how ProDOS has addressed these and made improvements.

The technical portion of the book begins with a chapter describing how data is stored on a floppy disk using the Apple II drive (or equivalent). The authors point out that this chapter should not be considered a prerequisite for understanding succeeding chapters. For this reason, I think it may have been more appropriate to place this chapter at the end of the book, perhaps as an appendix. The material, much of which is applicable to other Apple operating systems (DOS, Pascal, CP/M), would be of interest only to the advanced programmer who wants to access the disk at the lowest levels.

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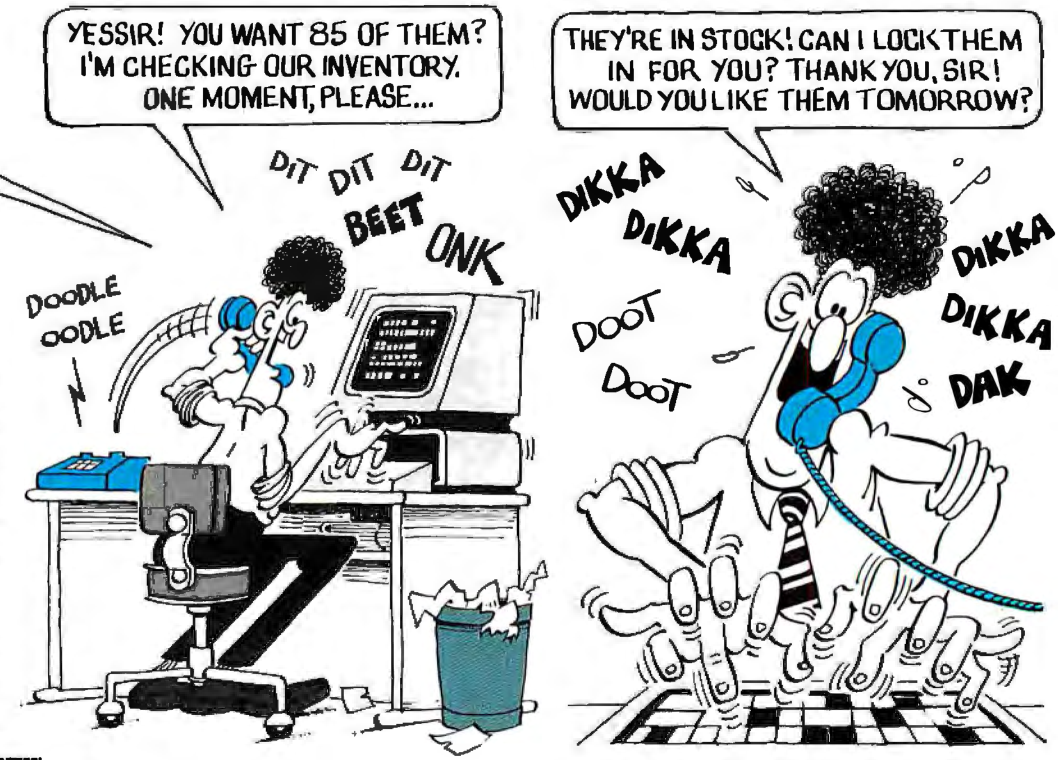

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dition to the main directory on each volume, ProDOS allows subdirectories within the main directory. Each subdirectory can hold files of any type, including further subdirectories. In this manner, a nested structure is created that allows easy file organization and access through individual pathnames. The chapter that follows discusses how ProDOS organizes information on a disk to provide the directory structure just described. Although this discussion assumes the medium is a standard Apple 35-track floppy disk, all of the information presented is applicable to other disk sizes and even to a hard disk.

Worth and Lechner then embark on a detailed description of how individual blocks of data (512 bytes) are allocated on the disk, beginning with the initial formatting that creates the volume directory and volume bit-map blocks. They describe the internal layout of different types of files, complete with numerous examples and excellent diagrams that show data organization and storage. These include directory files as well as typical file types such as BASIC programs, binary files, and text files.

At this point we are introduced to the ProDOS assembly-language program itself, which is loaded into RAM (random-access read/write memory) when the disk is booted. It consists of two parts: the ProDOS kernel and the BASIC interpreter. The kernel is made up of subroutines that can be called by any assembly-language program to access the disk, either block by block or file by file. The BASIC interpreter acts as a translator between a BASIC program (or a user's immediate commands) and the kernel. A short chapter shows the memory usage of these two components and explains how they are loaded into the computer during the booting process.

The remaining three chapters, which occupy more than half the book, are intended to aid the assembly-language programmer who wants access to the routines within the ProDOS program. In contrast to Apple DOS, ProDOS provides a set of 20 externally callable subroutines in the kernel. These subroutines, referred to as the machine-language interface (MLI), provide a simple method for accessing the operating system's disk, time and date, and interrupt-handling functions. Entry points are well documented, with detailed descriptions of all the required input parameters. A list of MLI error messages includes explanations that would be valuable when debugging.

One of the most interesting and potentially useful aspects of ProDOS is the provision for adding extra user-written commands to the BASIC interpreter. The chapter entitled "Customizing ProDOS" examines this feature. The authors even include a program in the appendix that installs a "Type" command. You can use this command to display the contents of an input text file on the screen.

In the final chapter of the book, Worth and Lechner describe the ProDOS global pages. These two pages always occupy a fixed position in memory and contain system-status and device-configuration information. Addresses in these pages are of use to the programmer for

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MWC86 is the easiest to use of all compilers. One command runs all phases from pre-processor to assembler and linker. MWC86 eliminates the need to search for error messages in the back of a manual. All error messages appear on the screen in English.

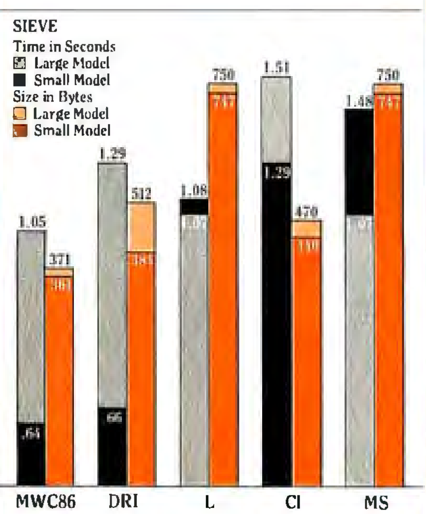
A recent review of MWC86 in *PC World*, June, 1984, summed it up:

"Of all the compilers reviewed, MWC86 would be my first choice for product development. It compiles quickly, produces superior error messages, and generates quick, compact object code. The library is small and fast and closely follows the industry standard for C libraries."

csd C Source Debugger

Mark Williams was not content to write the best C compiler on the market. To advance the state of the art in software development, Mark Williams wrote *csd*.

csd C Source Debugger serves as a microscope on the program. Any C expression can be entered and evaluated. With *csd* a programmer can set tracepoints on variables and expressions with full history capability and can single step a program to find bugs. The debugger does not affect either code size or execution time. *csd* features online help instructions; the ability to walk through the stack; the debugging of graphics programs without disturbing the program under test; and evaluation, source, program and history windows.



csd eases the most difficult part of development — debugging. Because *csd* debugs in C, not assembler, a programmer no longer has to rely on old-fashioned assembler tools, but can work as if using a C interpreter — in real time.

The C Programming System from Mark Williams now supports the following libraries:

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Inquiry 253

such tasks as calling the MLI via the BASIC interpreter or setting vectors to point to user-supplied command routines. The current ProDOS code occupies more than 22K bytes of memory. The authors expect that this code will change in the near future. Consequently, they have decided to describe only the BASIC-interpreter global page and the ProDOS global page. A special supplement is available from the publisher for those readers who wish to obtain a complete description of every piece of code and data within the ProDOS components.

Have the authors achieved their objective of improving upon the documentation provided by Apple? Yes, but I wish they had included even more information.

Martin Kalman (POB 243, Friday Harbor, WA 98250) *has an* M.S. *from* MIT *and works as a freelance computer programmer and writer.*

PRODUCTIVE SOFTWARE TEST MANAGEMENT
Reviewed by Douglas L. Freeman

Very little has been written about the testing of software. Since even the simplest program requires testing, clear-cut guidance is valuable to anyone who develops software. Michael W. Evans has missed the opportunity to provide this guidance because he has written a very complex book that will not appeal to a wide audience. He attempts to reduce most concepts to charts, some of which are fairly complicated, and he has a tendency to use acronyms excessively. Though *Productive Software Test Management* gets bogged down in details about organization, testing committees, definitions, and phases, some of the topics it raises are worth reviewing.

THE PLANNING PROCESS

Thorough software testing is often overlooked and undervalued. Testing can be easily overshadowed by the other complexities of software development. Evans correctly emphasizes the importance of planning. He begins his book with a story about a failed project and then tells how the disaster could have been avoided. The author points out that developers have a better chance of getting the resources needed for adequate testing if they've planned well for it at the beginning of a project.

Creating a detailed plan of how a system will be developed is a difficult task. In the early stages of a project, information and technical requirements are often vague. Precision is difficult to attain. The prudent systems manager will work hard to produce a strong software-development plan. According to Evans, planning should be done in a hierarchical fashion by first defining the top levels of development requirements (what is to be done) and structure (management and control). The development plan should contain a software test and integration segment. This segment describes the testing structure,

(continued)

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phases, levels, and organization. It lays the foundation for the entire software-testing process.

Test planning is the central theme throughout the first five chapters. Though Evans almost wears out the subject, he does make several good related points. He cautions the software manager against trading short-term project demands for long-term planning requirements. As a project proceeds, the demands on the manager increase. Time that was intended to be spent on planning disappears. The obvious result is a poorly developed software product and sometimes a failed project.

The author also observes that managers often try to apply techniques that worked for large projects to the development of small projects and vice versa. He advises that the software-development controls must be scaled to the technical and administrative requirements of the individual project. Readers should keep this point clear as they try to implement concepts from this book.

Evans devotes a chapter to the subject of motivating a software-test staff. This chapter is one of the best in the book. It gives the reader good advice about management direction and responsibility. The author counsels the software-test manager to "look and act like a leader" and "present a positive image to staff, customer, and management personnel." He also tells how to motivate three types of personnel: fast trackers, average performers, and poor performers. This advice is useful to managers of all disciplines.

The Real Work of Testing

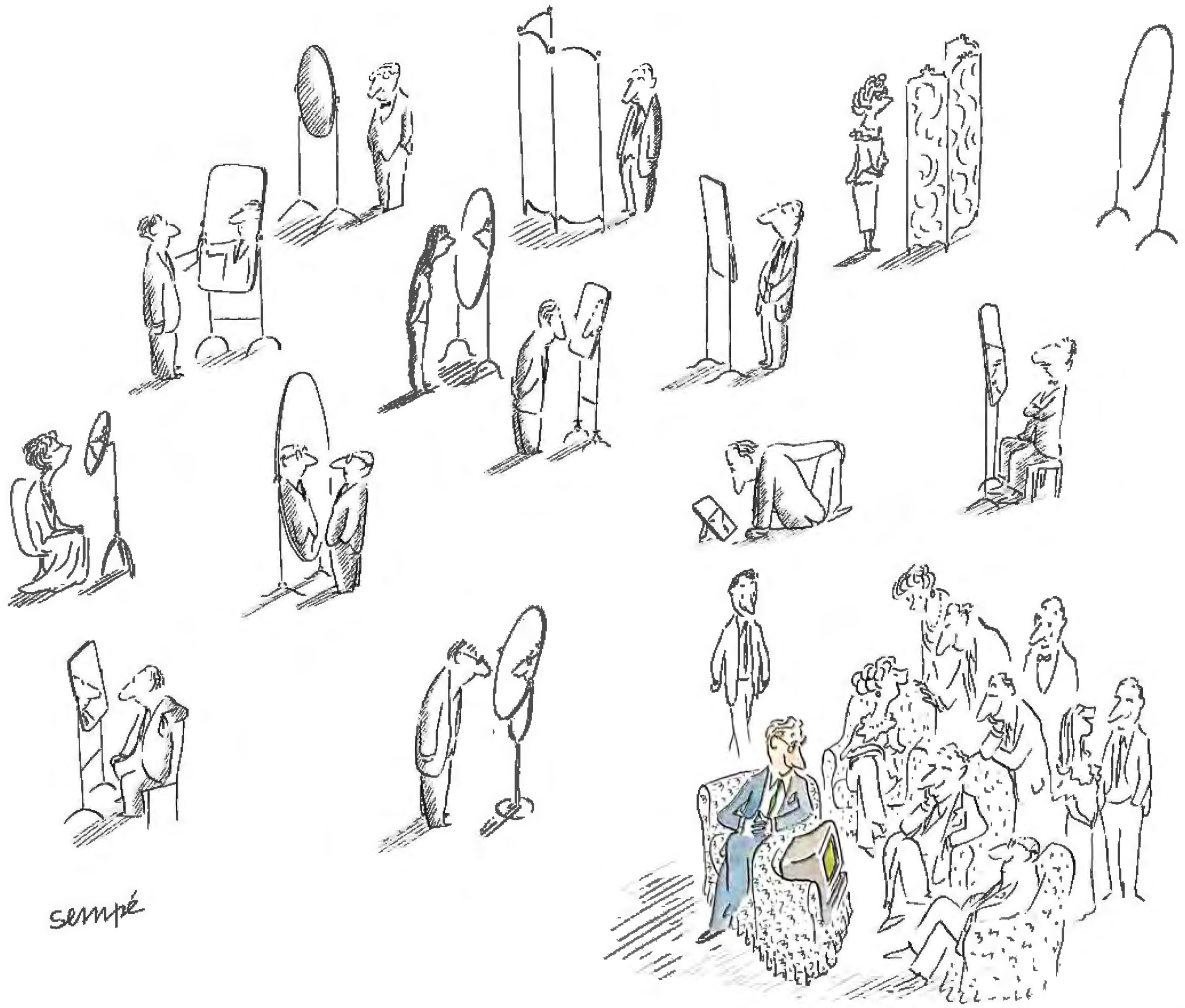
You have to read more than half of the book before you come to the two chapters that cover test specification and testing methodology. Evans warns that "personnel easily bog down in the morass of technical detail," but he does not follow his own warning. He proceeds to describe software testing in a style that is dense with terminology and definitions. In spite of this, a dedicated reader can still gain an insight into proper testing methods from these chapters.

A Word of Caution

Perhaps the most worthwhile part of the book's second half deals with satisfying the customer requirements of the project. Here Evans stresses the importance of customer participation throughout the software development. He states that customers will be more willing to accept a system if they have participated in the testing process.

Productive Software Test Management is not a book for every computer user. It would be of most interest to people involved in managing major software projects at very large development organizations. To other software developers the book would probably be fairly dull, and to casual users of microcomputers it would be close to useless. ■

Douglas L. Freeman (37819 Valley Rd., Oconomowoc, WI 53066), formerly a software-development consultant, is currently president of Color Corporation of America, Milwaukee.



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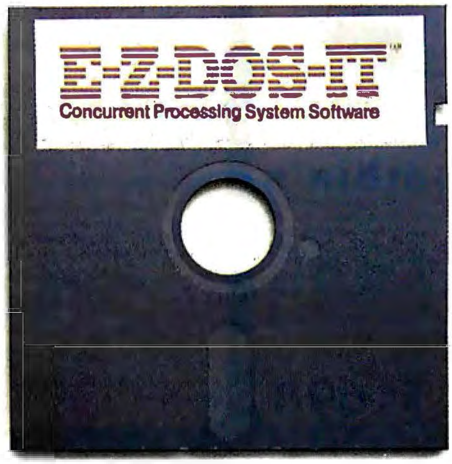

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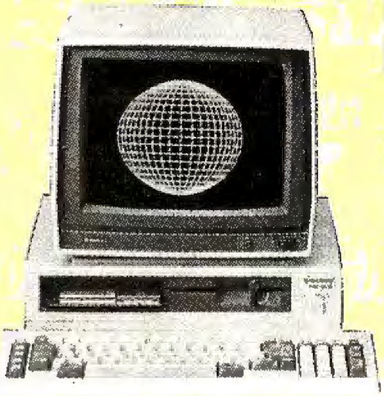

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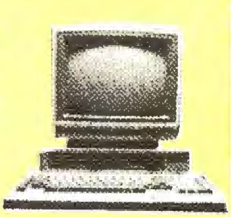

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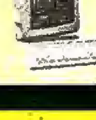

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May 1985

● BUSINESS RESEARCH Applications Seminars, various sites throughout the U.S. and Montreal, Quebec, Canada. A seminar series for those researching business topics. Contact Data Courier, 620 South Fifth St., Louisville, KY 40202, (800) 626-2823; in Kentucky, (502) 582-4111; in Canada, (800) 626-0307. *May–June*

● 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. *May–June*

● CLASSES IN UNIX, C UNIX and C Classes, City University, Bellevue, WA. Four-hour to five-day courses. Fees range from $100 to $750, depending upon course length. Contact Kathy Howard, Specialized Systems Consultants, POB 7, Northgate Station, Seattle, WA 98125, (206) 367-8649. *May–June*

● CONFERENCES FOR MANUFACTURERS, USERS Conferences for Manufacturers and Users, various sites throughout the U.S. Planned are "Document Processing in Tomorrow's Office" and "Document-based Optical Memories." Contact Richard D. Murray, Institute for Graphic Communication Inc., 375 Commonwealth Ave., Boston, MA 02115, (617) 267-9425. *May–June*

● FIX-IT WORKSHOP Computer Repair User Workshops, various sites throughout the U.S. A one-day seminar on repairing computers. The fee ranges from $140 to $175, depending upon location. Contact Cascio School of Computer Technology, Suite B109-Q, 2580 San Ramon Valley Blvd., San Ramon, CA 94583, (415) 829-5140. *May–June*

● HOME, OFFICE COMPUTING—New Olden Spring and Summer Computer Workshops, New York City. Introductory and advanced workshops on personal, executive, and secretarial computing. Fees range from $45 to $400, depending upon duration. Contact The Olden Computer Workshops, 1265 Broadway, New York, NY 10001, (212) 685-1234. *May–June*

● MICRO WORKSHOPS Microcomputer Workshops, various sites throughout the U.S. and Canada. More than 20 workshops for all levels of expertise. Contact Rhonda Carney, Intel Corp., Customer Training, 27 Industrial Ave., Chelmsford, MA 01824-3688, (617) 256-1374. *May–June*

● NETWORK PROTOCOLS Network Communication Protocols, various sites throughout the U.S. Major topic areas include elements of data communications, data-link control concepts, and bit-oriented protocols. The fee is $695. Contact Center for Advanced Professional Education, Suite 110, 1820 East Garry St., Santa Ana, CA 92705, (714) 261-0240. *May–June*

● SEMINARS AND SYMPOSIA—EDP Seminars and Symposia, various sites throughout the U.S. "Database Management Systems and Fourth Generation Languages for Personal Computers" and "Introduction to the UNIX System" are among the offerings. Fees range from $395 to $895. Calendar available. Contact Software Institute of America Inc., 8 Windsor St., Andover, MA 01810, (617) 470-3880. *May–June*

● SUMMER SEMINARS Summer Seminar Series, Rochester Institute of Technology, NY. A series of one-week seminars. Titles include "Introduction to Linear Systems and Digital Signal Processing," "Basic 6800/6809," and "Advanced Digital Logic." For details, contact Yvonne Fish, School of Engineering Technology, Rochester Institute of Technology, One Lomb Memorial Dr., POB 9887, Rochester, NY 14623, (716) 475-2915. *May–June*

● 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. *May–July*

● CONSULTANT TRAINING Learn How to Be a Successful Independent Computer Consultant, various sites throughout the U.S. The risks and rewards of consulting, planning and marketing, legal considerations, and resources are covered. Contact Education Technology Center Inc., Suite 1042, 485 Fifth Ave., New York, NY 10017, (212) 505-6148. *May–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 Lake, NJ 07675, (201) 930-4600. *May–July*

● SOFTWARE COURSES Software Short Courses, various sites through out 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. *May–August*

(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

● DEVELOPMENT SEMINARS—Professional Development Seminars, various sites around Boston, MA. One- and two-day seminars on computer competence, management, sales, marketing, and finance. Contact Boston University Metropolitan College, 755 Commonwealth Ave., Boston, MA 02215, (800) 255-1080; in Massachusetts, (617) 738-5020. *May–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. *May–November*

● MEDICAL GRAPHICS Computer Graphics in Medicine and Surgery, Virginia Mason Medical Center, Seattle, WA. Contact Linda Orgel, Virginia Mason Medical Center, 1100 9th Ave., Seattle, WA 98111, (206) 223-6898. *May 10*

● C CONVOCATION C85: The First International Conference on the C Programming Language, Ramada Renaissance Hotel, San Francisco, CA. A forum for programmers and developers using or considering the use of the C language. Sessions on ANSI X3J11 standard, portability, programming tools, and applications. Contact Lifeboat Associates, 1651 Third Ave., New York, NY 10128, (800) 847-7078; in New York, (212) 860-0300. *May 13–15*

● EDUCATION IN THE INFORMATION AGE Delivering Education in the Information Age, Radisson-St. Paul, MN. A focus on the planning and use of alternative and information-age systems as an educational medium. Contact Conference Coordinator, Minnesota Curriculum Services Center, 3554 White Bear Ave., White Bear Lake, MN 55110, (800) 652-9024; in Minnesota, (612) 770-3943. *May 13–15*

● ENGINEERING, DRAFTING GRAPHICS—Computer Graphics for Engineering/Drafting Practice and Computer Graphics Workshop, University of Texas, Austin. Short courses stressing the principles of computer graphics and developing the ability to prescribe graphics equipment for engineering applications. Contact College of Engineering, University of Texas, Austin, TX 78712, (512) 471-3506. *May 13–17*

● PROFESSIONAL TUTORIALS—Tutorials for Professional Development, Hyatt Hotel, Los Angeles, CA. A series of all-day seminars on software, logic programming, and communications. Contact Gerry Segal, Association for Computing Machinery, 11 West 42nd St., New York, NY 10036, (212) 869-7440. *May 13–17*

● COMPUTERS IN GOLDEN STATE—California Computer Show, Hyatt Hotel, Palo Alto, CA. Computers, software, engineering workstations, peripherals, and CAD/CAM systems. Contact Norm DeNardi Enterprises, Suite 204, 289 South San Antonio Rd., Los Altos, CA 94022, (415) 941-8440. *May 14–15*

● TEST, MEASUREMENT EXPO—The 1985 Test & Measurement World Expo, Convention Center, San Jose, CA. Conferences and technology exhibits. Contact Meg Bowen, Test & Measurement World Expo, 215 Brighton Ave., Boston, MA 02134, (617) 254-1445. *May 14–16*

● INTERACTIVE VIDEODISCS—Interactive Videodisc-West, Airport Hilton, Los Angeles, CA. Contact Raymond G. Fox, Society for Applied Learning Technology, 50 Culpeper St., Warrenton, VA 22186, (703) 347-0055. *May 15–17*

● MODULA-2 ENGINEERING—Software Engineering with Modula-2, Atlanta, GA. A course emphasizing methods for building large-scale software systems in Modula-2. Prerequisite: knowledge of Ada or Pascal. The fee is $495. Contact Elaine Hadden Nicholas, Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332-0385, (404) 894-2547. *May 15–17*

● SOUTHERN CAL SHOW The Southern California Computer Faire, Convention Center, Los Angeles, CA. Hardware, software, peripherals, and services for the home, office, and development site. Conference program. Contact Computer Faire Inc., 181 Wells Ave., Newton, MA 02159, (617) 965-8350. *May 16–18*

● OK SHOW The Eighth Annual Show & Tell Microcomputer Conference, University of Oklahoma, Norman. Microcomputer fans of all ages and levels of expertise come together to share ideas and to demonstrate applications and hardware. Contact Richard V. Andree, Show & Tell Microcomputer Conference, Mathematics Department, University of Oklahoma, 601 Elm St., Norman, OK 73019. *May 18*

● TELECOMM SYMPOSIUM—NTT International Symposium '85, Tokyo, Japan. Discussions on worldwide telecommunications policy, management, and societal and technological changes. Contact Ms. Yuko Ishida, Nippon Telegraph & Telephone, 200 Park Ave., New York, NY 10166, (212) 867-1511, or Ms. Shizu Munekata, Nippon Telegraph & Telephone, Suite 230, 4962 El Camino Real, Los Altos, CA 94022, (415) 940-1414. *May 20–21*

● COMPUTERS AND MEDICINE—AAMSI Congress 1985, Hilton Hotel, San Francisco, CA. Papers, sessions, and demonstrations. Contact American Association for Medical Systems and Informatics, Suite 402, 4405 East-West Highway, Bethesda, MD 20814, (301) 657-4142. *May 20–22*

● MANAGEMENT CONGRESS—Update '85, Sheraton Hotel, Brussels, Belgium. A briefing covering technological developments for those in the information-management and micrographic industries. Contact Update '85, International Information Management Congress, POB 34404, Bethesda, MD 20817, (301) 983-0604. *May 20–22*

● MICROS FOR ENGINEERS—Microcomputers for Engineers, Washington, DC. Two 2-day seminars on the use of microcomputers in engineering applications with a focus on hardware and software evaluation and selection. The fees are $425 (government) and $500 (industry). Contact Conference Manager, U.S. Professional Development Institute, 1620 Elton Rd., Silver Spring, MD 20903, (301) 445-4400. *May 20–23*

● GRAPHICS FOR PRODUCTIVITY—The 1985 Trends and Applications Conference, Sheraton Northwest Washington, Silver

(continued)

EVENT QUEUE

Spring, MD. Contact Trends and Applications '85, IEEE Computer Society, POB 639, Silver Spring, MD 20901. *May 21–22*

● PARISIAN CONGRESS
Intelligencia, Parc des Expositions, Porte de Versailles, France. An exhibition and congress on expert systems, simulation, graphics, courseware, and services. Contact Society for Computer Simulation, POB 2228, La Jolla, CA 92038-2228, (619) 459-3888; in France, AFIAS: Association Française d'Intelligence Artificielle et des Systèmes de Simulation, 211, Rue St-Honoré, 75001, Paris, France; tel: (1) 260 35 16; Telex: 214 456 F. *May 21–24*

● CAD TECHNOLOGY
CAD 2001: The Countdown, Dallas, TX. 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. *May 22–24*

● SOFTWARE AND HUMAN DEVELOPMENT
Computer Software and Human Development Conference, Royal York Hotel, Toronto, Ontario, Canada. Held in conjunction with the Third Annual Software Panorama, this conference will examine the impact of software development on business, education, health, and agriculture. Contact Reuben Lando, The Software Developers Association, Suite 500, 185 Bloor St. E, Toronto, Ontario M4W 1C8, Canada, (416) 922-1153. *May 22–24*

● SYSTEM INTEGRATION FOR USERS—Managers, Micros, and Mainframes: The 1985 NYU Symposium on Integrating Systems for End Users, New York University, New York City. Contact Matthias Jarke, Graduate School of Business Administration, New York University, 7th Floor Merrill, 90 Trinity Place, New York, NY 10006, (212) 285-6120. *May 22–24*

● DISK-STORAGE EXPO
The 1985 International Videodisc, Optical Disk, and CD-ROM Conference and Exhibition, London West Hotel, London, England. Workshops, presentations, and exhibitions. Contact Angela Suter, Meckler Communications, 11 Ferry Lane W, Westport, CT 06880, (203) 226-6967; in England, Alice Taylor, Meckler Communications, c/o Eurospan, 3 Henrietta St., London WC2E 8LU, England; tel: 01 240-0856. *May 29–31*

● MANAGE PROGRAMS
Configuration Management of Software Programs, Washington, DC. Methods for controlling the costs of development, maintenance, and operation of software. Contact Stod Cortelyou, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8520. *May 29–31*

● READYING FOR THE AUTOMATED OFFICE—Developing a Workable Plan for Office Automation, Washington, DC. Methods of planning for office automation and how to analyze technological developments. The fee is $730. Contact Chip Blouin, Continuing Engineering Education, George Washington University, Washington DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8527. *May 29–31*

● COMPUTER INTERFACING—Personal Computer and STD Computer Interfacing for Scientific Instrument Automation, Virginia

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Polytechnic Institute and State University, Blacksburg. A hands-on workshop with participants 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. *May 30–June 1*

June 1985

● ENGINEERING CONFERENCES—Engineering Summer Conferences, 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*

● 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–October*

● COMPUTER/HAMFEST The Fifth Annual Columbus Computerfest/Hamfest, Columbus, OH. A flea market featuring computers and electronic and amateur radio equipment highlights this event. Admission is $2 in advance or $3 at the door. Send a self-addressed stamped envelope to Bill Welch, W8LLU, 396 Brevoort Rd., Columbus, OH 43214. *June 2*

● LEARN TO BUILD PROGRAMS—First North American Summer School on Program Construction, Newport, RI. Methods for the effective construction of software will be taught. Contact Teleprocessing Inc., 60 State St., Boston, MA 02109, (617) 367-6227. *June 3–12*

● INTERFACES FOR SCHOOL LABS—Interfacing for School Laboratories, Miami University, Oxford, OH. A workshop for secondary school and college teachers on the construction and use of interfaces for laboratory instrumentation. Contact Bill Rouse, 301 McGuffey Hall, Miami University, Oxford, OH 45056, (513) 529-2141. *June 3–14*

● COMPUTER MAINTENANCE—Independent Computer Maintenance, Halloran House, New York, NY. Contact Carol Every, Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080. *June 5–6*

● OPTICAL STORAGE First Annual Conference on Optical Storage for Small Systems, Biltmore Hotel, Los Angeles, CA. Contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114-0817, (415) 626-1133. *June 5–7*

● COMPUTERS FOR SALE Computer Supermarket Show and Sale, San Mateo County Fairgrounds, San Mateo, CA. Retailers, manufacturers, and distributors will be selling hardware and software. Admission is $7; children, $3. Contact Microshows, Suite 203, 1209 Donnelly Ave., Burlingame, CA 94010, (415) 340-9113. *June 8–9*

● COMPUTER VISION Computer Vision and Pattern Recognition Conference, Cathedral Hill Hotel, San Francisco, CA. Submitted and invited technical papers. Contact Computer Vision and Pattern Recognition, POB 639, Silver Spring, MD 20901, (301) 589-8142. *June 9–13*

● 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*

● 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*

● 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*

● 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, The University of Michigan Medical School, Ann Arbor, MI 48109-0010, (313) 763-1400. *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*

● 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 workshops. 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*

● 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*

● 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*

● 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. 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*

● 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*

● CAD TECHNOLOGY
CAD 2001: The Countdown, Boston, MA. See May 22–24 for details. *June 26–28*

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

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*

● ADVANCED AUTOMATION—Robot Manipulators, Computer Vision, and Automated Assembly, Cambridge, MA. Contact Director of the

(continued)

EVENT QUEUE

Summer Session, Room E19-356, MIT, 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*

● 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. 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*

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

● 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*

● 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*

● 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* ■

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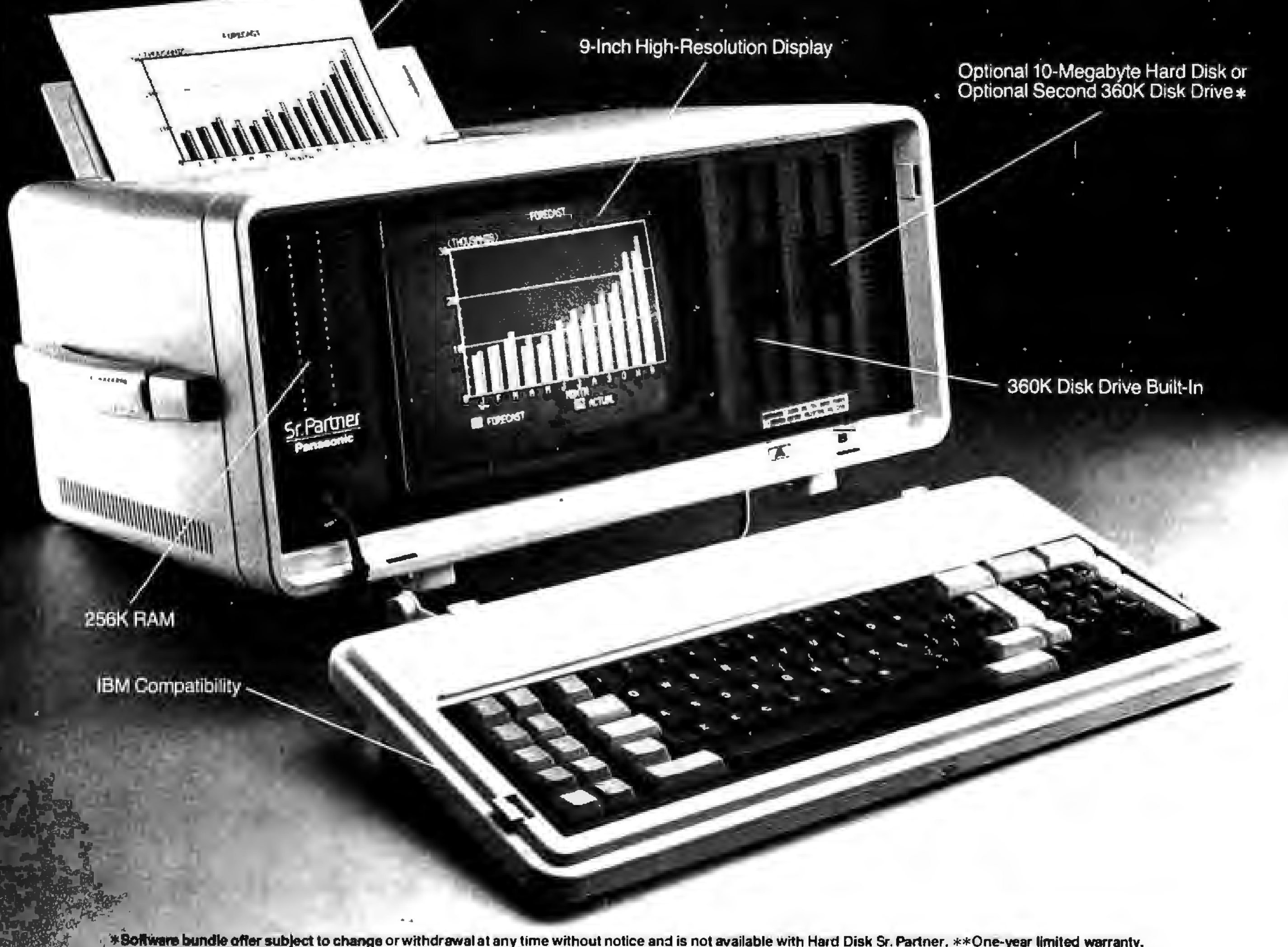

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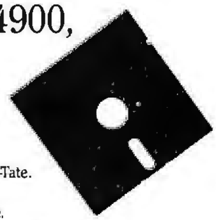

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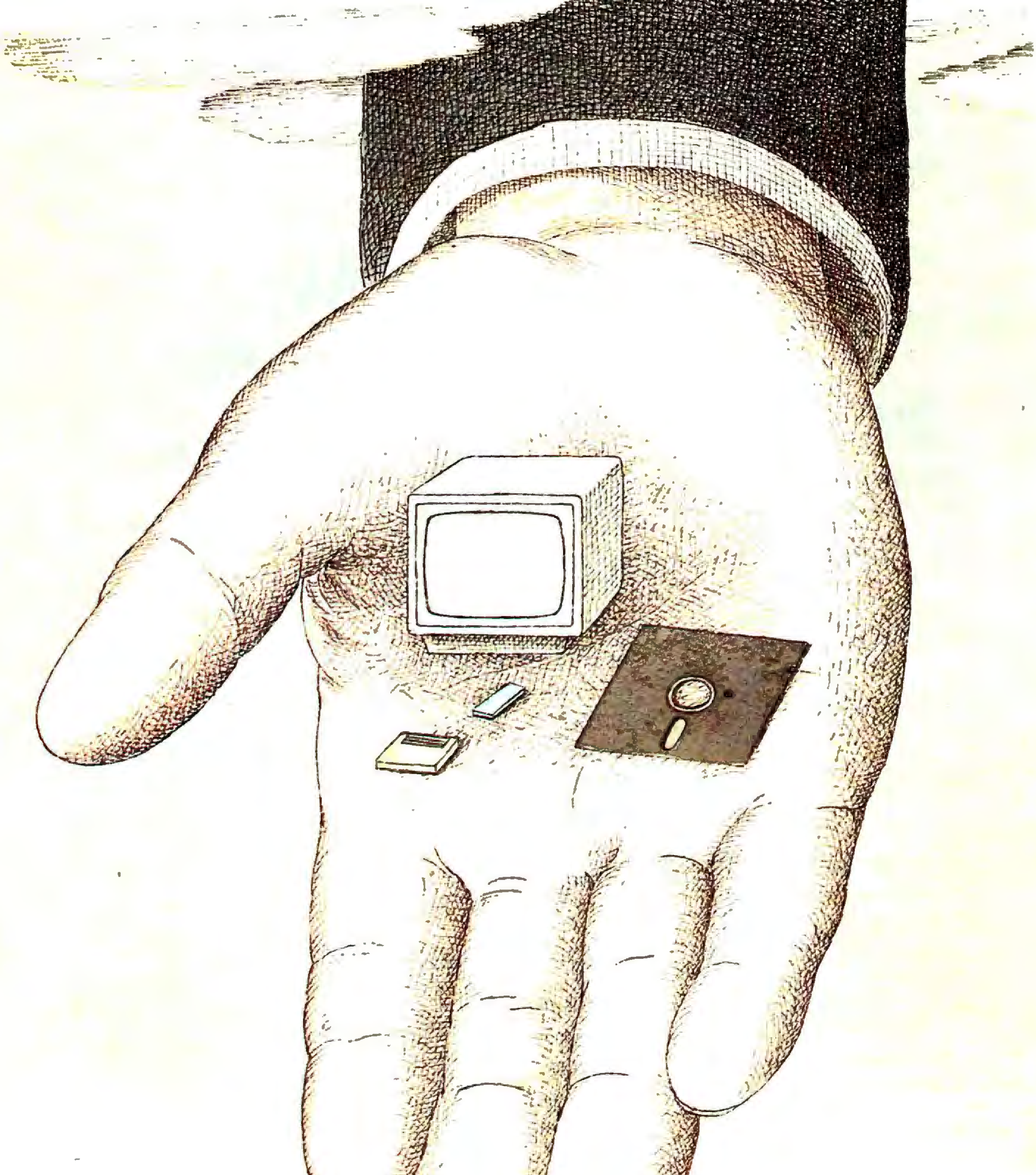


Features

THIS MONTH'S FEATURES lead off with a product description of the AT&T UNIX PC, a new machine from AT&T Information Systems. As Gregg Williams, senior technical editor, points out, with the UNIX PC, AT&T hopes to establish UNIX as a standard in the business world and challenge IBM. Gregg wasn't able to spend all the time he wanted with the machine, but he has some definite impressions of its pros and cons.

Steve Ciarcia continues with Part 2 of his Circuit Cellar Home Run Control System, explaining more of the details of his home and the system and how they come together.

Next, Al Schumer discusses "Set Extensions with Apple Pascal." He describes sets, operators, and logical machine equivalents and presents a fast extension program to Apple Pascal that increases the size of available sets and adds more set operations.

While "Build a Talking Clock Speech Synthesizer" might sound like a project that's been done before, this one adds the interesting capability of experimenting with unlimited-vocabulary speech processing. A couple of inexpensive chips, a few components, and your Commodore 64 or VIC-20 will keep time and also announce it.

People remember the August 1981 BYTE because of its Smalltalk theme. They also remember that Smalltalk wasn't available for microcomputers then and wondered when they would get a chance to experiment with this intriguing environment. This month we present a follow-up, what we call our Smalltalk trilogy.

First, contributing editor Bruce Webster and Tom Yonkman evaluate Methods, from Digitalk Inc., a Smalltalk version for the IBM PC and those machines that emulate it. Christopher Macie then describes his restricted version of Smalltalk, Smalltalk-PC, for the Apple II and others. And, finally, for those who would like a refresher on Smalltalk-80, Jim Anderson and Barry Fishman of Digitalk give us a brief review and an application that runs under Methods.

—Gene Smarte, Managing Editor

BY GREGG WILLIAMS

THE AT&T UNIX PC

Editor's note: The following is a BYTE *product description. It is not a review. We provide an advance look at this new product because we feel it is significant.*

THE UNIX OPERATING SYSTEM has been heralded as the answer to many of the problems that face computer users, especially those who need multiuser programs or who need to move a large software system from, say, a microcomputer to a mainframe. But, despite its good features, one fault of UNIX makes many people doubt that it can succeed in a commercial environment: UNIX contains many cryptic commands that must be mastered and remembered to make use of its power (for example, mv renames a file, cat prints it out, and ls gives a catalog of files in your current area).

The AT&T UNIX PC is AT&T Information Systems' attempt to establish UNIX as a standard for the business environment and to challenge IBM's dominance in the office. Its extensive use of windows and a menu-driven "front-end" program called the Office bring most of the power of UNIX to the unskilled user. Its Motorola 68010 processor gives the machine *virtual memory* capabilities—the system appears to software as if it has 4 megabytes of memory, even when it actually has as little as 512K bytes. Its telephone subsystem integrates the computer and the telephone, allowing such functions as computerized logging of phone calls, dialing from a customized directory, and saved, on-screen note taking during calls.

The UNIX PC comes with either a 10- or a 20-megabyte internal hard disk, can support up to two additional users (but without telephone services or multiple windows), and can read IBM PC-DOS data and source-code files. Although the machine has both good design features (it can be used equally well with or without its mouse, for example) and bad ones (windows respond sluggishly to mouse-initiated moves and change-size commands), its base price of $5590 for the 10-megabyte model (and $6590 for the 20-megabyte model) makes it a serious candidate for office use or UNIX program development. Buying the unit, however, forces you to cast your lot with the AT&T/UNIX world—AT&T says it has no plans to offer an add-on board that would allow the UNIX PC to run IBM PC programs.

SYSTEM DESCRIPTION

The UNIX PC was designed to AT&T specifications by Convergent Technologies of Santa Clara, California; its characteristics are summarized in the In Brief section on page 100. The AT&T mouse (see photo 1) has three buttons. These mimic the Enter, Cmd, and Mark keys on the keyboard (see photo 2); you can perform

(continued)

Gregg Williams is a senior technical editor at BYTE. *He can be contacted at* POB 372, *Hancock,* NH 03449.

Photo 1: The AT&T UNIX PC.

PHOTOGRAPHED BY AARON REZNY

P·R·O·D·U·C·T D·E·S·C·R·I·P·T·I·O·N

IN BRIEF

Name
AT&T UNIX PC

Price
$5095 with 10-megabyte hard disk and 512K bytes of memory (UNIX $495 extra, for a total of $5590); $6590 with UNIX, 20-megabyte hard disk, and 1 megabyte of memory (includes 512K-byte expansion card)

Microprocessor
Motorola 68010, a 32-/16-bit microprocessor (32-bit internal data path and registers, 16-bit external data bus), 24-bit address line (maximum address space of 16 megabytes), support for virtual memory

Clock Speed
10 MHz

Main Memory
512K bytes of dynamic RAM with parity bit on motherboard, currently expandable to 2 megabytes via expansion boards; machine's design allows for a maximum of 4 megabytes

Virtual Memory
Custom memory-management hardware and the Winchester disk allow a virtual memory space of 4 megabytes; page size is 4K bytes

ROM
16K bytes of EPROM used as initialization program when power or reset applied

Floppy Disk
Double-sided 5¼-inch floppy-disk drive using 48 tracks per inch; capable of reading IBM PC data and source-code disks; stores 320K bytes per disk AT&T format, 360K bytes per disk MS-DOS format

Hard Disk
10- or 20-megabyte Winchester disk

Mouse
Three-button optomechanical mouse (needs no special surface)

Video Display
12-inch green-on-black display; displays bit-mapped graphics at resolution of 348 by 720 pixels

Keyboard
Detachable 103-key keyboard

Serial Port
Standard RS-232C port configured as DTE (data terminal equipment); maximum transfer rate of 9600 bps (bits per second)

Parallel Port
Centronics-compatible

Telephone Subsystem
Built-in 300/1200-bps 212A-compatible modem, modular jacks for two incoming phone lines (one voice, one data), one outgoing line connects voice line to external telephone

Miscellaneous
Three expansion slots, battery-powered clock/calendar

Operating System
Custom version of UNIX System V, revision 2; extensions include demand-paging virtual memory, windows, shared function and source libraries, record locking at the character level; software provides for multiple users (up to three, with limitations) and multiple processes executing simultaneously for each user; only selected "core" functions provided with standard product; the rest of UNIX is available in optional AT&T UNIX Utilities package ($495)

The UNIX PC Office Program
A window- and menu-driven software environment that allows the non-UNIX user access to computer-assisted telephone functions, UNIX functions, and optional application programs

Optional Hardware
512K-byte expansion card, $1195

most operations with either the mouse or the keyboard. The video display is a bit-mapped display of 348 rows of 720 dots each—or 24 rows of 80 characters each (plus five lines of status information). The top line is a status line for the two phone lines, the time and date, and icons for window management and (if present) pending error messages and mail. The bottom two lines show the current functions of the eight function keys on the keyboard.

The UNIX PC is shipped with all its software already on the hard disk. The floppy-disk drive's odd placement (behind the ledge in which the keyboard fits) reflects the designers' UNIX orientation: Everything you need is on the hard disk. Still, you will use the floppy-disk drive to back up the contents of the hard disk, to install commercial software onto the hard disk, to format a floppy disk for later use, or to read data or source code from an IBM PC disk for use in the UNIX environment.

This system makes considerable use of windows but only occasional use of icons. Windows represent *folders* (which can contain files and other folders), but the UNIX PC represents an item inside a folder as a single line of text—its name, type, and optionally some other information.

THE OFFICE PROGRAM

The Office program is the mechanism through which most users will interact with the UNIX PC. It is a menu-driven "front-end" program that translates your selection to the proper UNIX commands and executes them. Once the Office window has been made active, you can execute an item by highlighting it with the cursor keys and hitting the Return key, by pointing to it with the mouse cursor (which highlights it) and pressing the left mouse button (or, equivalently, the Return key), or by typing enough of the item's name for the software to recognize it (this highlights the item) and hitting Return. When the software needs more information, it opens up another window that contains the additional choices.

The Administration item leads, through additional menus, to 24 operations that must be performed to keep the computer and the part of it you control in order. This includes everything from changing your password, to configuring the parallel and serial ports, to backing up the hard disk (see table 1 for a full list). Normally, you would need considerable knowledge about UNIX *and* the file structure of the machine to perform these functions; for example, it takes four pages of C code to implement the add/change/delete user log-on menu. The Administration item is at the heart of AT&T's attempt to make UNIX palatable to the average user.

The Clipboard item is rarely opened; it stores files and parts of files that are being transferred to a new location.

The Filecabinet item opens to a window that contains all your files and folders; the Filecabinet window is open in photo 1. The Filecabinet window can also contain modem data and RS-232C *profiles*. A profile contains the information needed to set up the internal modem or the serial port for a given use.

The Floppydisk item expands into a window that displays the contents of the disk currently in the floppy-disk drive. By copying files and folders into the Floppydisk window, you copy them onto the disk itself.

The Preferences item expands into several menus that allow you to change the order and manner of displaying items within windows, change the default window size, and turn on or off the availability of the UNIX window and certain Administration items.

The system automatically puts all material to be printed into a print queue and prints it as a background task. The Printer Queue item expands into a window that lists all items awaiting printing; you can examine the list and, optionally, cancel one or more items.

The UNIX System item expands to a window that acts like a standard UNIX terminal. This item defaults to the Bourne *shell* (this is a UNIX term that denotes the user interface between you and UNIX); you can access other shells (when they become available) by specifying a shell's name in the Office Preferences window.

When files and folders are deleted, they move to the Wastebasket. Only when they are removed from this window are the files and folders physically deleted from the hard disk.

WINDOWS

Windows in the AT&T UNIX PC behave differently from other windowing systems on personal computers. Different programs control their windows in different ways, and windows often adjust their dimensions to what they think best. The windowing system (called the *user agent* in the AT&T literature) automatically positions windows so that, if possible, all windows are at least partly visible from the screen. When that is not the case, you can cycle through all the windows by using "next window" and "previous window" function keys, or by opening and choosing from a window that lists all the windows currently open.

A window always has four icons (the ones in the corners) and may have pairs of arrows on the right edge (for up/down scrolling) and the bottom edge (for left/right scrolling); these arrows appear only if the window cannot display its complete contents. The corner icons are, clockwise from upper left, the move-window, help, grow-window, and close-window icons. The help icon, when clicked on, *always* gives a window—sometimes several—of explanatory information. The close-window icon, when clicked, causes the window to vanish; if it represents a program, closing it exits the program.

The move-window and grow-window icons must be dragged—place pointer on icon, hold down the left button, move the mouse (which drags the icon with it), then release the button. When you press the left button, a "W" in a box appears with a ghost outline of the window; both follow the mouse movement until you release the left button. The UNIX PC displays inferior behavior to its competitors when moving or resizing a window; see the "Problems" section for details.

SYSTEM V UNIX

The UNIX PC contains a complete implementation of UNIX System V, revision 2. AT&T has added some enhancements including: demand-paging virtual memory, windows implemented as character devices, multiple processes in different windows executing simultaneously, Bass-style record locking at the character level (needed for multiuser business software), shared function libraries (saves space by using only one copy of a routine used by multiple processes), and shared source libraries (has a similar effect on simultaneous compilations). AT&T will not offer the source code for the enhancements to the standard release of System V UNIX.

To execute UNIX functions, you can either open a UNIX window (see photo 3) or, from any window, you can execute any single UNIX command by preceding it with the customary "!" sign.

Although the basic system contains the full UNIX operating system, it does not contain many of the utilities associated with a UNIX software developer's workstation. Instead, AT&T has divided the software into the Foundation Set ($495), the UNIX Utilities package ($495), and a UNIX Development Tools pack-

(continued)

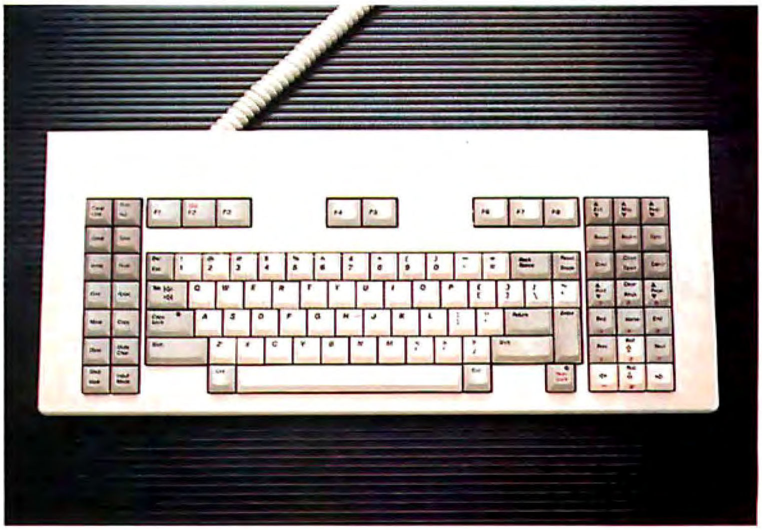


Photo 2: The UNIX PC keyboard. Many of the dedicated keys allow the computer to be controlled without using the mouse.

Table 1: Functions handled through the menu-oriented Administration window.

- Change password
- Set date and time
- Run diagnostics from floppy disk
- View system configuration
- User log-ins (add, change, delete)
- Disk backup and restore (full, incremental, single user, by filename)
- Floppy-disk operations (copy disk, format, read MS-DOS disk)
- Hardware setup (RS-232C, serial printer, parallel printer, telephone, drivers)
- Software setup (install, remove, show installed software)
- Mail setup (name this machine, identify other machine)

Table 2: Software announced for the AT&T UNIX PC at the machine's introduction.

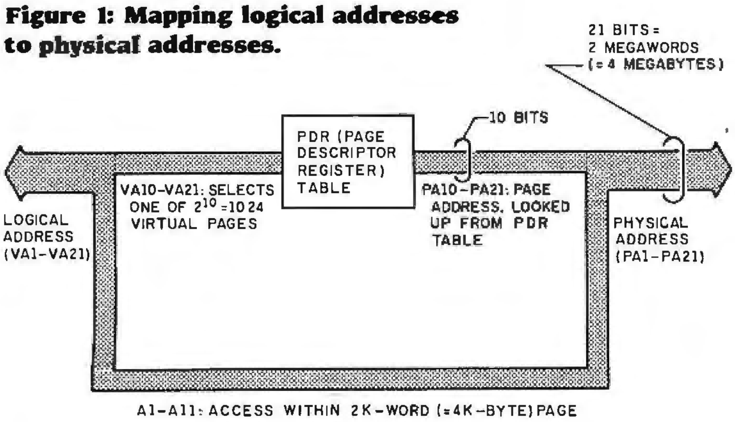
SOFTWARE FROM AT&T

- AT&T UNIX PC Word Processor
- AT&T UNIX PC Business Graphics
- AT&T UNIX PC Electronic Mail
- AT&T UNIX PC BASIC Interpreter
- AT&T UNIX PC BASIC Compiler
- AT&T UNIX PC UNIX Utilities (includes C and assembler)
- AT&T UNIX PC Development Tools
- AT&T UNIX PC Business Accounting System General Ledger, Accounts Payable, Accounts Receivable, Order Entry/Inventory, and Payroll (five packages)

SOFTWARE FROM THIRD-PARTY VENDORS

- Language Processors Inc. Debugger, COBOL, Pascal, C
- Silicon Valley Software Pascal and FORTRAN
- SUPERcomp 20 (spreadsheet)
- Graphic Software Systems Inc. Chart
- CDI Sound Presentations
- Microsoft Word, BASIC, and Multiplan
- Ashton-Tate dBASE III
- Ryan-McFarland Inc. RM/COBOL and RM/Run Time

Figure 1: Mapping logical addresses to physical addresses.



age (which includes ISAM-file and sort/merge routines, $395). For example, the Foundation Set contains the standard ed line editor, but the Utilities package contains things like the vi screen editor, the nroff text formatter, and the yacc compiler tool.

TELEPHONE FUNCTIONS

Though AT&T's adaptation of UNIX is more important, the telephone functions (called *telephony* in the AT&T literature) most visibly distinguish the UNIX PC from other personal computers. These functions are available by opening the Telephone item in the Office window, which becomes a window of names and phone numbers titled Call Screen. Convenience features include dialing both people and computers by selecting a telephone directory entry, timing a call, redialing the last number, single-keystroke speed dialing, and putting a call on hold.

Other telephone functions go beyond simple convenience and will prove invaluable to people who use telephones a lot. The UNIX PC automatically maintains a log of all incoming and outgoing calls, including the time and duration of the call (plus name and number for outgoing calls). In addition, it gives you a chance to open a "Current Notes" window to take notes in; if you have taken notes during previous calls to the same person, the computer shows them to you (annotated with date, time, and number called) in a separate window. If you have installed the optional Electronic Mail program, you can also send UNIX-style electronic mail through either the Call Screen or the Electronic Mail windows.

INSIDE THE UNIX PC

The UNIX PC consists of removable modules that can be replaced by the user. Once the cover is off, you can see a pan assembly (which houses the floppy-disk drive, the hard disk, and the power supply) and, under it, the motherboard. (The three expansion boards each slide underneath the motherboard from the rear of the machine and connect to each other through a narrow backplane that runs along the front of the machine. The slots have a 21-bit address bus and a 16-bit data bus.)

Photo 4 shows details of the motherboard; photo 5 shows the pan assembly and the motherboard. The on-board memory area contains 512K bytes (with parity) in 4864 64K by 1-bit dynamic RAM (random-access read/write memory) chips; the chips have an access time of 150 nanoseconds and run with no wait states. These chips are pin-compatible with 256K by 1-bit dynamic RAM chips; at some later time, AT&T will start using them to get 2 megabytes of RAM on the motherboard. (The system can add up to 2 megabytes of memory via expansion cards, for a maximum of 4 megabytes of memory. AT&T plans to use one slot to connect to an external expansion-card box, but expansion memory must be in the internal slots.) The bit-mapped video display requires 32K bytes of the memory.

The system contains only 16K bytes of EPROM (erasable programmable read-only memory)—two 8K by 8-bit 2764s. These contain bootstrap and diagnostic code for power-up, as well as code executed on shutdown that ensures that the attached telephone works when the computer is off.

The 10- and 20-megabyte Winchester hard disks are built by MiniScribe. The 10-megabyte drive, which comes in the basic system, has an 85-millisecond access time and a transfer rate of 5 megabits per second. The UNIX PC uses a novel form of DMA (direct memory access) to move data from the hard disk to memory. Most computers transfer control of the address and data buses to specialized hardware that first moves data from the hard disk to a buffer area; the processor regains control of the buses and moves the data from the buffer to its final destination. The UNIX PC speeds this process by capturing the buses many times, each time only long enough to move a word of data *directly* to its final destination. By not holding the buses while the hard disk is forming the next word to be transferred, this method also decreases the time the DMA transfer prevents the 68010 processor from doing its work.

Finally, three custom gate arrays (see photo 4) perform complex functions in much less space than they would have taken using discrete logic chips.

Memory Management

One of the main differences between the 68010 processor, used here, and the 68000 processor, used in the Apple Macintosh and other computers, is the former's virtual-memory capability. In a virtual machine, dedicated hardware looks at the memory address being asked for by the processor (the *logical address*) and translates it to a *physical address* that the processor can access if the data *is* currently in physical memory. If it is not (meaning that it is stored instead on the hard disk), the hardware generates a *page fault* that eventually causes the needed data to be swapped into physical memory before allowing the memory to be accessed. In a 68010-based computer, the page fault is fed to the BERR* (Bus Error) pin on the 68010; the 68010, in turn, suspends the current instruction in midexecution, runs a routine that swaps the needed data into physical memory, performs related housekeeping tasks, and completes the suspended instruction.

Most computers use a dedicated integrated circuit called an MMU (memory-management unit) to translate logical addresses into physical ones and declare page faults. Instead, the designers of the UNIX PC use discrete logic and a table of high-speed static RAM called the PDR (page-descriptor register) table to do the translation (see figure 1). The lower 11 bits of the address are left alone; this gives a page size of 2K words or 4K bytes. (The 68010 does not have an address line A0 as such, but it uses the UDS [upper data strobe] and LDS [lower data strobe] lines to access byte-sized data.) The PDR table contains 1024 16-bit entries, one for each logical page. Six bits in each entry give status information about the page (including whether or not the page is in memory). If it is, the remaining 10 bits give its physical page number; if not, the logic generates a page fault and the 68010 interrupts itself to run a routine that puts the page into physical memory and updates the PDR table.

Photo 3: A UNIX window. This window is running the Bourne shell and behaves like a conventional UNIX system.

Software

AT&T recognizes the need for as much application and system software as possible. Table 2 lists the software announced (at the time that this article was written) as immediately available. Included are several languages and popular application programs like Microsoft Multiplan, BASIC, Word, and Ashton-Tate's dBASE III. AT&T representatives said Lotus 1-2-3 will not be available; they also denied reports that they were developing an expansion card that would give their machine IBM PC compatibility.

Problems

Although the machine seemed to perform acceptably fast in the short time I had access to it (see "Caveats"), its behavior was definitely inferior to other 8086- and 68000-based windowing computers in its move-window and grow-window operations. In all cases, I measured a delay of between 1 and 1¾ seconds

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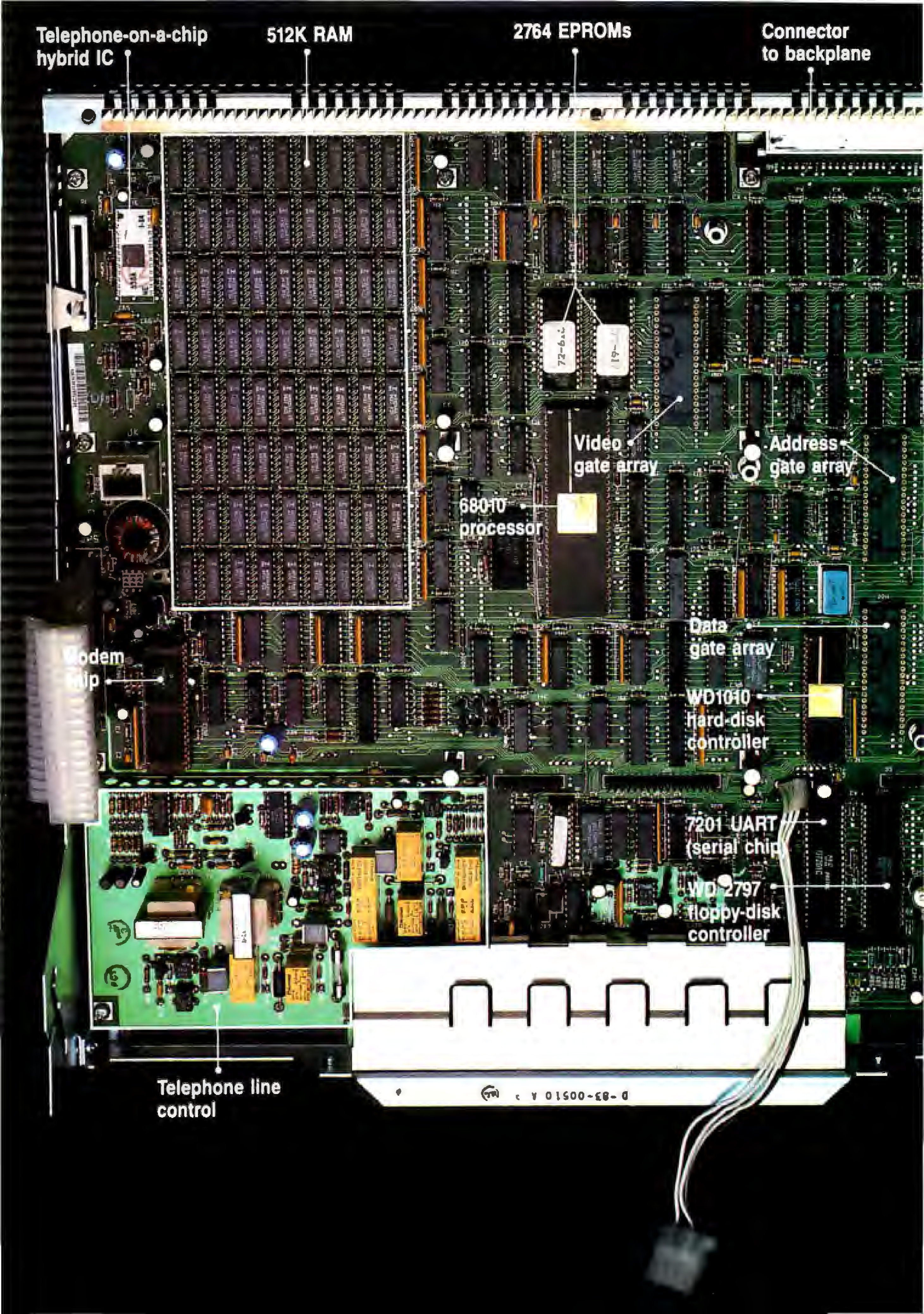
Telephone-on-a-chip hybrid IC
512K RAM
2764 EPROMs
Connector to backplane
Video gate array
Address gate array
68010 processor
Data gate array
Modem chip
WD1010 hard-disk controller
7201 UART (serial chip)
WD 2797 floppy-disk controller
Telephone line control

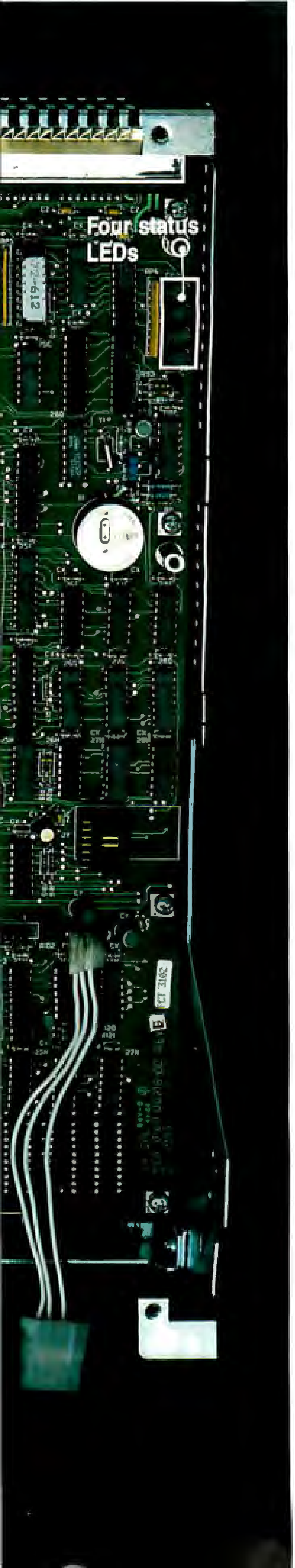

Photo 4: The UNIX PC motherboard; the front of the board is at the bottom of this photograph.

Photo 5: The pan assembly and motherboard. Here, the pan assembly (which holds, left to right, the floppy-disk drive, the 10-megabyte hard disk, and the power supply) is hinged upward to allow access to the motherboard.

between the time the left mouse button was pressed and the move or grow operation (indicated by the "W" icon) started. The ghost outline of the window's new dimensions begins at the window's current outline when the "W" icon appears. If the mouse pointer has been dragged to a new location before the "W" appears, the ghost outline may lag the mouse pointer's position by over three-quarters the length and width of the screen, thus limiting the amount the window can change before the pointer reaches the edge of the screen. (The ghost outline of a Macintosh window, in contrast, always stays with the mouse pointer.) Though this does not prevent the use of the UNIX PC, it definitely interrupts the flow of work and mars one's perception of a machine that otherwise seems to be quite fast.

Another thing that disturbs me at first impression is the designers' positioning of the floppy-disk drive, which, given the necessity of periodically using it for hard-disk backups, seems awkward to me. However, the final vote on that should come from the first people who actually use the machine for several months.

CAVEATS

I wrote this report after two days of conferences with AT&T engineers and officials, a few hours of demonstrations and hands-on experience, and considerable study of six user- and repair-oriented manuals. The machine I used was a preproduction model that used discrete logic chips to emulate the three gate arrays. The machine had the 10-megabyte hard disk and ran the finished version of the software; I did not see the machine supporting more than one user.

COMMENTARY

Although I would have liked to have had more time to study the machine, I feel confident in describing it as "quietly impressive." No one feature—menu-driven UNIX, true multiprocessing in a windowed environment, telephone functions, virtual memory—really excites me, although each one is an important "first" in the microcomputer world. Its success as a UNIX software-development workstation is assured (although it really needs a megabyte of memory for this), but its fate in the business community is promising but uncertain. Further details will be available in the full product review of this machine, which will appear in a future issue of BYTE. ■

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

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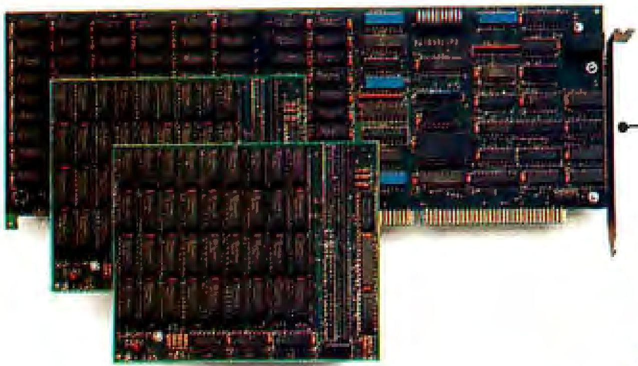

greater amounts of information, and process data faster and more efficiently than ever before. Plus, with "split memory mapping," Quadmeg-AT lets you expand the AT's base system memory to 640K without buying a space-wasting 128K card.

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.

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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.

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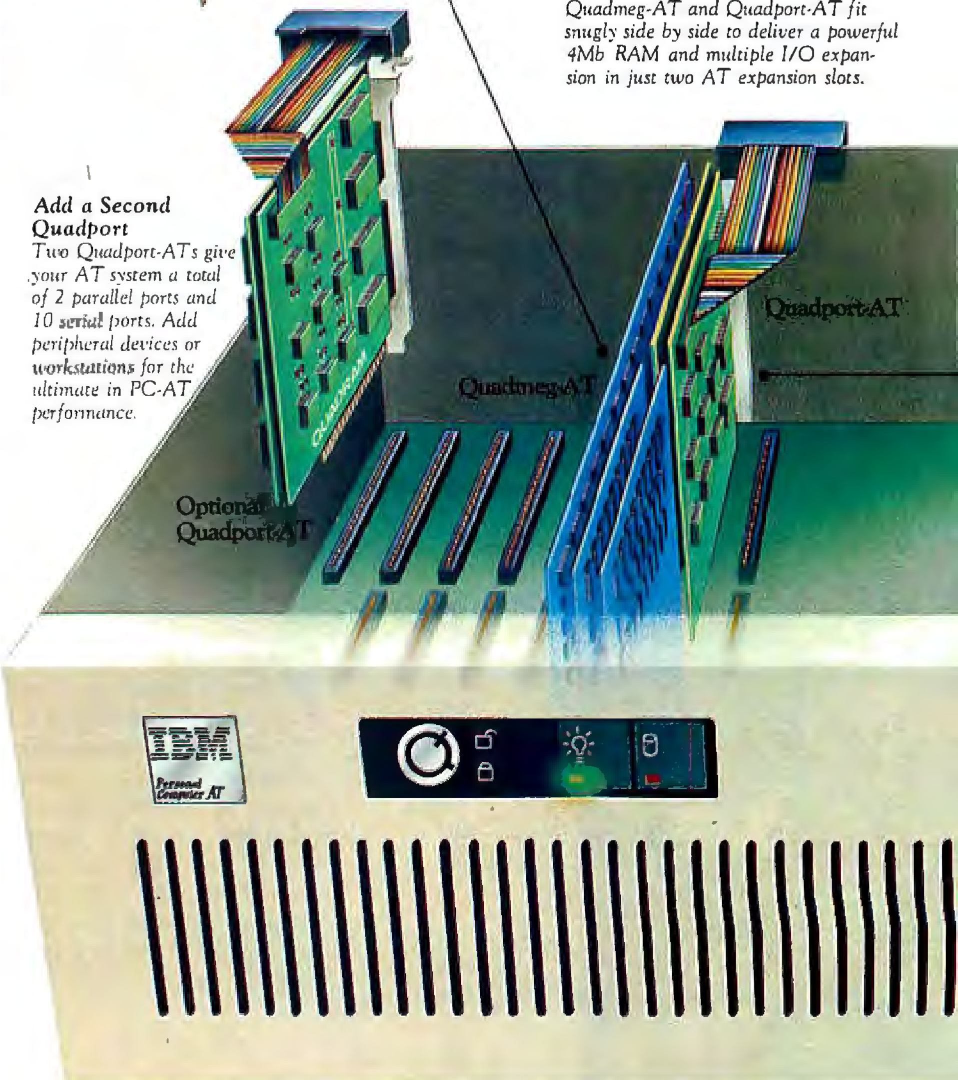

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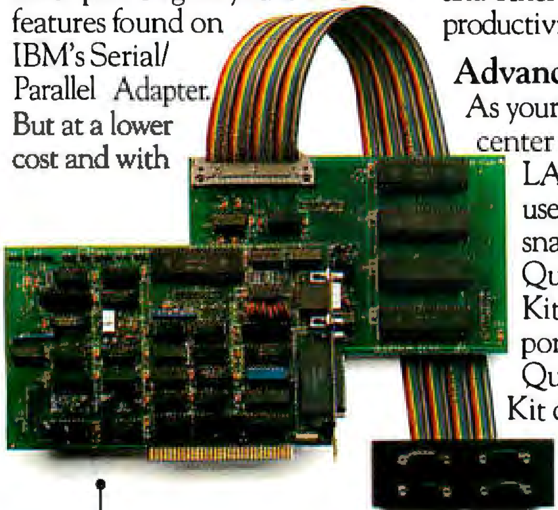


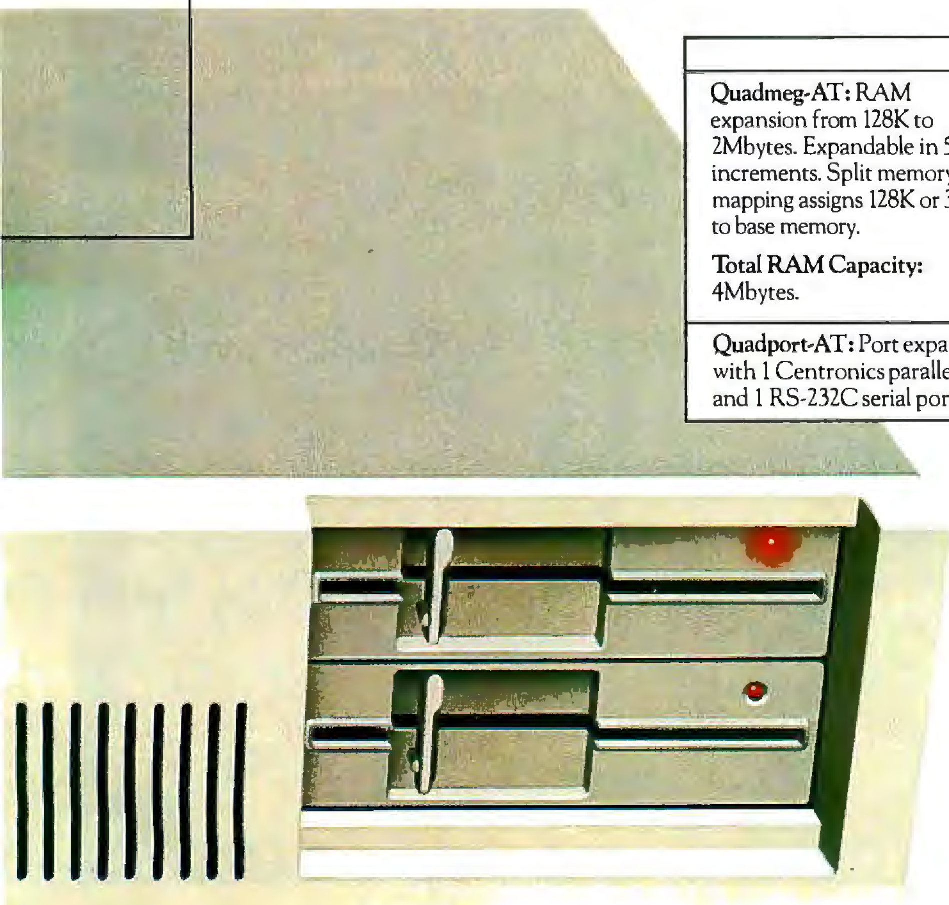
Advanced Port Expansion

As your AT becomes the center of a high-performance LAN or growing multi-user, multi-tasking system, snap on the optional Quadport-AT Expansion Kit and add 4 more serial ports to your system. The Quadport-AT Expansion Kit comes with software to access these ports, making it easy to add shared peripherals or workstations.

Enhance the smart way with Quadram.

For basic AT expansion, Quadmeg-AT and Quadport-AT work together to provide 128K memory expansion, a serial port, and a parallel port.

Then, as your system grows, Quadmeg-AT and Quadport-AT give you up to 4MB RAM, 1 parallel port, and up to 5 serial ports in just two PC AT expansion slots. Only Quadram combines so much power and expandability. That's PC AT enhancement the smart way.



Features	
Quadmeg-AT: RAM expansion from 128K to 2Mbytes. Expandable in 512K increments. Split memory mapping assigns 128K or 384K to base memory. **Total RAM Capacity:** 4Mbytes.	**Expansion Cards:** Two cards available. Each comes with 512K or 1Mbyte RAM installed. **QuadMaster-AT Software:** RAM Drives and Spooling for extended memory.
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PHOTOGRAPHED BY PAUL AVIS

BUILD THE HOME RUN CONTROL SYSTEM

PART 2: THE HARDWARE

BY STEVE CIARCIA

Energy management, convenience, and security in one package

I live in a large house with irregularly shaped rooms. The center section of the house is hexagonal, with a sunken living room in front of a fireplace. The kitchen is also hexagonally shaped and opens into a greenhouse. From the living room or the kitchen, you can descend to the "control center." The Circuit Cellar is also not your standard-shaped room. Defining a corner as the point at which two walls meet, you will find 13 corners in the Circuit Cellar.

My reason for describing this is not to elicit sympathy but instead to outline one of the reasons I designed the Home Run Control System (HCS). Visitors often comment on how wonderful it must be to live in a contemporary-styled home. Of course, they come from traditional houses with rectangular walls and light switches near the doors. There is no pattern of organization to the lighting in this house, and more than one light must be turned on in the Circuit Cellar and adjacent storage areas just to see around obstacles. If you try to walk around in the dark through some areas in this house, you can find yourself somersaulting over shin-high railings into pits, impaled on glass table corners, stunned on dark-painted Lally columns, or entangled forever in the masses of wires strung between groupings of electronic equipment. Walking around this house in the dark can be hazardous to your health.

Over the years I've designed control systems that involved automatic lighting including the BSR. Unfortunately, the hand-held controller was always some place I wasn't, or the command console was pointed in another direction (and rooms with 13 corners have lots of directions).

While I could have bought out the local Radio Shack and put controllers and modules everywhere, the problem was one of greater dimension. I ultimately wanted a control system that followed prescribed security and environmental procedures when I wasn't there but that could redirect its control functions to provide simple, automatic convenient living when I was.

Bumping into things in the dark was merely an inconvenience. I solved it in the interim by just leaving lots of lights on at night. In the long run, however, I've been directing my efforts to building the true home-control system: one that senses presence in rooms and automatically turns lights on, raises the

(continued)

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heat or lowers the air conditioning, and follows a variety of prescribed control sequences (as opposed to one) defined by the real-time assessment of the activities of the house's occupants. Finally, it is a reality, and photos 1–3 show some aspects of the system installation at my home.

The BSR by itself does not have the logical decision power to provide this capability. These functions require a computer and a program dedicated to analyzing and reacting to the environment. Home Run is such a dedicated home-control system. It uses BSR X-10 (Sears Home Control, Leviton, and Radio Shack Plug-N-Power, among others) remote-controlled receivers as many commercial timer/controllers do, but its concept and capabilities greatly exceed those systems. The Circuit Cellar HCS is a video-based closed-loop control system. The text box on page 112 outlines Home Run's basic functions.

This month, I will continue the description of the HCS with an in-depth analysis of the hardware design. First, since much of the hardware function deals with the BSR remote controllers, I'll start by reviewing their function and the communication codes they use.

BSR X-10 System Components

When I first wrote about the X-10 in January 1980, the system consisted of five modules: command controller, cordless controller, lamp module, appliance module, and wall-switch module. The line has now been expanded to include a programmable timer, wall-receptacle modules, automatic setback thermostats, and a telephone auto-answer controller. The HCS can use and control any BSR receivers.

The command controller (or any unit that functions as a command transmitter) is the central element in the system. It sends commands to the receiver modules by coded messages sent through the AC power lines. The cordless controller is a remote extension of the command controller and has a matching keyboard. When pointed at the command controller from up to 30 feet away, any command that is selected on it will be transmitted ultrasonically to the command controller and carried out.

Lamp and wall-switch modules are essentially the same. They are triac-controlled on/off switches, rated at 300 watts (W), that include dimmers. The lamp module is plugged into a wall outlet in series with the light to be controlled while the wall-switch

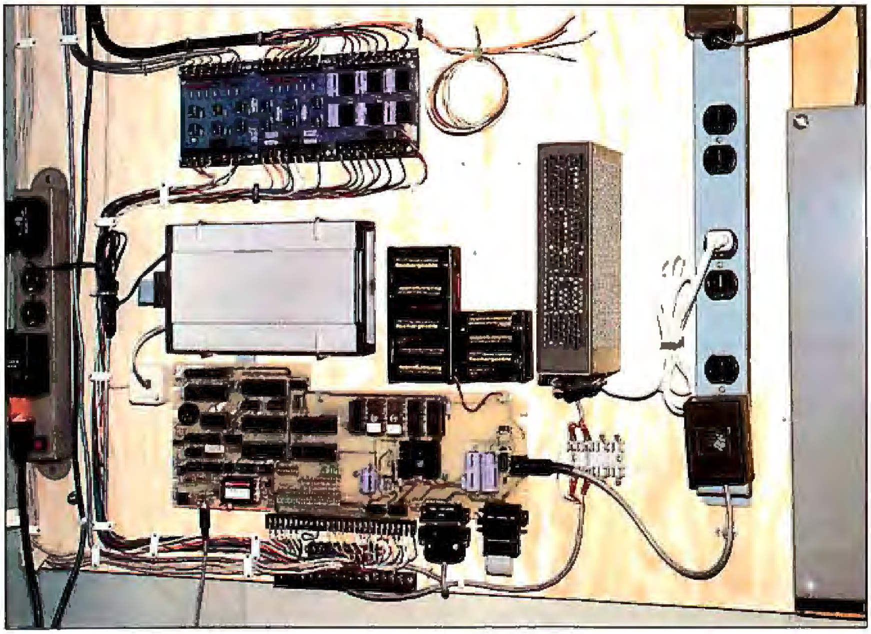

Photo 1: *I'm getting very serious about using the HCS in my home. I installed a 3- by 4-foot piece of plywood next to the breaker box and started stringing wires everywhere for closed-loop input control. The HCS board is mounted in the bottom center. Directly above it in the silver box is a Hayes 300-bps auto-answer modem. To the right of that are the rechargeable battery backup and 12-V power supply for the motion detectors and interface boards. Directly above the modem is a custom optoisolated level shifter and AC-to-DC converter interface that connects the Touch Plate, a low-voltage relay system, and commercially installed alarm-system sensors to the HCS. By the time this series of articles is finished, the rest of the board should be filled.*

Photo 2: *Much of my application for the HCS deals with its use for security and automatic lighting. Shown is the installation of a typical passive infrared motion detector. Costing in the neighborhood of $140 each, these units detect the movement of objects (like people) that have a different temperature than the surroundings. The units require a 12-V power source. Output is a contact closure: closed is no motion and open is motion detected.*

module replaces a conventional wall switch. For heavier or nonresistive loads, a contact-closure-output appliance module or wall-receptacle module is used. These are rated at 15 amperes (A) (about 1700 W).

At the heart of a BSR command module, as well as of the other system components, are custom LSI ICs (large-scale-integration integrated circuits) manufactured for BSR by General Instrument Corporation. Fully expanded, the BSR system can accommodate 256 independently addressable receivers. That is accomplished using 16 sets of addresses called *house codes* and 16 *device codes* for each house code. The separate house codes allow next-door neighbors to use X-10s without interfering with each other. A thumbwheel switch on the bottom of the command controller and the receiver modules sets the 4-bit house code.

In normal operation, the 22-button keypad, which is wired as a 3 by 8 matrix, is scanned at a rate of 3.8 kHz. When a button is pressed, its designated function and the house code (see tables 1 and 2) are combined into a single message. The digital message is directed to the transmitter section, where it generates 120-kHz signals that are used to modulate the AC line with pulse-width modulation.

To synchronize the digitally encoded serial output with the 60-Hz AC line, the circuit includes a zero-crossing detector. The transmitted message is clocked a bit at a time on zero crossing. A command message contains 9 bits of information, consisting of the 4-bit house code and the 5-bit matrix (keyboard-function) code. Each message is transmitted in true and inverted format on successive half cycles of the AC waveform. This is illustrated in figures 1 and 2. A logic 1 bit consists of three 1-millisecond (ms) bursts of 120-kHz signal commencing approximately 200 microseconds (μs) after the zero crossing of the AC line. A logic 0 bit is represented by no signal for that half cycle. To synchronize the receivers with the transmitter, a trigger code consisting of 3 successive logic 1 bits followed by a logic 0 bit is used. The complete message takes 11 full AC cycles (183 ms) to complete.

Actual attachment to the AC line is accomplished by means of a transformer and capacitor coupler. That combination is necessary both for protection and economics. The effective range of this system is generally all the wiring from the controller to the nearest power company step-down transformer. Usually, five or six houses are on each transformer; some coordination with respect to the choice of house codes may be necessary. Also, since the version of the X-10 sold in the U.S. is a 117-volt (V) unit, and because most homes derive their 117-V power from both sides of a 220-V line, problems can sometimes occur in obtaining consistent operation when receiver modules are used on both 117-V lines and relatively few 220-V appliances are in operation to act as a communication bridge. Placement of the receivers could require some experimentation, or a capacitor jumper could be added between the sides of the 220-V line.

The receivers are quite sophisticated, considering that each one usually costs less than $17. All receivers (lamp modules, appliance modules, wall-receptacle modules, and wall-switch modules) are essentially the same. Also incorporating a custom LSI IC, the receiver section monitors the AC line, waiting for a coded message corresponding to its unique house code (A through P) and unit device code (1 through 16). To turn on channel 10, you simply press 10 and ON, one after the other. When an appliance or wall-receptacle module activates, it energizes a relay.

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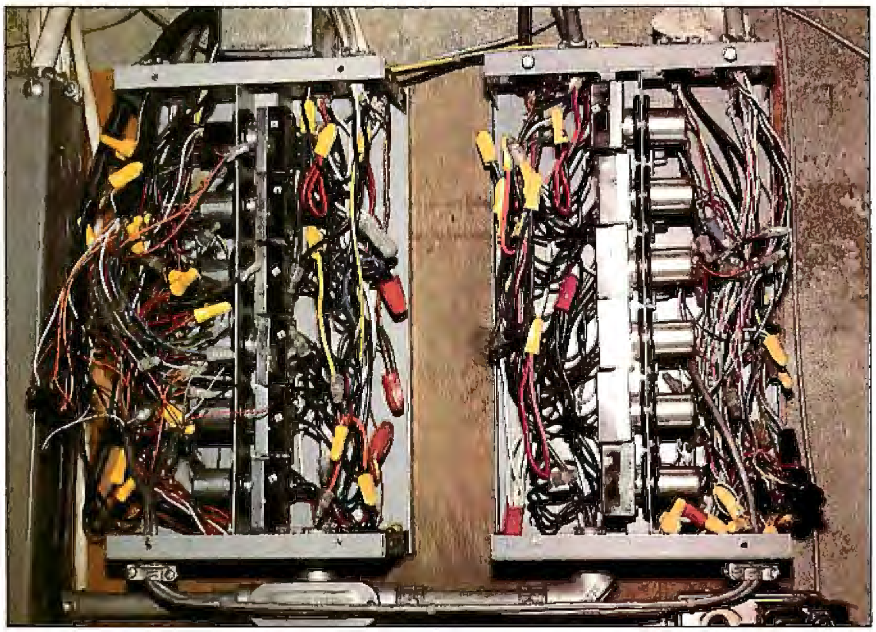


Photo 3: *Much of the outside lighting and some of the outlets in my home are already remotely controlled through the Touch Plate. An absolute rat's nest of expensive electrician-installed wire controls 12 specific circuits. The highly reliable latching relays are controlled at various points in the house by illuminated push buttons. Their operation is push-on/push-off single-button control. When the circuit is on, the button is illuminated by a second low-voltage signal. Given the closed-loop nature of Touch Plate, I decided to connect some of the circuits to the HCS. The six relays wired in at present required a separate interface board to convert the low-voltage AC Touch Plate to TTL levels and an 18-conductor cable to route the signals. The HCS can now control as well as ascertain the present on/off state of the outside lighting.*

Home Run Control System: Overview

The Home Run Control System 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. The system can also directly control processes through hard-wired outputs. The following outline itemizes the features of the computer.

1. Versatility. The HCS can accommodate 48 BSR modules. 16 digital inputs, 8 TTL-compatible outputs, and 16 messages.
2. Self-containment. The HCS can use any terminal (or personal computer emulating a terminal) at 75–4800 bps. The HCS also incorporates an integral video-display generator to provide a 24-line by 40-character display either directly to a composite video monitor or television set. A keyboard encoder allows connection of either an Apple II-compatible parallel-encoded keyboard or an unencoded scanned-matrix keyboard. An additional serial port has been provided to which an auto-answer modem can be attached (such as the Hayes 300 or 1200). When the modem answers, the HCS allows the remote calling terminal to access and control the HCS.
3. Flexibility. The HCS can schedule to turn outputs on or off based on combinations of the following conditions:
   a. time of the week (e.g., Tuesday at 4:32)
   b. time of the month (e.g., 22nd at 11:20)
   c. input line going high
   d. input line going low
   e. turn off after time delay (e.g., remain on for 15 minutes)
   f. one-time action triggered by specific input or time

   When you want to create an event, various combinations of inputs and time can be specified. They are as follows:

   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
   or
   ON while specified input occurs

   5 ON when specified input occurs
   OFF after period of time

4. Superkeys. The HCS has 16 function-key inputs called superkeys, which cause a user-defined list of actions to be performed when the appropriate key is entered. This allows a complete sequence of events to be transmitted. The number of commands defined by a superkey is limited only by available RAM.
5. Light dimming. Lights can be dimmed to one of 16 levels. This allows mood control, a night light, or power-conservation operation.
6. Display messages. Text messages of variable size can be scheduled as announcements or reminders.
7. Low power. The HCS can be used to control energy consumption of a house, thus it is designed to be efficient. Power requirements are under 5 watts.
8. Battery backup. The processor and clock will continue to operate during a power failure; scheduled events will still be noted in memory. When AC power is restored, the HCS will restore all modules to the state they would be in if power weren't interrupted.
9. Sunset adjustment. The on time of desired modules, usually lights, will track the sunset. This alleviates having to adjust the schedule many times per year as the sunset changes. There is a command to compensate sunset times for daylight saving.
10. Automatic restore. The HCS can optionally restore the status of all modules every 4 minutes. This is useful in commercial applications where a module may be turned off by a transient or non-HCS-generated command. Restore can also be triggered by an input line. The HCS always restores all modules after a power loss.
11. Schedule bypass. Modules can be bypassed for a selected interval (up to 44 days). This can be used for vacations or holidays.
12. Hold on input. This allows an input occurrence to lock out specified modules.
13. Accurate clock. The clock accuracy can be adjusted by software to within 1 second per day.
14. List events. The entire event schedule can be listed to the serial port. The speed of the listing can be controlled to allow for printing of the schedule.

The lamp and wall-switch modules use a triac instead and have the capability to brighten or dim in response to control commands.

Home Run Hardware

The Home Run Control System is a complete microcomputer. Functionally block-diagramed in figure 3, it contains RAM (random-access read/write memory) and ROM (read-only memory), serial and parallel I/O (input/output) ports, a keyboard, and a video display. In its fully expanded form, it can communicate with an external terminal or a modem and display the events and status on its own display simultaneously. The HCS is based on the 6802 processor and runs entirely on interrupt. These interrupts update the real-time clock, scan the event tables, read the input lines, set the outputs, refresh the video display, transmit the BSR codes, and service the communication ports.

Home Run was designed to work in a variety of home and industrial applications. As such, it accommodates both encoded and unencoded keyboards, terminal and integral video display, and BSR and direct I/O. Its software is flexible enough to work

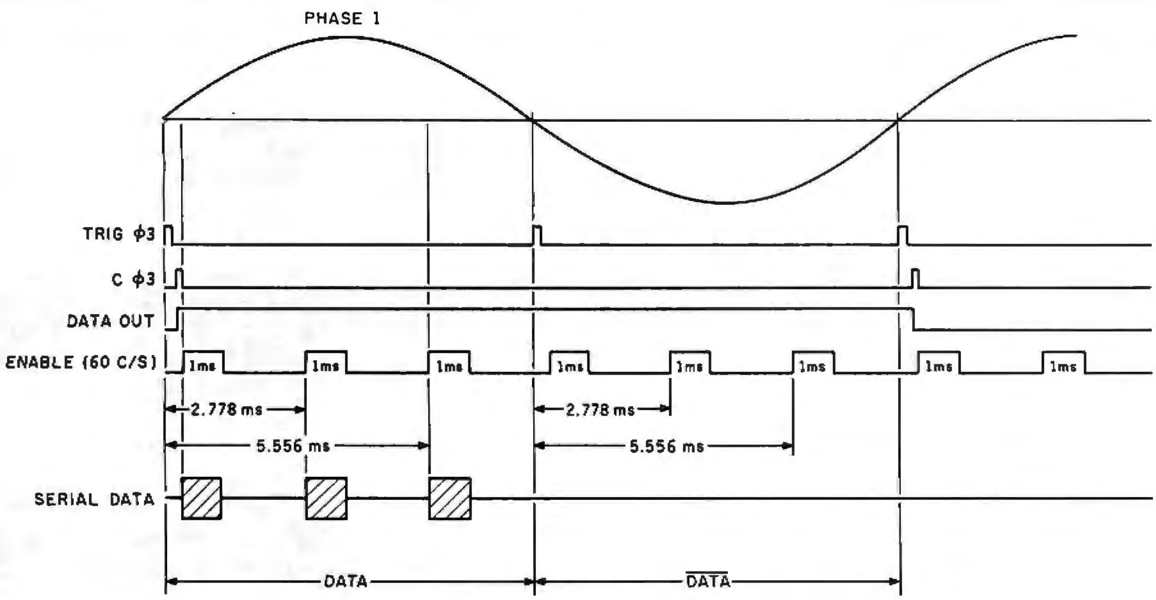
(continued)

Table 1: *Security house codes.*

STATE	H8	H4	H2	H1
A	0	1	1	0
B	1	1	1	0
C	0	0	1	0
D	1	0	1	0
E	0	0	0	1
F	1	0	0	1
G	0	1	0	1
H	1	1	0	1
I	0	1	1	1
J	1	1	1	1
K	0	0	1	1
L	1	0	1	1
M	0	0	0	0
N	1	0	0	0
O	0	1	0	0
P	1	1	0	0

Table 2: *AC-line matrix key codes.*

KEY	D8	D4	D2	D1	D16
1	0	1	1	0	0
2	1	1	1	0	0
3	0	0	1	0	0
4	1	0	1	0	0
5	0	0	0	1	0
6	1	0	0	1	0
7	0	1	0	1	0
8	1	1	0	1	0
9	0	1	1	1	0
10	1	1	1	1	0
11	0	0	1	1	0
12	1	0	1	1	0
13	0	0	0	0	0
14	1	0	0	0	0
15	0	1	0	0	0
16	1	1	0	0	0
CLEAR	0	0	0	0	1
ALL	0	0	0	1	1
ON	0	0	1	0	1
OFF	0	0	1	1	1
BR	0	1	0	0	1
DIM	0	1	0	1	1



The transmitted message is synchronous with the AC line, and each bit is clocked on zero crossing. Each message contains 9 bits of information: 4 bits of security code and 5 bits of matrix code. Each message is transmitted in true and inverse form on successive half cycles of the AC-line signal.

A 1 bit is 3 × 1-ms bursts of 120 kHz, commencing approximately 200 μs after the zero crossing of each phase. A 0 bit is no signal for that half cycle. To synchronize the receivers with the transmitter, a Start Code consisting of 3 successive 1 bits followed by a 0 bit is used. Thus, a complete message takes 11 full cycles of the AC line to complete.

Figure 1: BSR *transmission protocol and timing.*

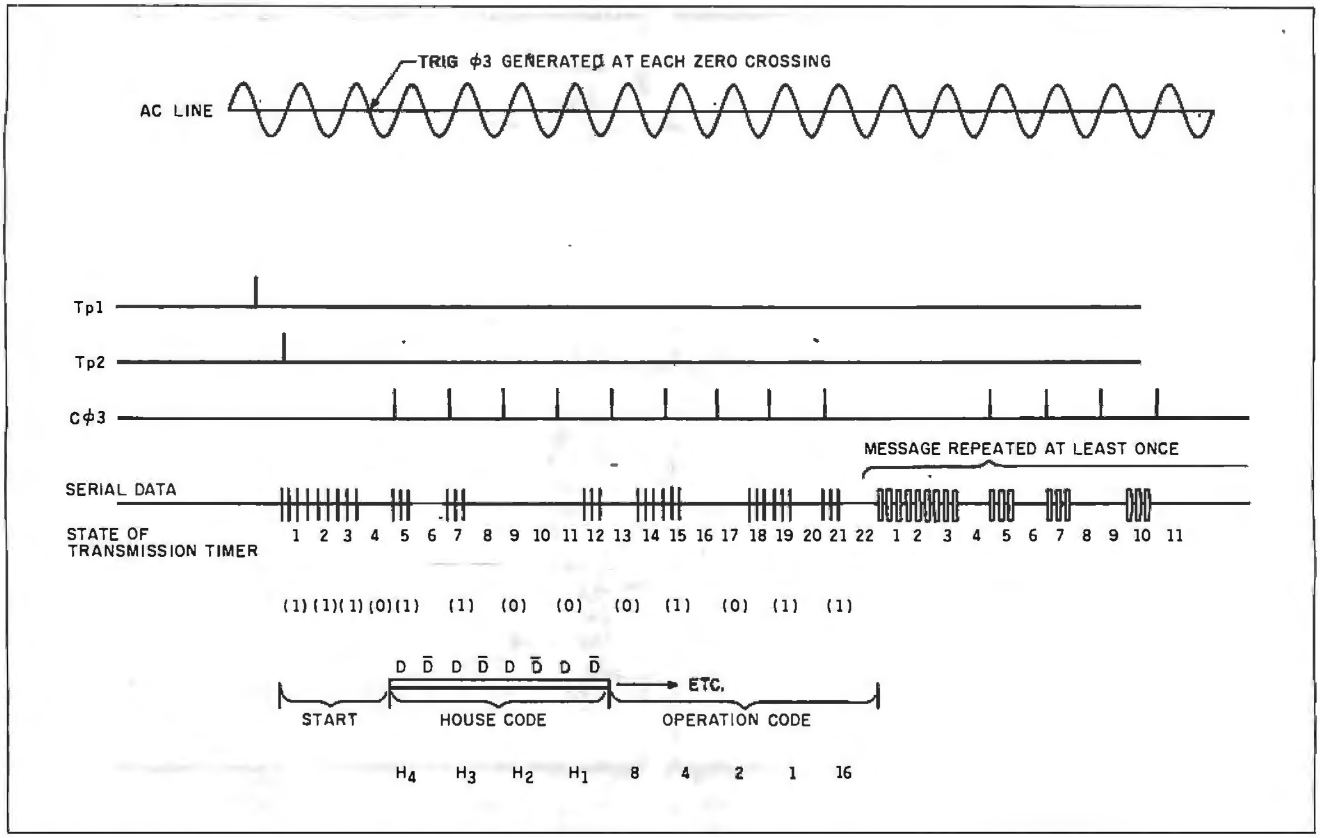


Figure 2: BSR *transmission protocol and timing continued.*

with any combination or all of these subsystem peripherals. If you don't have a terminal or an auto-answer modem, you can configure a video-based-only HCS and leave the serial components out. (Because some users may not initially need or be able to afford all the functions supported by the HCS, it is available as a partially populated board. You can add the additional support chips at any time.) Figure 4 is the complete schematic of the Home Run Control System. I will explain it in five sections: processor and memory, timing, serial and parallel I/O (see photo 4), video display, and power supply.

Processor and Memory Section

At the center of the HCS is a Motorola 6802, IC1 (block-diagramed in figure 5). The 6802 is an 8-bit processor that is software-compatible with the standard 6800. It contains the same registers and accumulators as the 6800 plus an internal clock oscillator and driver. In addition, it has 128 bytes of on-chip RAM addressed at hexadecimal locations 0000 through 007F. A 4-MHz crystal is used with IC1 and results in a 1-MHz system-clock output on pin 37. This clock is divided by counters in the timing section to provide the various interrupt clocks and pulse-signal sources. The processor is reset by pressing PB1, attached to pin 37.

The 16-bit address bus is decoded through a 74LS138 (IC5) into eight 8K-byte blocks designated by chip-enable lines Y0 through Y7. RAM occupies the space from 0000 to 3FFF. ROM occupies the range from A000 through FFFF.

The HCS has two 28-pin RAM sockets that can accommodate either 6116 (2K by 8-bit) or 6264 (8K by 8-bit) 350-nanosecond (ns) CMOS (complementary metal-oxide semiconductor) RAM chips. The HCS requires a minimum of 4K bytes of RAM to function. A jumper that selects/deselects address line A11 sets, whether a 2K-byte or 8K-byte RAM is inserted. The software auto-sizes and allocates available memory on power-up (be sure to remove the battery backup when changing or adding any chips). Table 3 designates the various legal RAM configurations.

Three program ROM sockets are designed for 2764-type 8K by 8-bit EPROMs (erasable programmable read-only memories). The HCS program presently resides in 16K bytes and uses IC11 and IC12. IC19 is an empty socket intended for future program expansion and enhancements. (Eventually, I hope to design an analog I/O expansion board for the HCS, and I decided that it would be a good idea to put in the hooks now. Direct temperature monitoring and HVAC [heating, ventilating, and air conditioning] motor control are a possible consideration.) Portions of

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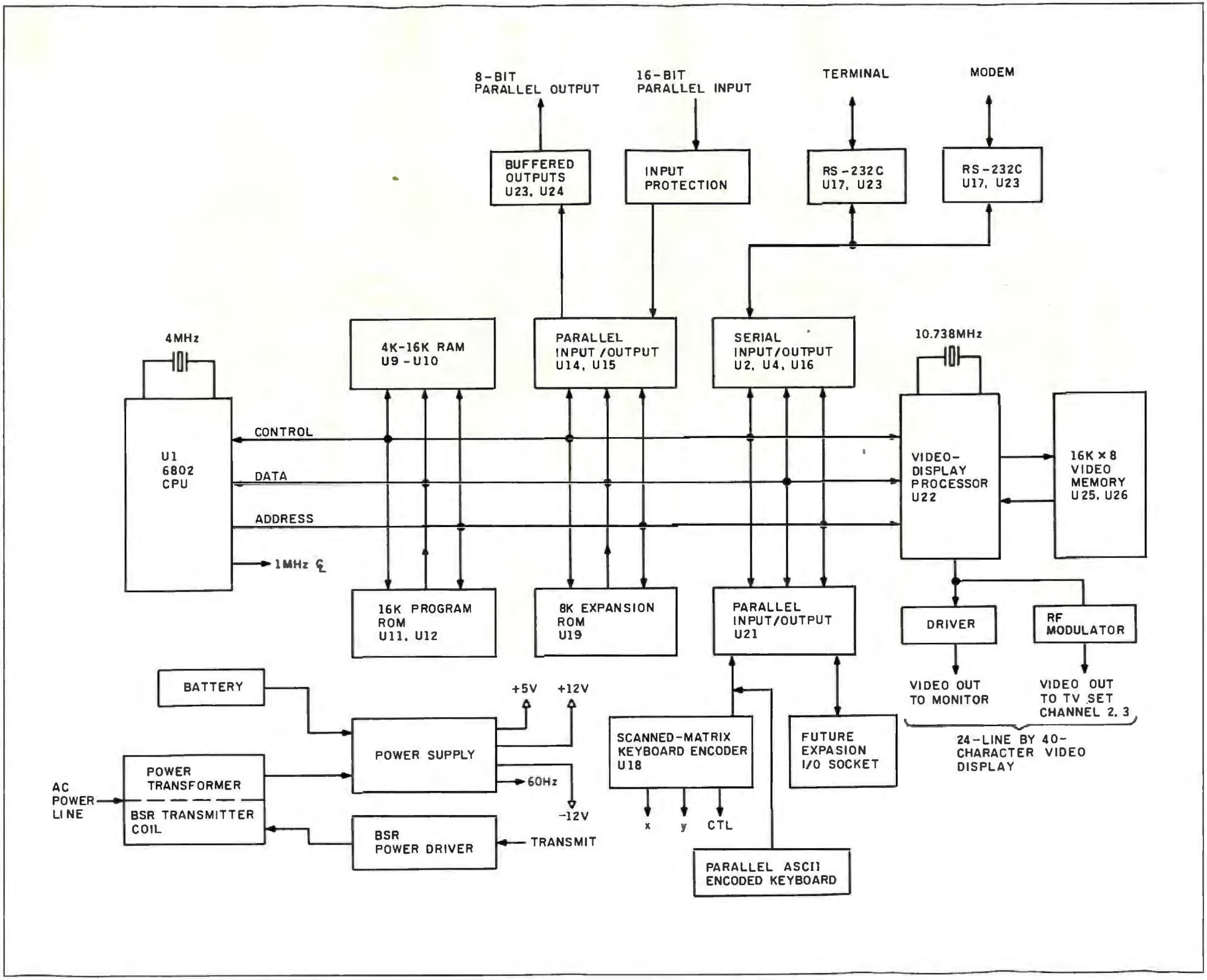


Figure 3: *A block diagram of the Home Run Control System.*

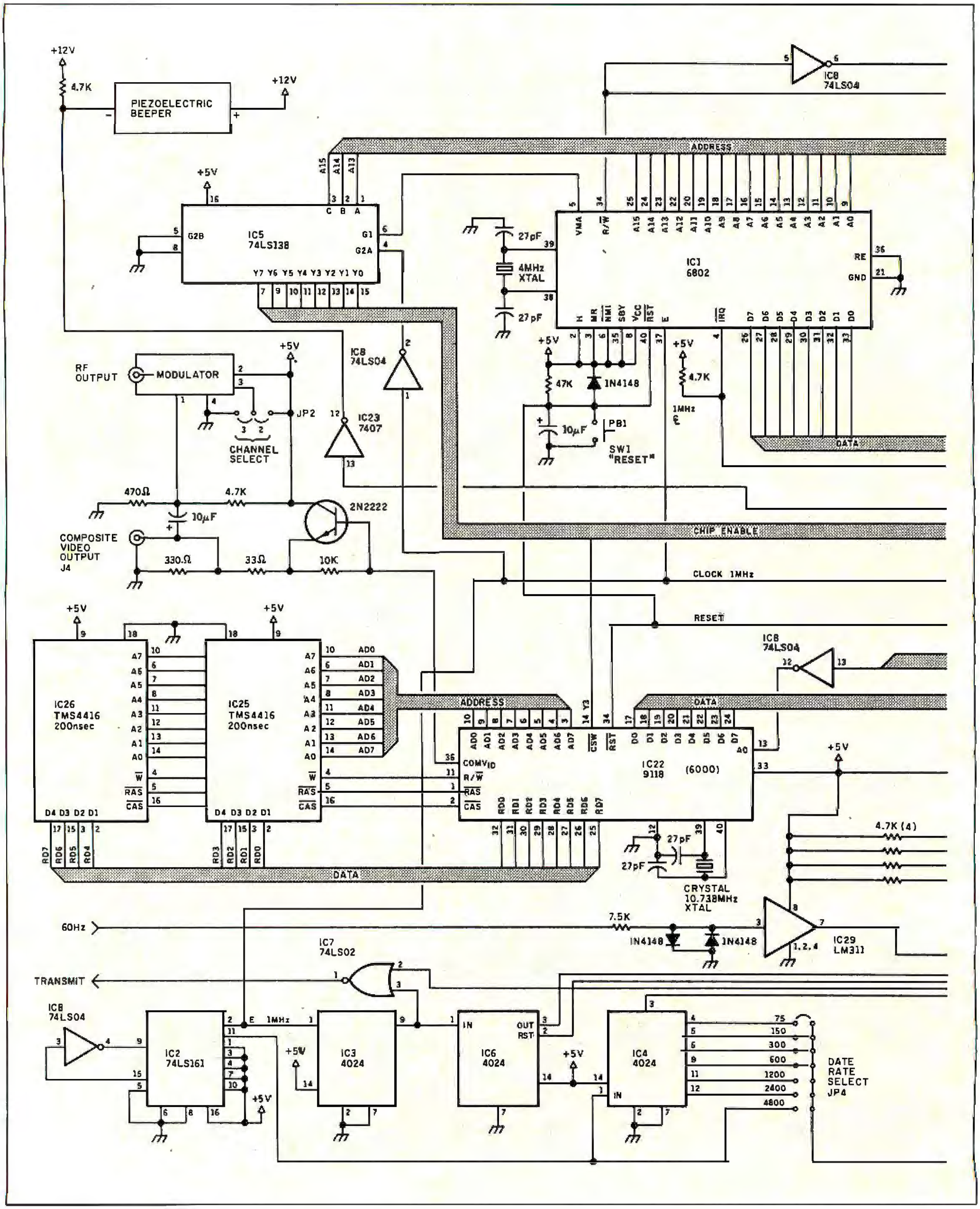
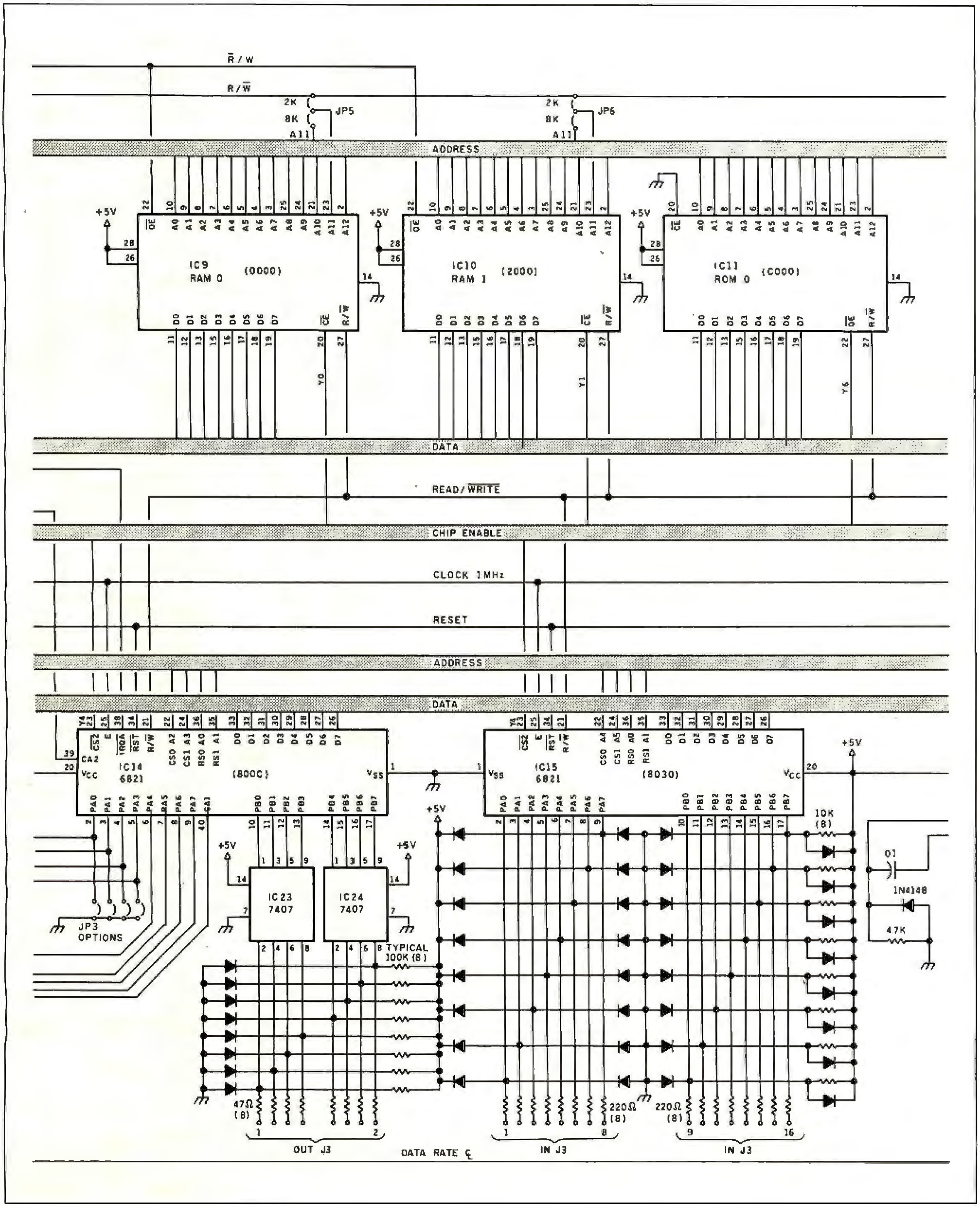


Figure 4: *The schematic of the Home Run Control System.*



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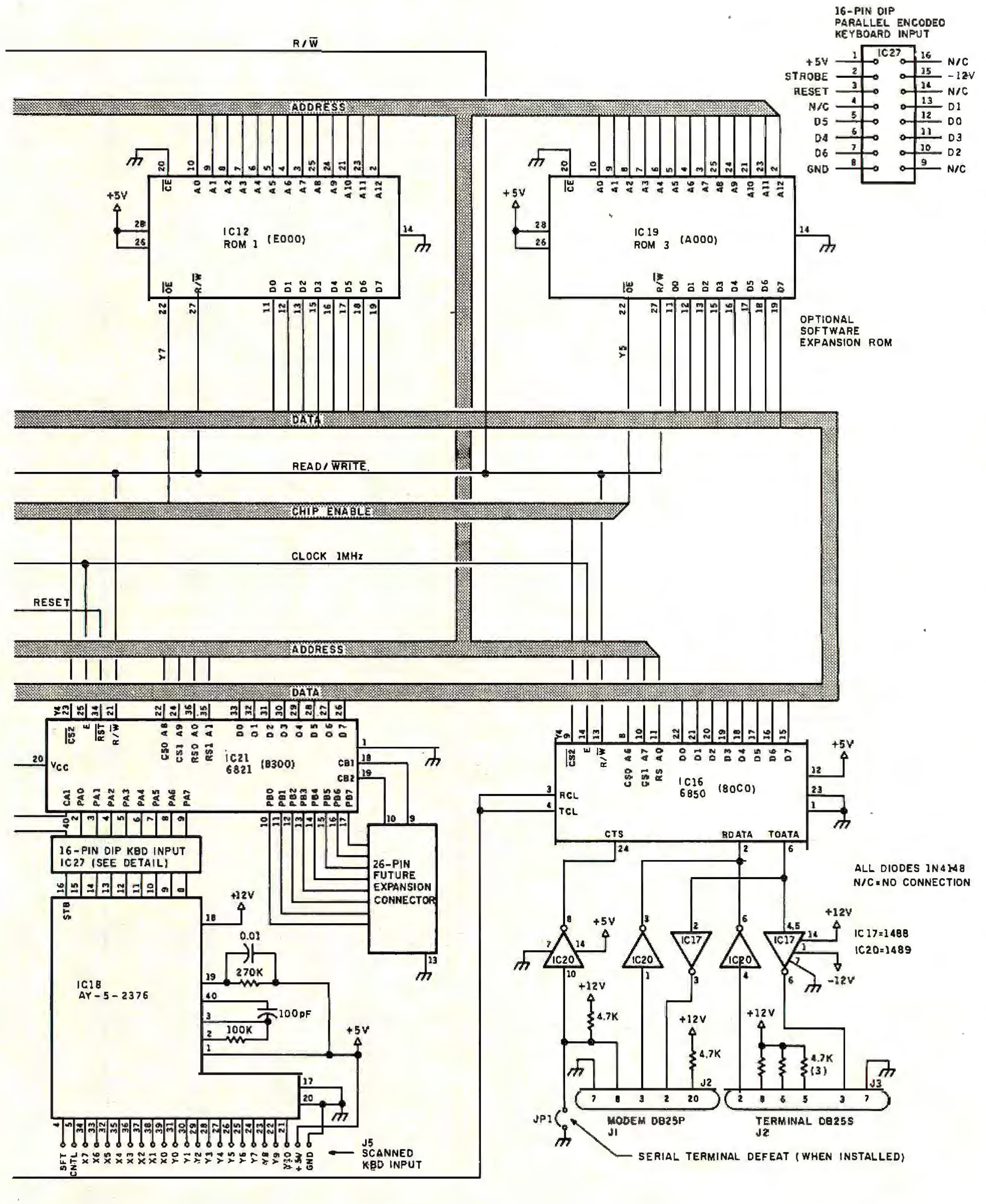

the I/O are also set aside for expansion.

TIMING LOGIC

Figure 6 outlines the section of the circuit that generates the timing signals. All the clocks are derived from a master 1-MHz clock produced by the processor. The 1 MHz is divided by 13 through a 74LS161 (IC2) to produce 76,923 Hz. This frequency is only 0.16 percent off the 76,800-Hz frequency normally used for communication at 4800 bits per second (bps). The other data-transmission rates (2400, 1200, 600, 300, 150, and 75 bps) are produced by further dividing this frequency through the binary counter, IC4. One of the seven output frequencies is jumper-selected as the terminal/modem communication rate and directed to the transmit/receive clock input of the serial I/O chip, IC16.

The frequency at the final output of IC4 is 601 Hz. This frequency is used as the master interrupt clock for the HCS. Every 601 times the interrupt is called, the real-time clock is incremented 1 second. At various other increments in time, event and input status are checked and output set.

The BSR transmission timing is also controlled through this circuit. The 1-MHz system clock is divided by 8 through IC3 to produce 125 kHz. While slightly off the 121 kHz normally specified for BSR line transmission, it is within tolerance of the receivers. The 125 kHz is gated on and off through NOR gate IC7 by an output bit from IC14. An LM311 (IC29) high-speed comparator functions as a zero-crossing detector to let the processor know when to gate the 125 kHz onto the AC line.

The 1-ms pulse bursts are timed by IC6. The elapsed time between releasing the reset line of counter IC6, which is clocked at 125 kHz, and an output change of state is 976.56 μs, or 1 ms in the real world. The clock period of the output waveform is 1 ms, but changes of logic state occur on the half period, 0.5 ms. By counting three of these changes of state, 1.5 ms, the typical time interval between 125-kHz pulse bursts is also derived.

The BSR driver is functionally part of the power-supply section, and some elements will be explained later. Basically, it is a simple two-transistor power driver attached to the primary side of a tuned transmitter coil. NOR gate IC7 drives the output in 1-ms bursts of 125 kHz. The voltage swing is from +12 V to −12 V on the primary side through a high-voltage driver transistor, type NTE288 or equivalent (I_c = 300 milliamperes [mA], V_{ce} = 300 V). The secondary side of the transmitter coil is coupled to the AC line through a 0.22-microfarad (μF) capacitor (400 V). A separate tuned secondary winding increases the transmission amplitude.

SERIAL AND PARALLEL I/O

Home Run uses three 6821 PIA (peripheral interface adapter) chips and one 6850 ACIA (asynchronous communications interface adapter) chip to connect real-world activities to the processor. Each 6821 has two 8-bit,

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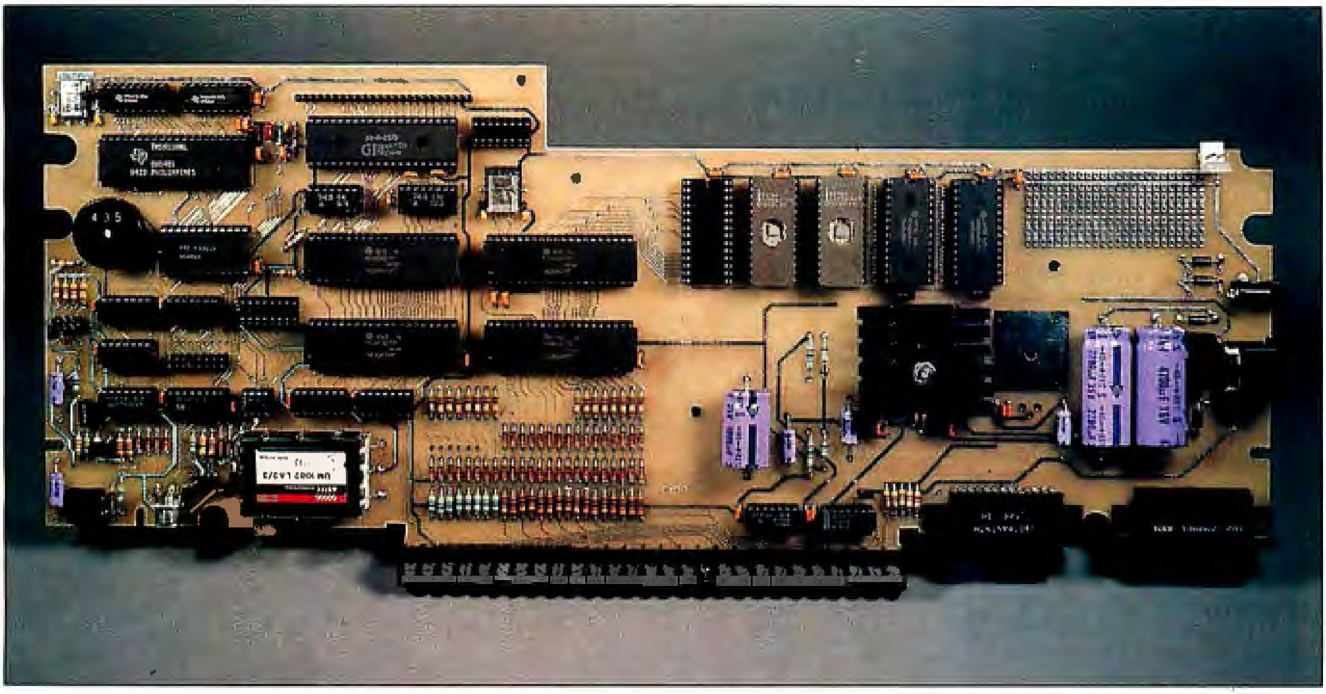

Photo 4: *The Home Run Control System prototype printed-circuit board. Input and output connections are made via screw terminals at the bottom of the board. From bottom left to right, the connections are composite video out, RF video out, eight direct outputs, three ground pins, 16 direct inputs,* DB-25S *terminal connector, and* DB-25P *modem connector. The transformer/transmitter module connects to the board at center right.*

Table 3: RAM *configurations.*

IC9	IC10	Memory Size (bytes)
6116	6116	4K
6264	EMPTY	8K
6264	6116	10K
6264	6264	16K

(Note: 6116 RAMs are 24-pin devices. They are inserted into the lower 24 pins of the 28-pin socket.)

bit-programmable, bidirectional parallel ports and four control lines, which serve primarily as interrupt inputs.

IC14 is the only 6821 that must be installed for the HCS to run. Through port A it reads the 60-Hz zero-crossing signal, the 601-Hz "heartbeat" interrupt, the 1/1.5-ms timers, and sets the beeper output and the BSR transmitter gate. Four extra future-option jumpers are included should I need them when I expand the capabilities of the HCS. (If the HCS is fully populated as shown in figure 4, no jumpers need to be installed. If you configure an HCS video version or don't plan on including the serial-modem capability afforded through IC16, then install a jumper at PA0 and leave the 6850 out. This tells the processor to ignore serial I/O.)

Port B of IC14 drives eight open-collector output lines that are set or reset by the action of driver number 6 on the main menu. These lines are activated by following the same procedures as for the BSR modules. However, direct outputs such as these are immune from line transients and cannot be reset by errant use of a BSR command controller in another part of the house. Diagramed in figure 7, each output is protected against accidental shorts to a negative-voltage source and excessive current drain. A 100k-ohm resistor allows the outputs to be read with a meter during testing and will not interfere with normal operation. The 7407 drivers are rated for 30 mA at 30 V.

IC15 is entirely dedicated to input data acquisition. Each of the 16 inputs is diode-protected and current-limited. They will accept standard TTL

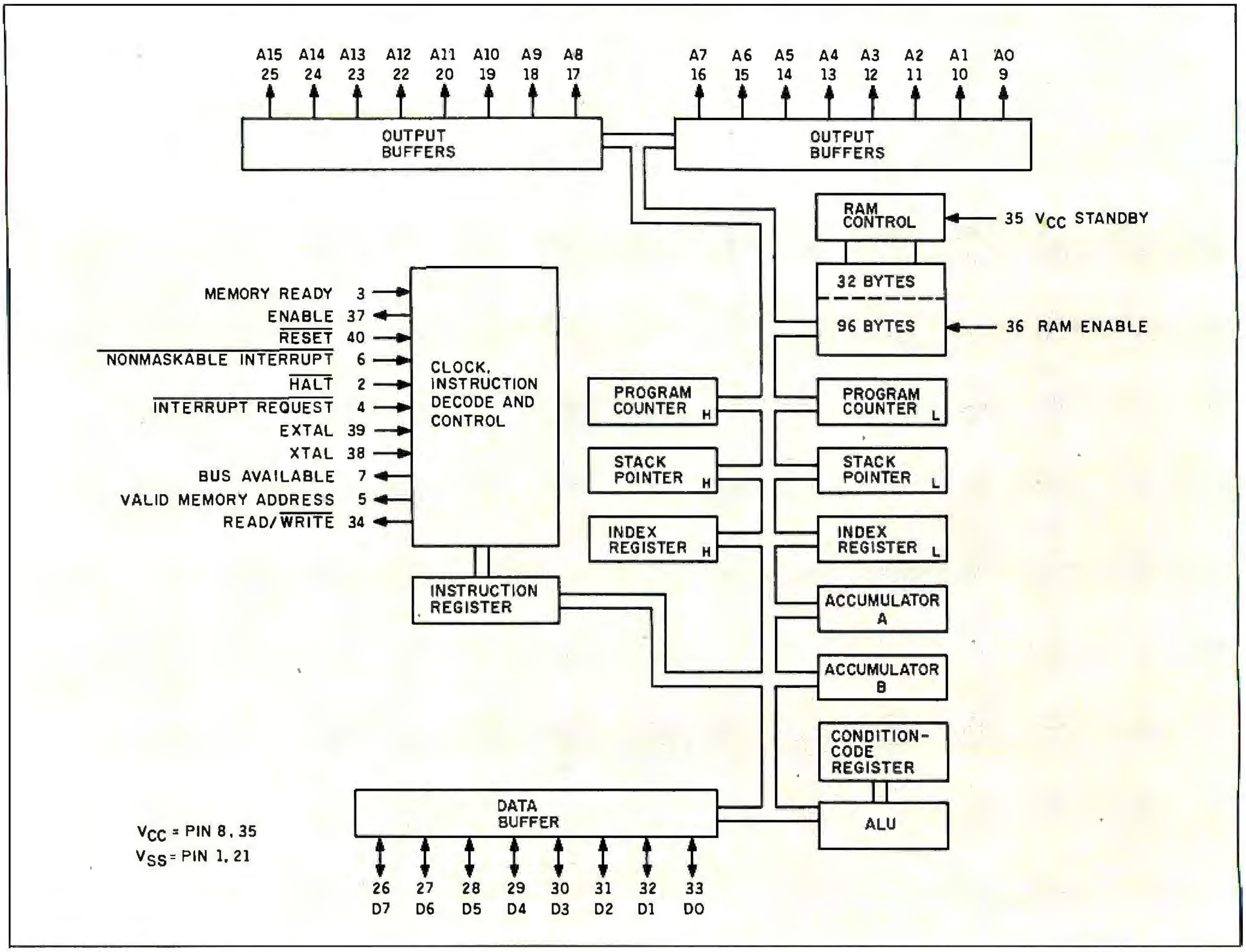

Figure 5: A 6802 *block diagram.*

(transistor-transistor logic)-level input signals or any voltage between +9 and −9V. (The range 0 to −9 V is a logic 0. The range 2 to +9 V is a logic 1.) Contact closure should have an external voltage supply and should not rely on an open-circuit input always being a logic 1.

IC21 is dedicated to keyboard input and future expansion. Eight bits and a control line of port A receive ASCII (American Standard Code for Information Interchange) input data. This data can come directly from an ASCII-encoded keyboard via a 16-pin DIP (dual-inline package) socket (IC27) or from a scanned-matrix keyboard through a keyboard-encoder chip installed in IC18. The matrix keyboard is plugged into a 22-pin ribbon-cable header adjacent to IC18.

One or the other keyboard option must be chosen and not both concurrently. If a parallel keyboard is used, no encoder chip should be inserted in IC18. Similarly, if IC18 is installed, a parallel keyboard should not be plugged in. (If you are using a terminal with the HCS, neither type of keyboard need be installed and both IC18 and IC21 can be removed.) The parallel-keyboard input socket, IC27, is compatible with the Apple IIe.

Port B of IC21 is reserved for future expansion. As previously mentioned, the HCS has an 8K-byte EPROM socket, four jumpers, and an 8-bit I/O port reserved for future expansion.

The HCS's serial I/O is through a 6850, IC16. The serial port is connected through separate level shifters, IC17 and IC20, to two connectors. One connector is wired to attach to a modem (DCE), and the other is configured to connect to a terminal (DTE). The communication data rate is set by the data-transmission-rate selection jumpers at IC4.

The HCS screen displays operate at different rates, depending upon whether the system is configured to use the internal video-display generator or an external terminal. If a terminal is attached (JP1 should not be installed), all displays are refreshed at the selected communication rate. (A terminal and a modem should not be trying to communicate at the same time.) When using a terminal, how-

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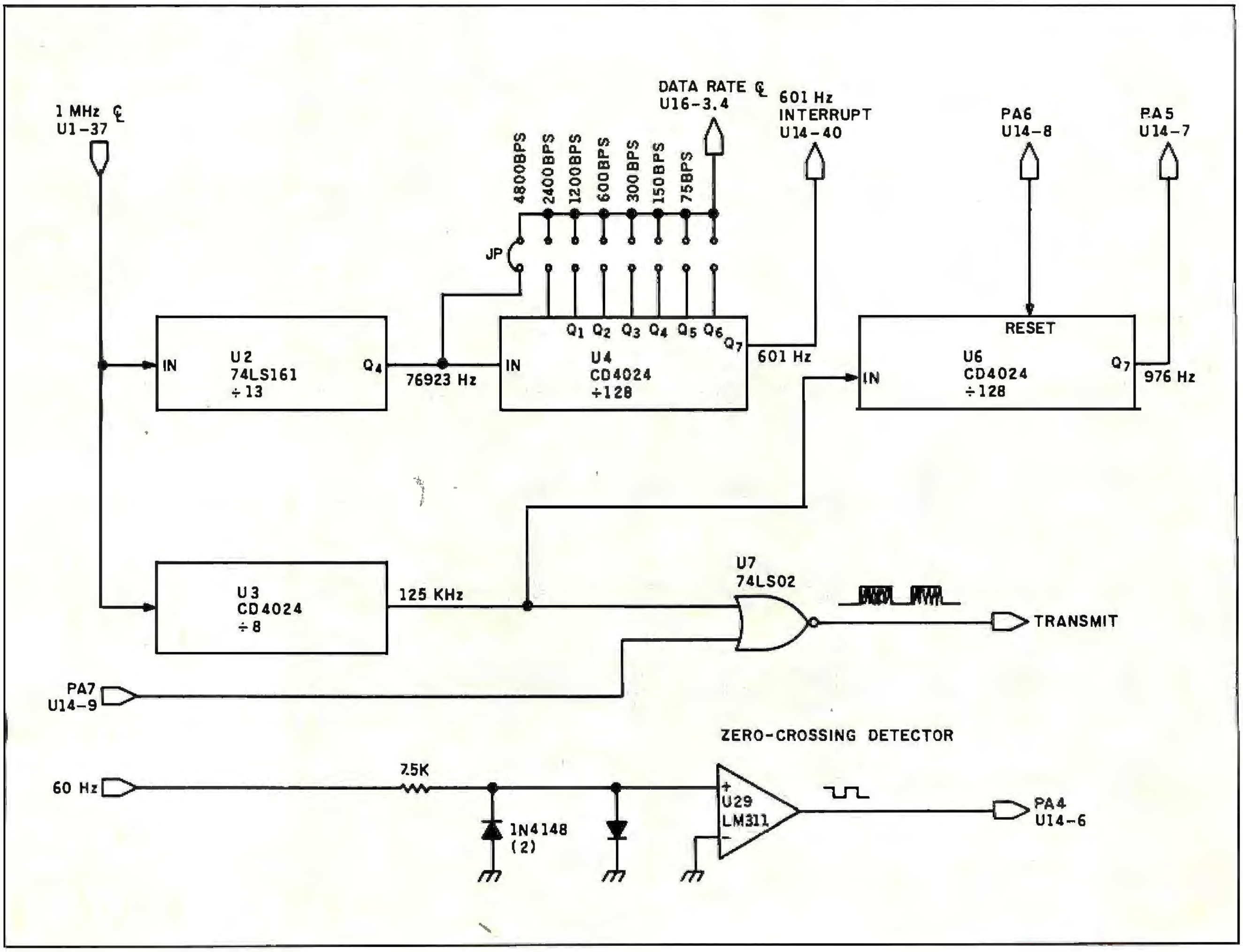

Figure 6: *The timing-generator circuit.*

ever, both the internal display and the terminal refresh at the same data-transmission rate, and status updates appear only once a minute. Physical control operations still occur as serviced by the interrupts, but, because a terminal could be communicating at 75 bps, the status display is rewritten only once per minute. (A status update can be forced at any time on the terminal by entering a carriage return.) When using the internal video display (JP1 installed or a shorting wire connected between pins 7 and 8 of J2), the screen refreshes at full processor speed (it appears to be about 9600 bps), and the status display is updated upon occurrence of any programmed event.

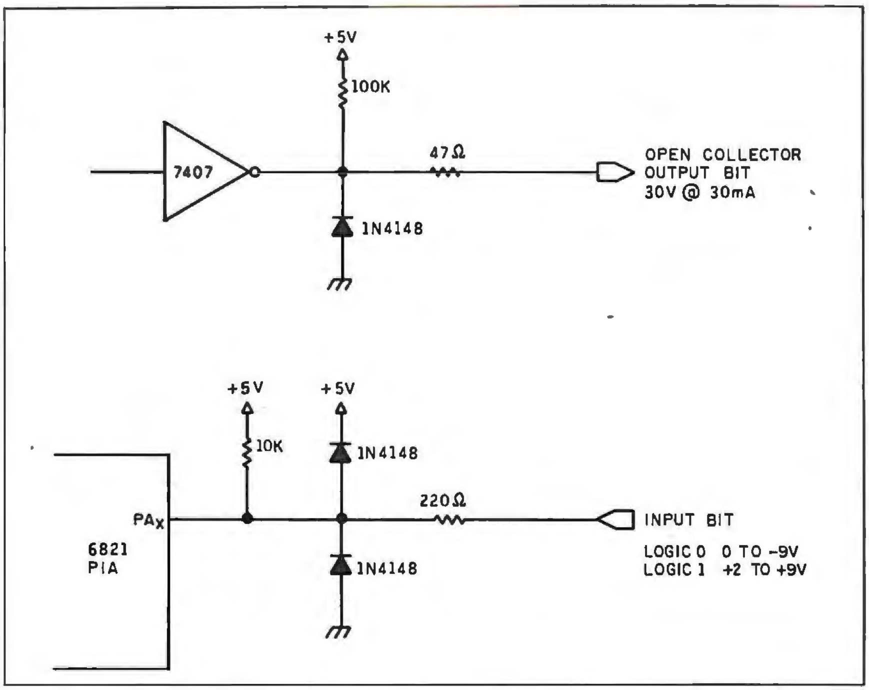

Figure 7: *The input/output circuit. Substituting a 1k-ohm resistor for the 220-ohm resistor expands the voltage range to* ± 15 V.

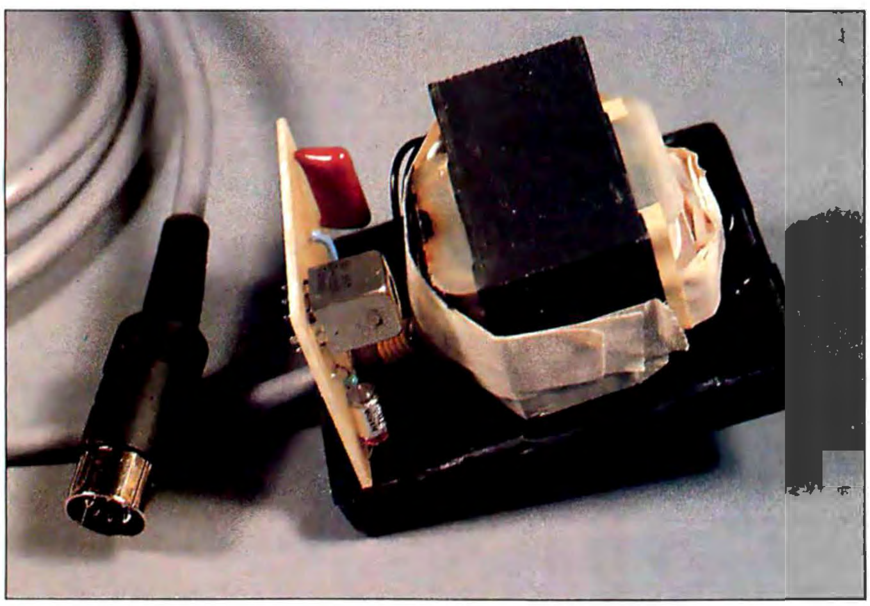

Photo 5: *The power supply for the Home Run Control System contains both the transformer and the high-voltage section of the BSR transmitter. The sealed transformer module with BSR PC board effectively isolates the user from the AC power line. Connection to the circuit board is through a 7-pin DIN connector.*

There is an effective compromise when using a modem, with JP1 not installed. With an auto-answer modem such as the Hayes 300 or 1200 attached to the modem input, the HCS will automatically switch communication rates. Using the internal video display and JP1 removed, the HCS updates the screen at high speed. Upon sensing a CTS (clear to send) signal from the auto-answer modem, the HCS switches its screen speed to the modem's data rate (set on the data-rate selection switches at IC4) and communicates with the remote terminal or computer. After the modem hangs up, the screen resumes its normal speed. I must mention, however, that screen refresh rate is in no way related to the speed of control operations. Real-time screen updates are necessary only if you require notice of an event in less than the once-per-minute terminal refresh and in fact need to see every output event as it occurs.

HOME RUN VIDEO DISPLAY

Besides accommodating terminal or modem communication, the HCS has its own video-display generator. The display is 24 lines by 40 characters produced with three chips: IC22, IC25, and IC26.

Some of you will remember an article I did in the August 1982 BYTE about building a 10-chip E-Z Color graphics display. The TMS9918 video-display processor used in that article has been replaced in this design with a TMS9118 chip, IC22. Functionally the same, the 9118 uses 5-V 64K-byte DRAMs (dynamic RAMs) instead of the older three-supply 4116 types. By using TMS4416 16K by 4-bit DRAMs,

(continued)

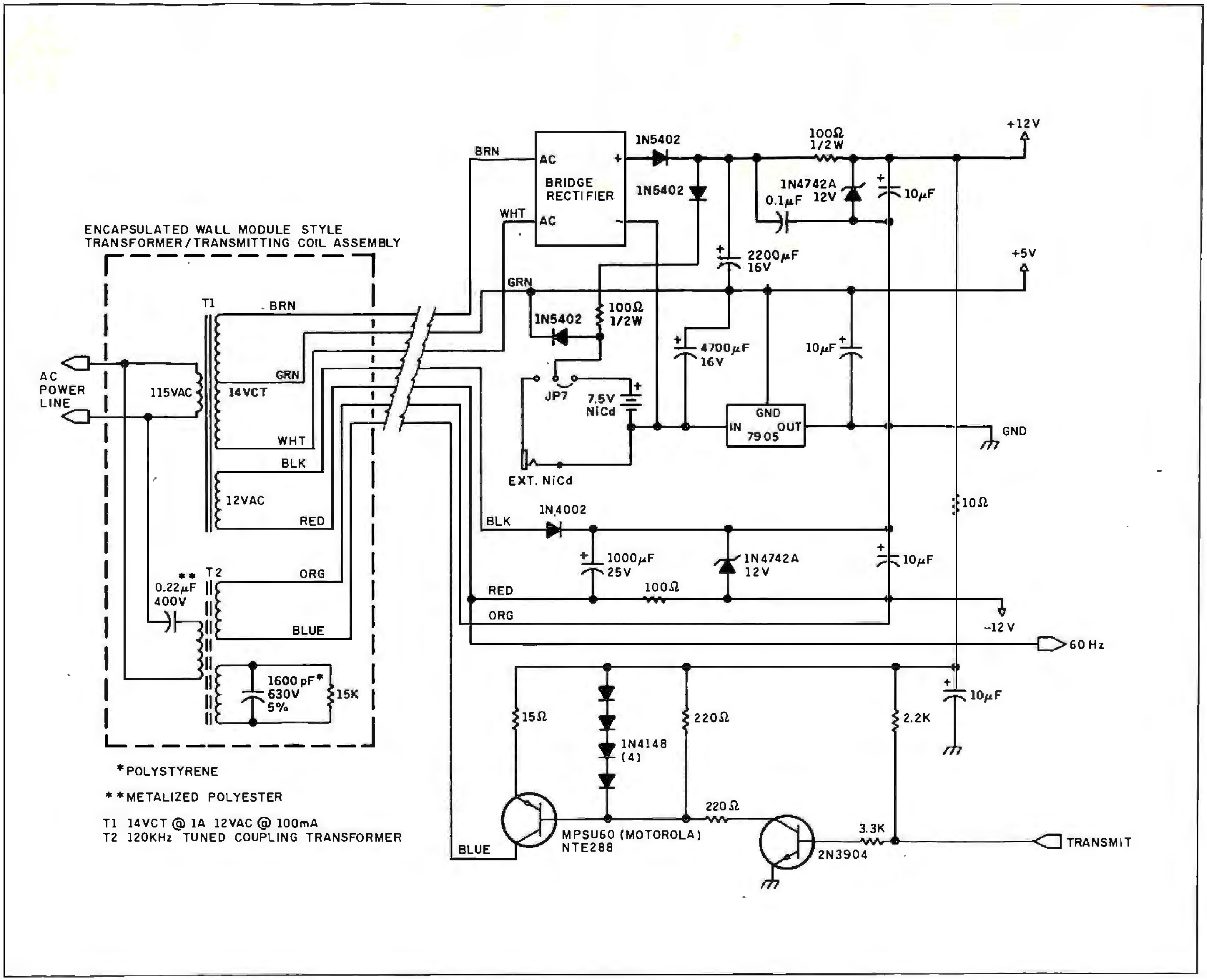

Figure 8: *Power supply and transformer/transmitter assembly.*

the 16K-byte video memory requires only two chips. (The primary reason for choosing the 9118 was board space and single-supply operation. The HCS is battery-operated on power outages, and 4116s would have been difficult to accommodate. A TMS9918 will not run with 4416s; however, it can still be used in this design if you replace the 4116s with 4164s. It's expensive, but it's 5 V only.)

I will not belabor the point describing how the screens are entered into display memory or what commands are necessary to control the video-display processor. Instead, I refer you to the August 1982 Circuit Cellar article. One final note for mad programmers. The video-display memory is 16K bytes, but only about 1500 bytes is currently being used for the alphanumeric-mode status and menu displays. The TMS9118/9918 is capable of producing a 16-color 256- by 192-pixel graphics display in three operating modes. Given a few more man-years of software, I could possibly have provided the same pretty graphics as those presented on GE's HomeMinder, but the present emphasis is on control capabilities. Perhaps such features will be included in future peripheral expansion. If you are interested in the graphics potential, look at any ColecoVision or Adam computer. They also use the TI graphics chip.

The output of the TMS9118 is NTSC (National Television System Committee) composite video that is buffered and available for direct connection to a video monitor. Optionally, an RF (radio frequency) modulator can be installed that will allow a standard television set to be used concurrently or in place of a monitor. In my opinion, displays are much sharper on a video monitor than on a television set.

POWER SUPPLY AND BSR DRIVER

The power-supply section of Home Run posed a particular problem and almost scuttled its development. Circuit Cellar projects are designed to be built, not just read. Unfortunately, I cannot always count on everyone taking the same care and precaution in assembly that I do. The BSR transmitter is connected directly to the AC line through a slug-tuned transmitter coil. While isolated after the transformer coil, most manufacturers take the economical approach and mount this coil and associated components on the same PC (printed circuit) board with the processor. Since the AC line must then be brought to the board and a number of components, it presents a serious hazard. While I could instruct you to pot or otherwise insulate these areas, this was deemed unsatisfactory. I needed to feel that anyone building Home Run either from a kit or scratch would not get electrocuted.

The solution was to combine all the high-voltage components into one sealed module and have only isolated low-voltage wiring exit from it (see photo 5 and figure 8). The hot components in the HCS are the AC-line connected sides of the power transformer and the BSR transmitter coil and series capacitor. Using a wall-module transformer with an additional circuit board containing the transmitter coil and components, these circuit elements can be isolated. A 7-wire cable exits from the wall module and ends in a 7-pin DIN (Deutsche Industrie Norm) connector. Two wires go to the transmitter coil, and five wires come from the power-transformer secondary windings. This transmitter/power module is more expensive than conventional approaches, but it is much safer.

Figure 8 shows the HCS's regulator circuit. It uses a rather novel approach to produce +5 V, +12 V, and −12 V.

The +5-V and +12-V outputs are produced from a 14-V CT (center tap) transformer output. The three 14-V CT output windings are connected to a full-wave bridge and capacitor filter in the traditional manner. Each output, referenced to the center tap, will be about 9.5 V peak. Using a 7905 regulator connected to the negative filter side, −5 V is easily produced. In this design, however, the output of the 7905 is reversed and connected to the HCS power ground. The transformer center tap, now referenced to the HCS power ground, will read +5 V!

A zener regulator with a series-blocking diode is connected to the positive filter output. The ground pin of the circuit, normally connected to the center tap in conventional designs, is connected to the new HCS power ground at the output of the zener. The effect is a −5-V reference applied to the ground lead of the zener. Instead of requiring 14.5 V at its input to produce 12 V, it now needs only 9.5 V above the center tap.

The −12-V supply is a conventional half-wave rectifier configuration. Since it is required only by the RS-232C and BSR drivers, regulation does not have to be precise and a zener diode is adequate.

I chose this particular power-supply configuration to reduce power dissipation. The HCS takes about 0.9 A at 5 V. Conventional linear designs would have suggested using a 22- to 24-V CT transformer winding, resulting in about 8.5 W of power dissipation. In a sealed enclosure, this can make things very warm. With this design, dissipation is reduced to about 4 W. The only alternative would have been to use expensive switching supplies.

BATTERY BACKUP

The last area of the power supply is the battery backup. It consists merely of six C-cell nickel-cadmium batteries in series to produce 7.5 V (6 × 1.25 V). They are connected between the transformer center tap and the input of the 7905 (note polarity). A 3-A 1N5402 diode is inserted in series so that the batteries supply power to the regulator only when none is being provided from the transformer. Another resistor and diode supply a trickle charge to the battery. This trickle charging rate should be about 20–30 mA. A 1N5402 blocking diode at the input of the positive regulator prevents the battery from backflowing through the transformer to other components.

During a power outage, only the +5-V supply is maintained. If you have a battery-operated monitor, it will continue to receive status displays, but RS-232C, modem, terminal, and BSR functions will be suspended. (When the power returns, the HCS automatically restores all I/O to the proper state.) Direct outputs continue to occur on schedule. In my experience, power outages are either under a few minutes or for many hours. Experiments show that C-cell nickel-cadmium batteries last for about 90 minutes.

EXPERIMENTERS AND OEM USERS

As always, I try to support the computer experimenter by providing sources for many of the components. The Circuit Cellar Home Run Control System is a single-board design 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 and take heart. Send me a picture of your board, and I'll send you a 16K-byte hexadecimal dump 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 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 424.

NEXT MONTH

I'll describe how the HCS software works specifically, explain each of the menu functions listed in the first article, and demonstrate a simple control application. ■

Special thanks to Bill Summers and Leo Taylor for their software expertise.

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4. Home Run HCS—Terminal-based kit. Includes PC board and all components except video-display processor (IC22, IC25, and IC26). No keyboard, enclosure, or RF modulator HCST06, $289
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7. Wall transformer/transmitter module (available separately) HCS22, $40
8. IBM PC Upload/Download event-schedule-storage software with terminal emulator, written in C, provided on IBM PC-DOS 2.0 disk HCS25, $49

All kits and assembled units include operators manual, power supply with wall transformer/transmitter module, and 8K bytes of RAM. All units are supplied without keyboard-encoder chip (not necessary when using encoded keyboard, IC18—optionally available). All item numbers that list enclosures also include backup battery holder (six C cells), less batteries. Serial-port and video-display-processor upgrades for items 3 and 4 and various other components are also available.

Please include $8 for shipping and handling in the continental United States, $12 elsewhere. New York residents please include 8 percent sales tax. Connecticut residents please include 7.5 percent sales tax.

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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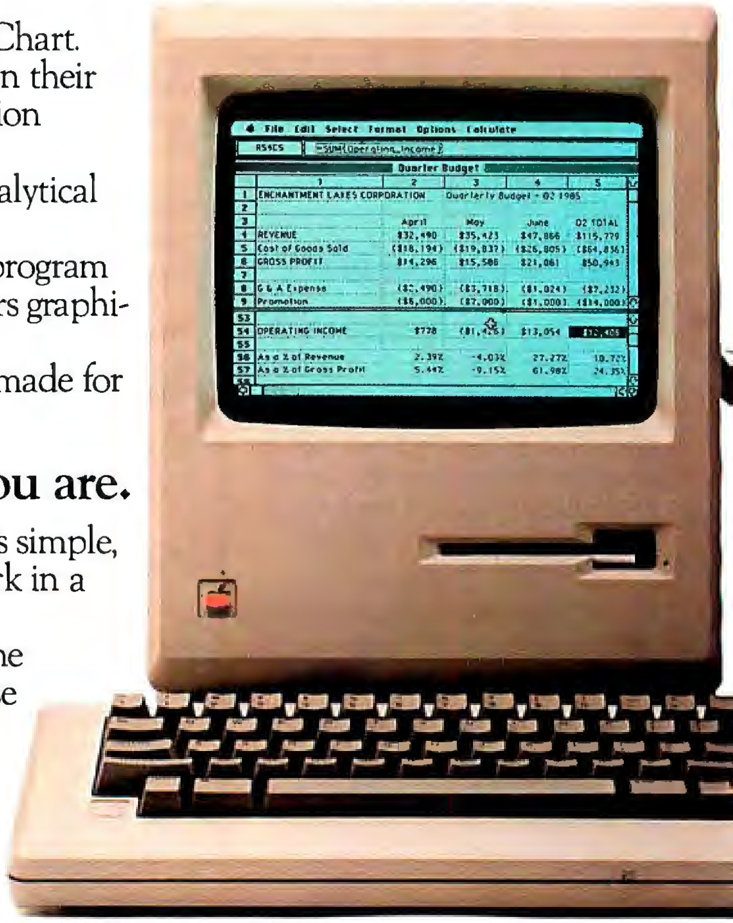

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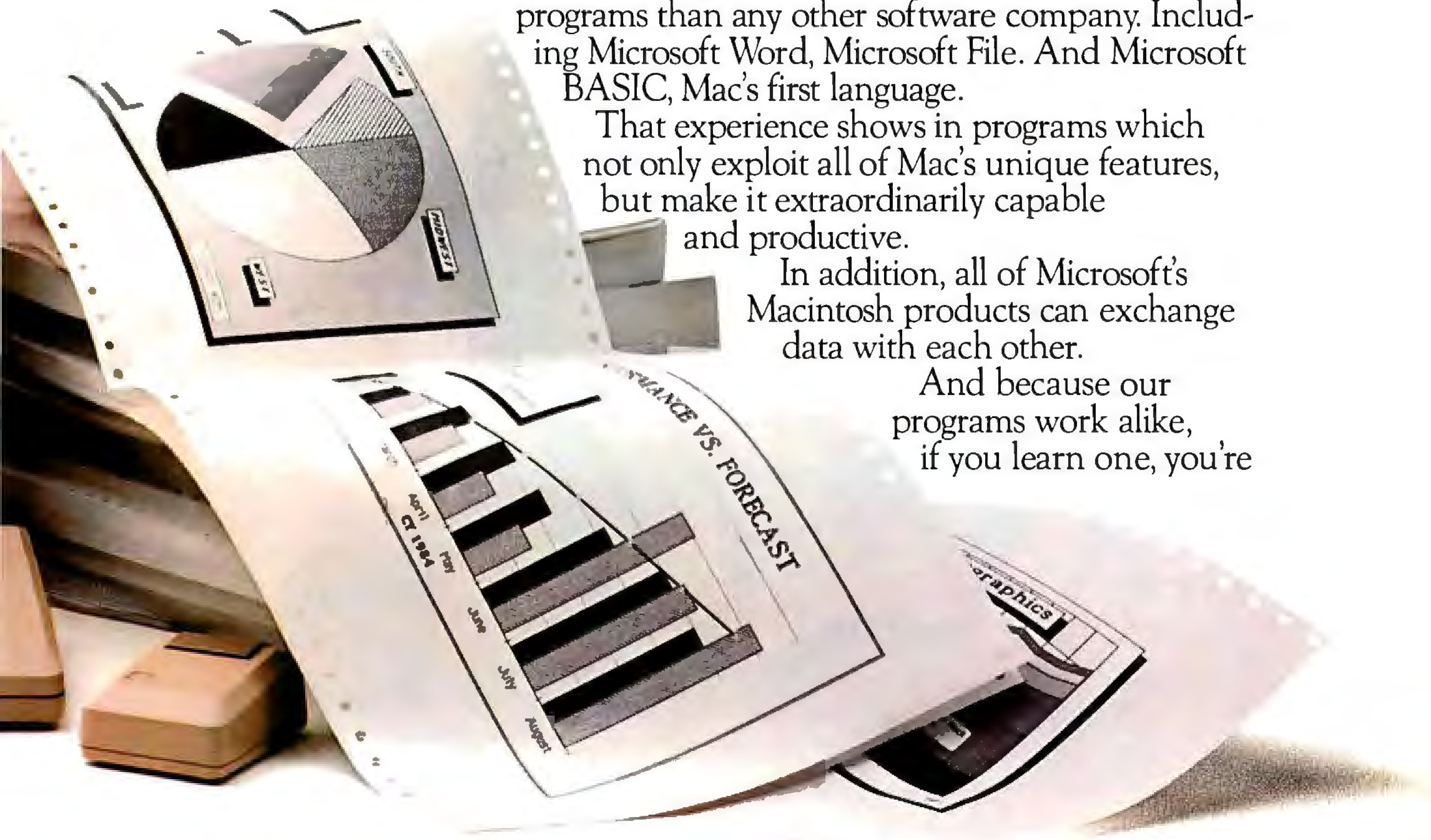

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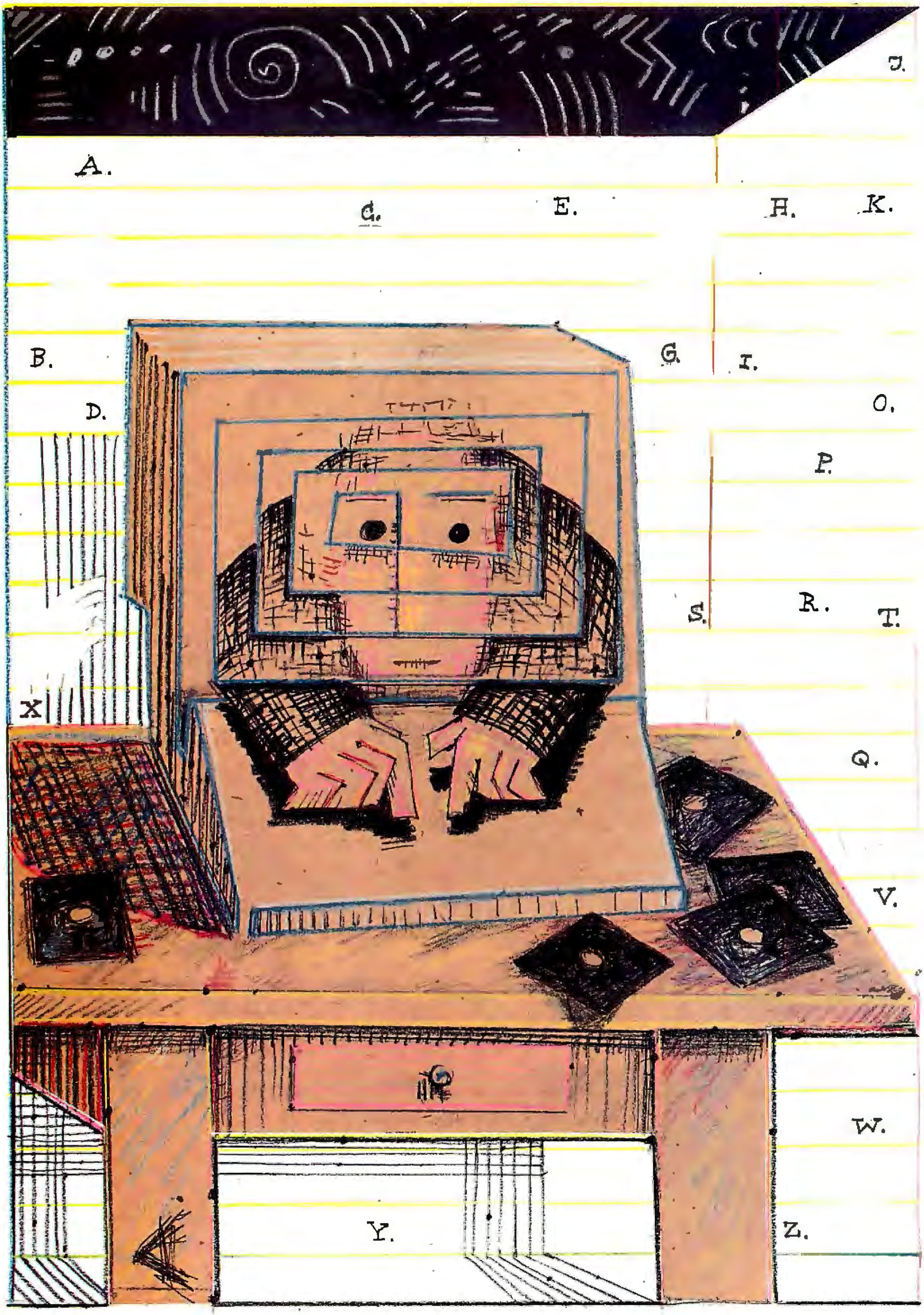

ILLUSTRATED BY MACIEK ALBRECHT

BY ALFRED L. SCHUMER

SET EXTENSIONS WITH APPLE PASCAL

Add useful set operations to your programs

Sets offer a powerful and logical construction in Pascal. In conjunction with user-defined types, they can significantly enhance program design, maintenance, speed, and readability. Unfortunately, many programmers shy away from using sets because of their high level of abstraction and a lack of understanding of how to implement sets at the machine level.

In order to promote a greater understanding of set constructions in Pascal, I will describe sets, their operators, and the logical machine equivalents used in relational set operations. Second, I will present a fast extension to Apple Pascal. The maximum set size and the number of set operations vary from implementation to implementation. This SuperSets program increases the size of Apple Pascal sets (from 512 to 65,536 elements per set) and adds more set operations. The program is written in 6502 assembly language and is, therefore, reasonably fast.

PASCAL SETS

To test for membership of characters in a set you might be tempted to use nested IF. . .THEN . . . ELSE statements, such as IF ch = "a" THEN {execute code inserted here} ELSE IF ch = "b" THEN {execute code} ELSE if ch = "c" THEN {execute code} ELSE {insert code for ch not in set}. A more elegant method uses the set operator IN to test for membership. With it you can reduce these statements to IF ch IN ['a','b','c'] THEN {insert code for ch in set} ELSE {insert code for ch not in set}.

A set in Pascal is a collection of objects of the same type (called the "base type" of the set). It may be any scalar type; it may not be a structured type. Size limitations on sets are defined by the particular implementation and generally range from 64 to 512 elements. Apple Pascal sets can have up to 512 elements and occupy memory according to the following formula: ((*n*– 1) DIV 16) + 1 words, where *n* equals the number of elements. Conversely, UCSD Pascal sets may have (at most) 4080 elements and are limited in size to 255 words.

With set operators you can perform relational operations on sets of the same base type, such as testing for the inclusion of one set in another or for equality. In addition to the special membership operator IN, four relational operators are typically supported: set equality (=), set inequality (<>), inclusion/contains (>=) and inclusion/contained in (<=). Although these relational operators yield a Boolean result, you can also form sets logically from the union, difference, or intersection of two sets. The union (A + B) results in a set that contains all members of A and all members of B. The difference (A – B) results in a set that contains all members of A that are not members of B. And the intersection (A*B) results in a set of all members of A that are also members of B.

MACHINE-LEVEL STRUCTURE

To illustrate the machine-level structure of sets, I will first define a set (such as TYPE *charset* = set of characters) and define the variables Set_A and Set_B as that type. Internally, Apple Pascal allocates an array of 256 bits (16 words, each containing 16 bits) representing the 256 possible ASCII (American Standard Code for Information Interchange) values for characters. Individual elements occupy 1 bit, indexed by the scalar value of the character into the set. An element is considered to be in the set when its bit is turned on (has a binary value of 1).

To locate the word offset into the array containing a particular element's bit, the scalar value of the element is divided by 16 (or divided by 8 to locate the byte offset). The bit posi-

(continued)

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SuperSets increases the size of Apple Pascal sets and adds more set operations.

tion within the word is merely the scalar value modulo 16, or the remainder from the division. You can add an element to a set by indexing into a set's array of words and turning the appropriate bit on. Similarly, to remove an element, turn the bit off. To test for an element's membership in a set, you use the same indexing technique to determine the state (off or on) of the appropriate bit.

LOGICAL OPERATORS

The logical operators on sets are somewhat tricky. While they don't require indexing individual elements—entire sets are operands—the Boolean logic of unions, differences, and intersections requires some explaining.

Testing for set equality (=) involves comparing all the words of one set against the other. If any two corresponding words differ (their bit patterns do not match), the sets are not equal. This follows from the logic that different bit patterns within a word indicate either Set_A contains a character not contained in Set_B, or Set_A does not contain a particular character that Set_B does.

You can test for the inclusion (<= or >=) of, for example, Set_A in Set_B at the word level by determining if for each bit turned on in Set_A, the equivalent bit (in the equivalent word) in Set_B is also turned on. However, the converse might not be true; Set_B may contain elements that are not in Set_A. In other words, Set_B may contain Set_A while Set_A does not contain Set_B unless the two are equal.

The union, difference, and intersection set operators differ from equality and inclusion in that they do not test bits but set or clear them. The resulting word is stored into the set assigned as the result. The union (+) of two sets, word for word, produces a new set with the bits turned on if either or both bits in the operand sets are turned on. If both bits are off, the resultant bit in the new set is also off.

The intersection (*) of two sets resembles the union except that both corresponding bits must be on for the resultant word's bit to be turned on. If either bit is off, the resultant bit is also off.

Taking the difference (−) between two sets is the opposite of finding their union. However, unlike intersection and union, the order in which the sets are specified is important. (Set_A − Set_B is not the same as Set_B − Set_A unless the sets are equal.) An element common to both sets is removed—the appropriate bit is turned off—if the corresponding bits in each set are both on. However, if the first set's bit is on while the second set's bit is off, the resultant bit is turned on. If the opposite condition is true—the first set's bit is off while the second set's bit is on—the bit in the result remains off.

If you are an assembly-language programmer, you have probably noticed by now that these logical operators resemble the 6502 machine instructions AND, ORA, and EOR. In fact, the truth tables for each instruction are nearly the same as their counterparts in set operators.

For comparison, table 1 contains the truth tables for the machine instructions and those for relational set operators. If you examine both groups of truth tables, you will find that union is equivalent to ORA, intersection to AND, and equality to NOT EOR. You can build inclusion and difference from a combination of AND and EOR. Inclusion (A>=B) may be constructed as ((A EOR B) AND A), and difference (A − B) as ((A AND B) EOR B). Bear in mind that the order in which you specify the sets as operands is important.

SETTING UP SUPERSETS

How can you use this information to expand the set capabilities of the Apple implementation of Pascal? The SuperSets program duplicates the standard Pascal set operators in assembly language with enhanced addressing and provides some procedures and functions to use the expanded set sizes. Because the technique used for indexing into the set uses a 16-bit value, sets can contain up to 65,535 elements. Before going into the specifics of the program, however, some housekeeping items are in order. [*Editor's note: The listing for the SuperSets program is available for downloading via BYTEnet Listings. The telephone number is (603) 924-9820.*]

First, Apple Pascal does not permit the declaration of a set size greater than 512 elements. Therefore, you must use a packed array of type Boolean as the data type declaration—which is what it is internally. For example, if you wish to use a set of 10,000 elements, the declaration must be PACKED ARRAY [0..9999] OF BOOLEAN. Note that BOOLEAN can be any user-defined type with either a base type of Boolean or scalar that occupies 1 bit. An example is TYPE *gender* = (male,female).

Second, the set operators that use two operands or sets in the program are quite powerful and, used indiscriminately, can cause a system failure. Assignments or operations on sets of different sizes are not picked up by the compiler or the run-time code and might overwrite other data-storage areas. Even worse, such actions might destroy integral parts of the Pascal interpreter and cause unpredictable results or a system crash. To avoid this, you can assign as a result a set larger than either of the operands, provided you keep in mind that the elements beyond the operand set sizes are meaningless.

Third, your method of using SuperSets' procedures and functions is entirely up to you. If you choose to link the code in after compiling your host program, remember to declare the procedures and functions EXTERNAL. (This option is assumed in the listing.) If you choose to use the Library.Code program that comes on Apple III to include the code as a unit

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This code should work on all present versions of Apple Pascal, including the Apple III's Pascal.

in your System.Library, remember to declare the code at the start of your program by USES SUPERSETS; then call the procedures and functions normally.

Fourth, the procedures and functions in SuperSets require an unsigned integer to be the element type WORD. You should declare this as TYPE *word* = 0..65535. However, if you anticipate sets less than 32,767, you may declare WORD as type integer. Failure to observe these requirements can cause disastrous results.

Finally, this code should work on all present versions of Apple Pascal, including the Apple III's Pascal implementation. Be forewarned that future versions of Apple Pascal might not support these routines.

PROCEDURES AND FUNCTIONS

SuperSets includes 11 procedures and functions that can be grouped by the number of sets they take as operands. Membership, Include, Exclude, and Nullify each take a single-set operand, while Union, Difference, Intersection, Equality, Inclusion, Assignment, and Symmetrical all take two.

The single-set operators—with the exception of Nullify—share the subroutine Index_set, which performs the necessary address translation for the elements within the set. Index_set saves the 3 least significant bits of the element (modulo 8) in the X-Reg for indexing to the desired bit. Then the binary value of the element is divided by 8 (8 bits per byte) and the effective address of the byte within the set is formed from the set address, offset by the Y-Reg.

The value in the X-Reg is used to index into the 8 bytes beginning at

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the label Bit_masks, which are hexadecimal equivalents for each of the 8 bits per byte. The appropriate value is loaded into the accumulator to be used with the machine op codes ORA and AND, which set or clear the bit, respectively.

The function Membership uses the value in Bit_masks with the machine op code AND to zero out all the bits in the set except the one you're testing. If the bit you're testing is on, the result of the AND is nonzero. (Testing for a nonzero result either increments the Boolean result to 1' indicating true—the element is there—or leaves it 0—it's not there.)

Include, rather than zeroing out all the bits except the one you're interested in, forces the bit on with the machine op code ORA, then stores the byte back into the set. Conversely, Exclude forces the bit off; first, however, it must reverse the Bit_mask bit pattern—setting the bit you want to use explicitly off and all the rest on. Then, if you use an AND op code, you won't affect the other bits in the set, but the bit you wish to clear will be turned off. Again, the byte operated on is stored back into the set.

Table 1: *Truth tables for machine instructions on the left, and their corresponding relational set operators on the right.*

<Union>

ORA	0	1	A/B	0	1
0	0	1	0	0	1
1	1	1	1	1	1

<Intersection>

AND	0	1	A/B	0	1
0	0	0	0	0	0
1	0	1	1	0	1

<Inclusion>

A/B	0	1
0	1	0
1	1	1

<Difference>

A/B	0	1
0	0	0
1	1	0

<Equality>

EOR	0	1	A/B	0	1
0	0	1	0	1	0
1	1	0	1	0	1

Dual-set operators require a somewhat different process, a sequential processing of each byte in a set, rather than the individual bits. The method used here is described in Bob Sander-Cederlof's article, "How to Move Memory" (*Apple Assembly Line*, January 1981). Basically, the number of bytes to be moved is broken down into pages of 256 bytes and a remaining partial page with a byte count less than 256. Whole pages are moved first, then the partial page. The parameter Set_size contains the number of bytes to be moved (operated on) and should be passed to the procedures using the built-in Pascal function SIZEOF( ) applied to your declared PACKED ARRAY[*n*] OF BOOLEAN.

The Union, Intersection, and Difference procedures scan sequential bytes in each of two set operands, altering the bit patterns according to the truth tables in table 1. Union essentially uses the machine op code ORA to set bits on if the bit is on in either of the sets involved. Intersection, on the other hand, uses the machine op code AND to turn bits on only if they are on in both sets. Finally, Difference uses a combination of the machine op codes EOR and AND: it first turns off bits that are common to both sets (EOR), then ANDs this bit pattern with the original operand, Set_A, to clear those bits not originally part of Set_A—those turned on by EOR. (This becomes easier to understand if you try to work out a couple of examples by hand using table 1.)

The function Inclusion ANDs the two sets together, yielding a bit pattern that contains only those bits common to both sets. This pattern is then compared to the bit pattern of

(continued)

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Inquiry 270

the set you wish to test for inclusion (Set_B). If the patterns match, you know that all bits common to both sets are contained in Set_B. If not, the loop is exited to the code located at local label $4, which decrements the Boolean result to 0 (false) and returns to the caller.

The Assignment and Nullify procedures are fairly straightforward. Assignment copies the bytes from one set to another, while Nullify moves 0s—all bits off, thus no elements—to the operand set.

What would an extension to a language be without some new feature thrown in for good measure? How about a set operator from Modula-2, Niklaus Wirth's latest language? Titled Symmetrical, this dual-set operator is expressed as A/B (versus A – B for difference) and forms a new set with elements from either set, but not both. For example, *element* IN (A/B) is the same as NOT ((*element* IN A) AND (*element* IN B)). At the machine level, the op code used is EOR, which turns bits common to both sets off and turns on those bits not common to both. (Dyed-in-the-wool Pascal programmers should have some fun with this one.)

Execution Speed

As usual, there are trade-offs between the size of the code and its execution speed. Since the single-set operators require one access into a set, it seems reasonable that they share the necessary overhead. However, because the dual-set operators must make several accesses, they should use their own code exclusively. If the dual-set operators were to share a main loop for accessing memory, the overhead of both testing for the operator desired and JUMPing to it would slow execution by at least a factor of two.

How fast does this make SuperSets compared to Apple Pascal? Table 2 lists the procedures and functions of SuperSets, their equivalent Apple Pascal statements, and the relative execution times of each. In order to get a meaningful comparison, I used a set of 512 elements to compare Apple Pascal and SuperSets. The third column gives the results for a set of 1024 elements using SuperSets only.

As table 2 indicates, SuperSets' procedures are about twice as fast as their counterparts in Apple Pascal. Equally important, SuperSets' ability to handle sets of an increased size—such as 1024 elements—does not significantly slow execution. One reason for the performance increase is that Apple Pascal cannot add or subtract single elements from sets but must use an entire set for each operand. Also, Apple Pascal compiles to p-code, which must then be interpreted at run time.

(continued)

Table 2: *SuperSets' procedures and functions with their equivalent Apple Pascal statements and the relative execution times of each.*

SuperSets Procedure	Apple Pascal Statement	Apple Set of 512	SuperSet of 512	SuperSet of 1024
Membership	element IN set_A	1.000	0.688	0.688
Include	set_A := set_A + [element]	1.000	0.274	0.274
Exclude	set_A := set_A – [element]	1.000	0.270	0.270
Union	set_C := set_A + set_B	1.000	0.265	0.415
Intersection	set_C := set_A * set_B	1.000	0.531	0.810
Difference	set_C := set_A – set_B	1.000	0.578	0.931
Equality	set_A = set_B	1.000	0.629	0.947
Inclusion	set_A >= set_B	1.000	0.640	1.005
Assignment	set_B := set_A	1.000	0.823	1.240
Nullify	set_A := []	1.000	0.721	1.031
Symmetrical	set_C := set_A / set_B	1.000	0.278	0.430
Average Relative Execution Times		1.000	0.518	0.731

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SET EXTENSIONS

SuperSets permits set sizes significantly larger without much degradation in execution speed.

APPLICATIONS

You might keep in mind that SuperSets operates on packed arrays of type Boolean. Therefore, you can use SuperSets in Pascal applications that might not require abstraction at the set construct level—for example, bit-mapped graphics.

In addition to applications requiring larger set sizes, you can use SuperSets to formulate relational database requests that use large Boolean arrays, indexed by the record number, to construct subsets of the data. For example, several such subsets could represent an individual's gender, income, and whether he or she subscribes to a particular periodical.

By using the Union, Difference, and Intersection set operators, the database request can return those records where the individual is, for example, male and/or has a certain income and/or subscribes to a particular periodical. You can also use SuperSets in scientific sampling to operate on arrays of Boolean observations over time—the scalar index—to construct particular relationships among several such sets of observations.

You might find the equivalent machine op code for particular operators handy with graphics animation or bit-mapped character sets. Rather than redraw several sequences of an animation scene, you can use the operators to alter the bit pattern of the bit array and write it out to the graphics screen using the DrawBlock intrinsic provided with Turtle Graphics.

CONCLUSION

Sets are indeed powerful constructs in Pascal; take advantage of their ease of use, speed, and logical operators. In addition, knowledge of how sets work at the machine level can open new avenues of applications in areas other than the set construct. I hope SuperSets will expand your Pascal toolkit and enhance your program design. ■

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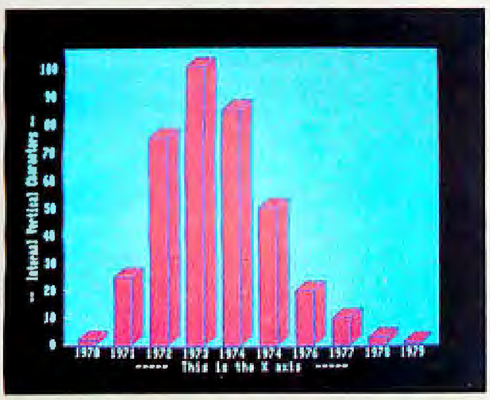

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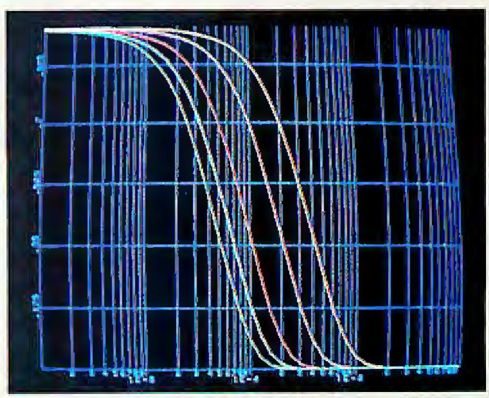

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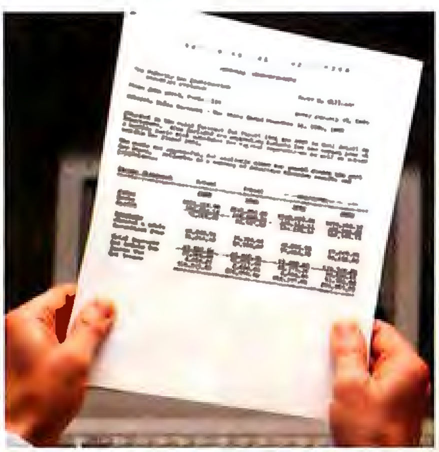

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Inquiry 372

By Ernest H. Piette

Build a Talking Clock Speech Synthesizer

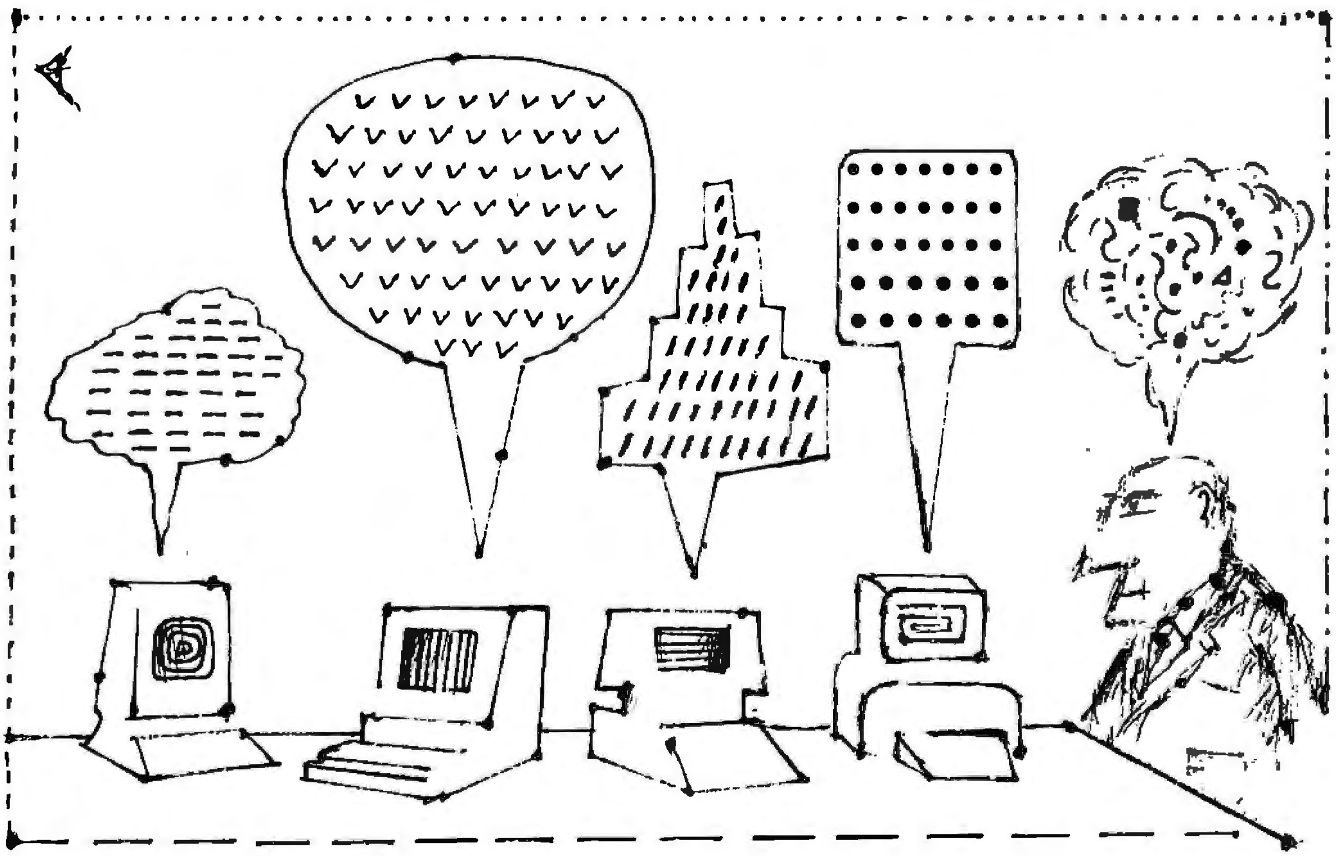
This talking clock chip circuit also allows experimentation with an unlimited-vocabulary speech processor.

Low-cost speech synthesis is now available for the computer hobbyist. Radio Shack has two speech-synthesis products (each selling for $12.95) and both can be interfaced to the Commodore 64, VIC-20, and the TRS-80 computer. One product is the General Instrument Talking Clock chip set, and the other is the General Instrument SPO256-AL2 Allophone Speech Processor. I'll explain how to interface these chips to the above-mentioned computers and describe a program for the Commodore 64 and VIC-20 that will keep time and give a vocal announcement of the time with the touch of a key.

Included in the General Instrument Talking Clock chip set are the SPO256-017 Speech Processor and the SPRO16-117 Speech ROM (read-only memory). A fixed vocabulary stored on the Speech Processor and the ROM contains 33 words and 3 melo-

(continued)

Ernest H. Piette is an off-site engineer in aerospace avionics presently working in the Republic of Korea for the Fairchild Republic Co. His interests include computers, and robotics. He may be contacted at PSC Box 905, APO, San Francisco, CA 96461-0006.



ILLUSTRATED BY MACIEK ALBRECHT

dies appropriate for a talking clock. The speech produced is highly intelligible and sounds natural.

The General Instrument SPO256-AL2 Allophone Speech Processor is capable of unlimited vocabulary speech using the allophone-synthesis technique. Stated simply, allophones are the basic sound components of any spoken English word. Radio Shack includes with the chip a data booklet that lists the guidelines for combining allophones to create words. (For a further discussion of allophones, see the text box "Speech and Voice Synthesis" by Tom Clune, September 1984 BYTE, page 340.)

Amazingly, a single circuit can be used to interface either the Talking Clock chip set or the Allophone Speech Processor to your computer. Figure 1 shows a diagram of such a circuit that you can connect to a wide variety of microcomputers. The circuit is small, composed entirely of inexpensive parts, and can be connected to the user port on the Commodore 64 and VIC-20, the printer port on the TRS-80, or any computer with a Centronics printer port.

Circuit layout is not very critical; the SPO256-017 seems rather forgiving in this regard. However, use good construction techniques to keep AC (alternating current) hum and noise pickup to a minimum. Also, you should use IC (integrated circuit) sockets for the Speech Processor and ROM chips.

You will notice that the circuit diagram shows the Talking Clock chip set in place. No physical modifications are necessary to switch to the Allophone Speech Processor; simply remove the SPO256-017 Speech Processor and the SPR016-117 ROM and plug the Allophone chip into the Speech Processor's socket (the ROM socket remains empty). Always be certain that there is no power going to the circuit before doing this.

I've written two BASIC programs that you can use for experimentation

(continued)

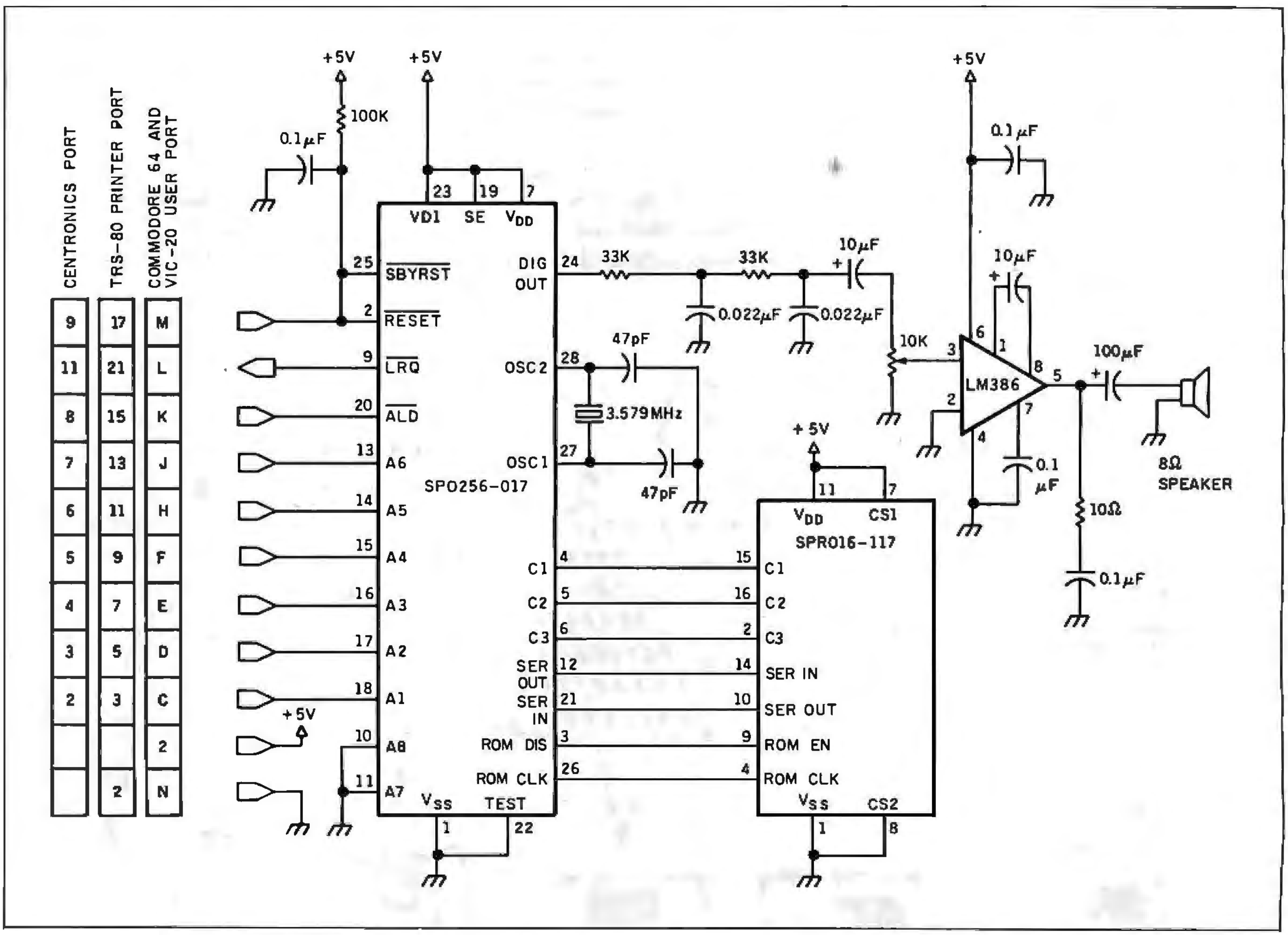


Figure 1: *The Talking Clock circuit for Commodore 64, VIC-20, TRS-80, or any microcomputer with a Centronics port. (The TRS-80 Model I requires an Expansion Interface.) The two 0.022-μF capacitors should be high quality, such as Radio Shack part number 272-1066, for best results. Use the 10k-ohm variable resistor for volume control. Although the manufacturer recommends a 3.12-MHz crystal, I found that a TV colorburst works well (Radio Shack part number 272-1310). Also, if you are using a TRS-80 or Centronics interface, you will have to supply an external +5-V power source.*

with this circuit. The first, named TCLOCK.BAS, creates a Talking Digital Clock on your Commodore 64 or VIC-20. (Use it with the Talking Clock chip set in place.) Run the program, enter the correct time in response to the initial prompt, and watch the digital display begin ticking away. Press any key for a verbal announcement of the time. (Be sure to read all REM statements before running the program; they will indicate any code that is machine-dependent.)

The second program uses the Allophone Speech Processor and will say "Hello" on the Commodore 64. This program is named HELLO64.BAS. [*Editor's note: The source-code listings for* TCLOCK.BAS *and* HELLO64.BAS *are available for downloading via* BYTEnet *Listings. The telephone number is* (603) 924-9820.]

Although I haven't mentioned any uses for the talking clock program, I'm sure you have ideas that you might like to try. A subroutine could be included to input an alarm time that would wake you in the morning. For commercial applications, the circuit could be integrated into a workstation, notifying an employee of the time when a particular job should be started, etc. It could even be included in a punch-clock station.

Talking games, spelling programs, math programs, etc., are just a few applications for the Allophone speech synthesizer. In any case, the SPO256 series of speech processors offers an extremely low cost introduction to speech synthesis.

The items to follow are available from Microtalk Inc., 39 Raymond St., Providence, RI 02908. For $18, the TT-1 Partial Kit includes an etched and drilled PC board, assembly instructions, and edge connector or ribbon cable (depending on computer: be sure to specify Commodore 64, VIC-20, or TRS-80). The SP0256-AL2 kit comes with the Allophone processor chip and the Allophone synthesis user's guide for only $16. Include $2 for shipping and handling in the continental United States, $5 elsewhere. Residents of Rhode Island should include 6 percent sales tax. ■

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Inquiry 29

SMALLTALK

COMES TO THE

Microcomputer World

*t*he August 1981 issue of BYTE focused on Smalltalk, a highly unusual programming language. The Xerox Palo Alto Research Center (PARC) designed Smalltalk to be a complete development environment. The language is somewhat esoteric; it uses unfamiliar terms such as "methods," "classes," and "objects," instead of more conventional jargon. And, while most languages deal with algorithms, Smalltalk focuses on data structures (objects) and their interrelationships. Smalltalk's lack of "modes" is also unconventional; it has no edit, compile, link, or execute mode. Instead, Smalltalk allows you to do virtually anything, anytime. The Smalltalk environment pioneered the concept of displaying different tasks in multiple windows on the screen, an idea that, at the time, represented a radical departure from punched cards and 80-column by 24-line ASCII (American Standard Code for Information Interchange) CRTs (cathode-ray tubes). Using a mouse for screen interaction is another Smalltalk innovation.

When BYTE introduced its readers to this fascinating language, many of them expectantly awaited Smalltalk's appearance on microcomputers. They waited . . . and waited . . . and waited. Then they began to complain. "Why," they asked BYTE, "did you devote an entire issue to a language we can't use? When are we actually going to see a version of Smalltalk?" The BYTE staff grew weary of the complaints, especially because they were justified.

Therefore, it is with great interest and relief that we print this series of articles. First, Tom Yonkman and I evaluate Methods (page 152), developed by Digitalk Inc. of Los Angeles, California, which brings Smalltalk-80 to the IBM Personal Computer (PC) and compatibles.

Then Christopher Macie discusses Smalltalk-PC, a restricted Smalltalk implementation he's developing for the Apple II and other computers (page 155).

Finally, for those of you who don't have the August 1981 BYTE handy, "The Smalltalk Programming Language" by Jim Anderson and Barry Fishman of Digitalk (page 160) gives a brief review of Smalltalk-80, complete with an application that runs under Methods.

A review of the August 1981 issue shows how heavily the Xerox PARC Smalltalk project has influenced modern software, most notably that for the Lisa/Macintosh. However, development languages like BASIC, C, FORTH, and Pascal remain largely unaffected. Perhaps now that some "real" Smalltalk implementations are reaching the microcomputer market, the object-oriented approach to software development will get its first true test.

—*Bruce Webster*

METHODS: A PRELIMINARY LOOK

Part 1: *Methods is object-oriented . . .*

BY BRUCE WEBSTER

The influence of Smalltalk-80, particularly the Xerox PARC implementation, on the microcomputer world has become just about legendary. Windows, mice, and pop-up/pull-down menus now appear on everything from small portables with LCDs (liquid-crystal displays) to expensive terminals hooked up to even more expensive minicomputers and mainframes. Ironically, however, most of the emulation is of the appearance and not of the substance of Smalltalk—and with good reason. Most people have agreed that expensive hardware is required for an acceptable implementation of the Xerox standard. For example, Tektronix recently announced their 4404 Artificial Intelligence System, a marvelous single-user development system running Smalltalk-80. It has a Motorola 68010 processor, 1 megabyte of RAM (random-access read/write memory), and a 20-megabyte hard disk. But its $15,000 cost will do little to bring Smalltalk to the masses. Yet, as the many articles in the August 1981 BYTE suggest, Smalltalk is a language from which the masses, from children on up, can profit.

A few years ago, two software engineers working on several large projects were frustrated with their development tools. Specifically, Jim Anderson and George Bosworth wanted a development environment that would help, rather than hinder, in producing solutions. They read the BYTE Smalltalk issue and found that many of the articles presented ideas similar to their own:

- Small personalized systems provide much more creative leverage for the user than large-scale standardized systems. (They had been using an extended Pascal under UNIX 4.2.)
- Complexity dilutes power. The UNIX systems certainly have power, but their complexities detract from their ability to harness it.
- A small number of concepts uniformly applied results in a powerful and understandable system.
- Self-organizing systems are the goal of the future.

Anderson and Bosworth decided that Smalltalk—or something like it—was their answer.

They wanted a commercially viable product, something that others could and would use. Initially, they approached

IN BRIEF

Name
Methods, version 1.0

Manufacturer
Digitalk Inc.
5200 West Century Blvd.
Los Angeles, CA 90045
(213) 645-1082

Type
Object-oriented program-development system, based on Smalltalk-80

Environment
Text-based windowing system with cursor-pad "mouse" and pop-up menus

Price
$250

Computer
IBM PC and compatibles with two 360K-byte disk drives (or a hard disk), at least 512K-bytes of RAM, a monochrome or graphics card, and either MS-DOS or PC-DOS

Documentation
Program-development-environment reference manual, Smalltalk language reference manual

Audience
Software developers and interested programmers

Bruce Webster is a BYTE *contributing editor as well as a* PMS *commando. He works with several programming languages and is seldom afraid to tackle a new one. He can be reached at* 6215 *Thorn St., San Diego,* CA 92115.

Xerox but decided that the hardware demands and licensing fees of Smalltalk-80 were too great. So, not knowing that it was "impossible" to bring up Smalltalk on the current generation of microcomputers, they agreed to implement Smalltalk on an Olivetti computer, retaining the right to market the results for other microcomputers. They picked the IBM Personal Computer as their target machine, assuming that would give them the largest possible market, and they formed Digitalk Inc. with Barbara Noparstak and Alberto Della Ripa. The result, two years later, is Methods, version 1.0.

Methods attempts to recreate the Smalltalk development environment on an IBM PC (and compatibles) running under MS-DOS. You don't need a hard disk—two 360K-byte floppy disks are sufficient—but you do need 512K bytes of memory. Nonetheless, most IBM PCs and compatibles now come with at least 256K bytes of RAM, and expansion cards with another 256K bytes are readily available.

USING METHODS

Methods uses two disks. One contains SOURCES.SML, a 300K-byte ASCII file containing the source code for all methods in the system. The other has IMAGE.EXE, a RAM image of the Methods system, and CHANGE.LOG, an ASCII file containing the source code for all changed methods and for expressions executed with the doIt and printIt menu commands.

It takes about a minute to load IMAGE.EXE, your development environment, into RAM. You can save new objects and methods to disk using one of the pop-up menus. Then, when you reload the image, you come up in the same environment you last saved, including all windows and their contents (definitions, commands, output).

Digitalk's biggest challenge was implementing the Smalltalk user interface. Windows, pop-up menus, and a free-roaming cursor are fundamental aspects of Xerox's Smalltalk systems, but not all IBM PCs or compatibles have graphics capability, and few support a mouse. Therefore Digitalk used a character-based windowing system and what they call the "right-hand-drive mouse."

The character-based windows, which use the IBM PC's extended character set and character attributes (bold, inverse, etc.), work well. Windows can overlap, move around, and change size. They can collapse down to their title, which can then be set off in a corner of the screen, or they can be removed altogether. They can hold more text than they show, and they support both vertical and horizontal scrolling. Furthermore, a given window can be divided into "panes," each with the same capabilities as windows. Two functions keys select the current window and pane: F9 cycles through the windows on the screen, activating each in turn by putting it "on top" of all others; F10 cycles through the different panes (if any) within the currently active window. Alternatively, placing the cursor in a window or pane makes it active. With a color-graphics card, the windows are still text-based, but you gain the ability to select the background and text colors for each window.

Text-based windows have three main advantages. They lessen the need for a graphics card, reduce memory requirements (because text information is more compact than bit-map information), and increase system speed (because text can be manipulated more rapidly than bit maps). The disadvantage, of course, is that some of the fancier features often associated with Smalltalk—different text fonts, graphics images, and the like—aren't possible.

The right-hand-drive mouse uses the cursor keypad to perform most of the functions of a mouse, including moving the cursor, scrolling windows, popping up menus, and selecting text. The arrow keys move the cursor around; if you use them with the shift key, the cursor moves in larger increments. The Home and End keys let you scroll text left and right within the active window/pane; similarly, the Pg Up and Pg Dn keys let you scroll up and down. The Ins and Del keys pop up menus for the the active window and pane, respectively. The + key selects a menu item or a location; the – key extends that selection over several lines.

SOME OBSERVATIONS

It was easy to evaluate Methods' user interface; it was more difficult to assess the language itself, especially to compare it with Smalltalk-80. Since I had little experience with Smalltalk (or, for that matter, any other object-oriented language), I asked someone with more experience and knowledge to perform that task. Tom Yonkman, who has developed object-oriented software applications for several years, graciously consented to write the second part of this article. I will share my own observations as a professional software engineer with a strong background in more traditional computer languages (Pascal, FORTH, FORTRAN, assembly). Keep in mind, however, that I worked with a prerelease version with no real documentation.

At first, I was very excited about Methods. I spent a few hours at the Digitalk offices watching the staff demonstrate the product. I was impressed with the user interface and amazed at how quickly they could create new applications and modify existing ones. I was anxious to start using it myself.

My initial sessions with Methods were frustrating. What seemed effortless and clear at Digitalk now seemed difficult and obscure. I had no problems with the user interface, but the language itself was challenging. In fact, I was probably a victim of my own training and experience, all geared towards "traditional" programming languages and techniques.

After a few days of playing around, I began to get results.

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I started to define some data structures and the methods needed to store and retrieve their information. The more I worked, the more potential I saw. Indeed, some of my long-term projects dealing with modeling large systems may be better implemented in Methods/Smalltalk than in any other languages with which I'm familiar.

My main difficulty with Methods was getting it to do something quickly. This was not an inherent problem with Methods; I had three handicaps: lack of documentation, lack of graphics and real numbers in my prerelease version (most of the examples in Smalltalk-80 books involve one or the other), and, of course, my own lack of familiarity with object-oriented languages. None of these handicaps should remain when Methods is commercially released (probably by the time you read this).

The bottom line is that Methods is a legitimate object-oriented development system, running on widely available, standard hardware. Since it is a departure from traditional programming environments, you will need complete, clear documentation to avoid frustration. How Digitalk addresses that issue remains to be seen. A more complete evaluation will have to await the release of the final product; nonetheless, anyone with an interest in object-oriented languages should take a close look at Methods.

Part 2: . . . *but is it Smalltalk?*

BY TOM YONKMAN

Methods is a complete software-development system, with an editor, compiler, executor, and debugger all in a multiwindow environment. Methods does not require a linker or a loader.

The language is similar to Smalltalk-80 (see *Smalltalk-80: The Language and Its Implementation* by Adele Goldberg and David Robson, Addison-Wesley, 1983). The syntaxes of the languages are identical except for characters that don't exist in the IBM PC character set. On the basis of limited testing, the semantics of Methods (what the functions do) also seem identical to those in Smalltalk-80. The user interface is similar to that of Smalltalk-80; differences owe to the space limitations of the 80-column by 25-line character screen and to the memory limitations of the IBM PC.

Methods provides the standard System Transcript, Workspace, Class Hierarchy Browser, Class Browser, Inspector, and Walkback (Backtrace) windows. Multiple instances of each window ("views" in Methods and Smalltalk jargon) can appear on the screen. The Walkback window traces the sequence of operations that led to an error state. The System Transcript window displays messages for the user. Workspace is a general utility window for editing text and sending messages to objects (i.e., executing programs).

The Browsers look at the existing hierarchy of classes, the message names of existing classes, and the definitions of existing methods. You can add or delete classes, edit a class's definition, protocol, or redefine its methods. The Browsers can access the Methods system in its entirety. You can see how the system developers do certain operations, and you can copy any statements you like, paste them into your own methods, or modify them. The Inspector allows you to view or change the current values of instance variables. Menu commands are provided so you can find all the senders and implementors of a specified method. These are very useful, given the inheritance mechanism of Methods.

You use Methods by sending messages to objects that perform some operation and return the result. If there is no class of objects with the capabilities you need, you can define new classes and associated protocols (message names and methods). Or you can edit existing methods or add new methods to existing classes. In any case, you are always interacting with the Methods system—a similarity this language shares with BASIC, LISP, and FORTH, among other highly interactive systems. Methods does not provide a System Workspace with templates for commonly used expressions, which would be a useful feature for users not yet familiar with the program.

The process of developing capabilities will involve testing your new methods. You do this by creating a new instance of your class, sending it a message, observing the response, and fixing the method if the response is incorrect. To fix the method, you select a Class Browser window, edit and recompile, select the Workspace where the message was sent, resend the message, etc.

While I know that I used a prerelease version of methods, I do have a "wish list" for the language. For example, it would be nice if more data were kept in memory at one time, so that browsing back and forth didn't require reloading the same source code as often. The designers may have traded memory for speed. I would also have preferred easier selection among panes of a window and among all windows. For example, a function key could cycle among the two most recently selected panes/windows or among the *n* most recently selected.

Despite the limitations of Methods, someone who becomes proficient with it should have no trouble with a "real" Smalltalk-80 system (like the Tektronix 4404). Best of all, you don't need to pay $15,000 to use Methods. ■

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SMALLTALK-PC

BY CHRISTOPHER MACIE

Objected-oriented software on the Apple II

Smalltalk bridges the gap between human and computer problem-solving logic. Essentially, programming is the process of creating a model of an activity or thought process. In traditional programming languages a small change in a problem can require a large change in the program code (owing to the languages' firm bases in machine representation). And many languages involve special, often particularistic, sets of skills. Higher-level programming languages are simply higher-level abstractions from machine logic.

Smalltalk, on the other hand, starts with an object-oriented model of problem-solving logic and deals with the machine logic internally and automatically. Where other languages need guiding constructs like "structured programming" to help control the complexity of machine representation, Smalltalk proceeds along more natural intuitive lines. And, as the needs of the Smalltalk user change, applications are easy to modify and maintain.

When I first saw Adele Goldberg demonstrate Smalltalk-72 at Xerox PARC in 1976, other programming languages and environments suddenly seemed obsolete. Between 1976 and 1981, I studied Smalltalk, applying its principles in new projects, and I decided that a full implementation would never work on the minicomputers then available.

But then the Apple II came along, with extendable architecture and a memory-mapped screen. When BYTE published the Smalltalk issue in August 1981, memory-extension cards were becoming available, and various game-paddle devices could simulate the functions of a mouse. The Apple II had become a candidate for Smalltalk experimentation. Smalltalk-80, the Xerox standard, had advanced and refined the Smalltalk concepts, but it seemed out of reach for the Apple II. Nonetheless, I began my own Smalltalk implementation on the basis of reverse engineering (see references 1 and 2).

SMALLTALK FOR LOW-COST PERSONAL COMPUTERS

I developed Smalltalk-PC to provide users with access to object-oriented programming on hardware systems like the Apple II and IBM PC. The language is intended for system designers and applications programmers who want a head start in object-oriented programming and for sophisticated users and programmers, especially those working with highly dynamic applications involving frequent reprogramming. Although Smalltalk-PC differs in several respects from Smalltalk-80, the general flexibility of the Smalltalk language will facilitate communication between the two.

Smalltalk-80 is written to such a deep level that it requires extraordinary processor power to perform adequately. Smalltalk-PC simplifies the hardware requirements by placing the entire system (which can be extended) in about 60K bytes of RAM (random-access read/write memory), using mass storage

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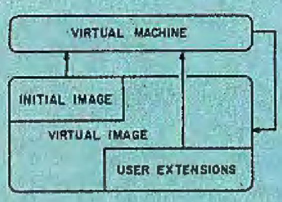

Figure 1: *The overall structure of the Smalltalk-PC system. The virtual image drives the virtual machine. The initial image implements the dictionary, user interface, and language systems.*

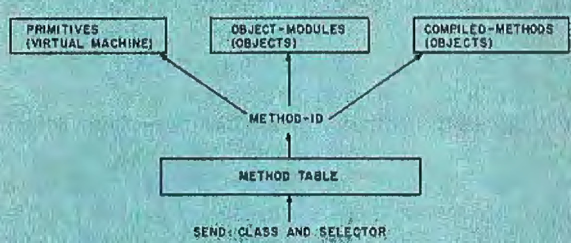

Figure 2: *Unified message sending to the different method-implementation types. Message sends are handled as lookup keys into the method table, which determines the implementation type and the path to the method code.*

for file I/O (input/output) and image storage but not for swapping. In Smalltalk-PC, therefore, the virtual machine (the lower level written in assembly code) is much larger than in Smalltalk-80, limiting modifiability at the lower systems' levels (such as object and class behavior, the system-level classes, including collections, and much of the user interface), but optimizing performance on the slower processors. Still, Smalltalk-PC preserves the flexibility of Smalltalk at its higher levels, those of interest to most personal computer and applications programmers. Smalltalk-PC embodies "open system" principles but also allows programmers to protect applications and their users from the pitfalls of fully open access.

SYSTEM STRUCTURES

Figure 1 shows the overall structure of the Smalltalk-PC system. The hardware is interfaced by the virtual machine or kernel system (see figure 3), which implements the class/object and message-passing machine. The virtual machine is in turn driven by the virtual image—the fundamental system classes and objects that implement the object-oriented modeling environment. The initial image, delivered with the system, implements the basic environment, including the dictionary, user interface, and language systems. It also contains some toolkit extensions for applications programming.

Methods can be redefined in the fundamental classes, as illustrated by the arrow leading from the virtual machine back to the virtual image. Smalltalk-PC thus preserves the essential flexibility of Smalltalk, although its speed suffers relative to the default-machine-coded versions when such methods are interpreted.

The package of modules has entry points for message sends (with arguments in an active context) and for message calls (with arguments in registers and internal global cells). Although the arrows in figure 3 go directly to modules, all message sends are in fact routed through the Virtual Environment (VE) module.

As you can see in figure 2, message sends are handled uniformly as lookup keys into the method table, yielding a method-ID (identification) whose encoding determines the implementation type and the path to the method code. The state of the system—all the data stored and retrieved as the virtual image—is structured as in figure 4.

THE SMALLTALK-PC LANGUAGE

The language system compiles Smalltalk-PC code into intermediate code in compiled methods, interprets it, and provides support for debugging and error handling. The language syntax is a modified form of Smalltalk-80 syntax (see reference 3).

There are three types of language tokens, each distinguished by their typography. Those beginning with lowercase letters represent selectors and context-dependent variables. Those beginning in uppercase letters but containing at least one lowercase letter signify global variables. Tokens that are completely in uppercase represent reserved words and are used for identifiers such as NIL, TRUE, FALSE, the pseudovariables SELF, SUPER, etc., and certain control-selectors that are treated as primitives.

The reserved-word syntax is also used to express an escape mechanism for encapsulating other "languages" in method code. This is used, for instance, for symbolic and hexadecimal representations of Smalltalk-PC intermediate code. Escape syntax is also used to specify a variety of modes affecting method compilation and execution. For instance, visibility layering and error handling are regulated by class- or method-level run-time modes.

THE CLASS SYSTEM

The Smalltalk-PC class system is structured in a hierarchical tree from the root class Object and resembles the basic parts of the Smalltalk-80 class tree. The metaclasses of Smalltalk-80, however, are not used in Smalltalk-PC, where class and instance behavior are both accessed through the class Class.

The class Collection has subclasses for RandomCollections (Bag, Set, Dictionary) and IndexableCollections, including Arrays (Strings, Symbols) and Ordered- or Sorted-Collections. The class Matrix is a subclass of Indexable-Collections. There are further subclasses for ByteMatrix (for WYSIWYG text) and PointerMatrix. These classes allow for large regular structures without proliferating sub-objects.

In creating IndexableCollections, there is an optional virtual dynamic-size control that uses an internally maintained current end marker. The feature reduces the amount of allocation/deallocation of objects, which often change in size.

Other fundamental classes include Undefined (NIL), Boolean (TRUE, FALSE) and Measure. Measure is similar to Magnitude in Smalltalk-80 and has subclasses for Character, SearchKey, and Number (which includes Integers and Float). Floating-point numbers are implemented in BCD (binary-coded decimal) format, with a 7-bit signed exponent, sign bit, and a 6-byte mantissa (12-digit precision).

The user interface contains classes representing the devices (Screen, Mouse, and Keyboard), their configurations, and a variety of window types and components. At the elemental level are WindowDimensions and WindowFrames and their components—TitleBars, ScrollBars, MenuBars, and Corners. Panes include TextPanes, ListPanes, and LabelValuePanes. PopUpMenus are a variety of ListPanes.

Complex forms are built by combining panes and dimensions or frames. Scanners are combinations of ListPanes used to scan through hierarchical structures like categorized dictionaries. Examiners are pairs of coordinated ListPanes used to examine or edit the state of any object. PropertyLists, arrays of LabelValuePanes, display labeled data or switches.

Windows combine frames and panes with the Director function to assume the behavior of processes that can be independently scheduled user tasks that reside in screens and present data that can be transferred between windows. TextWindows contain workspaces and documents; they are used in combination with dictionaries (ListWindows and Scanners) to build information trees or plexes.

ClassEditor is a more complex window that combines LabelValuePanes, ListPanes, and TextPanes for the display, generation, and modification of class definitions and methods.

Multitasking and Multiple Processors

Smalltalk-PC provides run-time scheduling and multitasking, allowing multiple active processes to compute simultaneously. The basic system classes furnish multilevel scheduling, queue handling, and semaphores for synchronization.

A variant of Smalltalk-PC, called Smalltalk-Mate, will run on multiple-processor hardware systems, including the Apple II and IBM PC with added processor cards, as well as newer machines with multiple processors on the motherboard. Smalltalk-Mate furnishes an interface to support multiple processing on a single-object memory or synchronization between different images and even between Smalltalk and other language systems. This capability allows Smalltalk-PC to run coresident with the p-System and MS-DOS, among others. Users can therefore take advantage of both preexisting software and the special strengths of Smalltalk.

Running Smalltalk-PC

The Smalltalk-PC boot disk contains the virtual-machine program and a prerun configuration routine that allows

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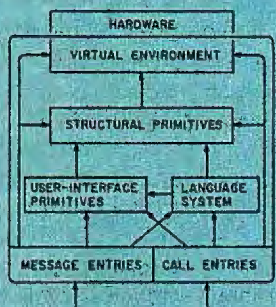

Figure 3: *The structure of the virtual machine. The Virtual Environment (VE) module interfaces devices and memory, implements classes and message passing, and handles access to objects and their fields. The Structural Primitives module contains various primitive methods. The User-Interface module carries out the primitive functions for screens and windows, while the Language System module contains the compiler, interpreter, and debugging subsystems.*

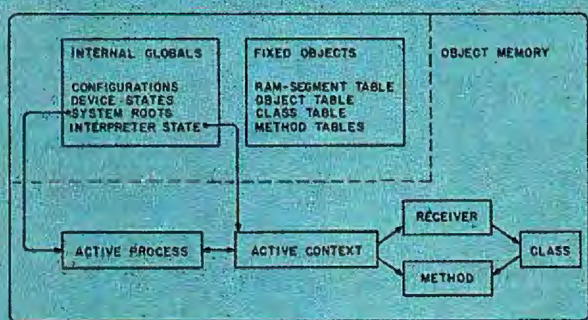

Figure 4: *The Virtual Image Structure. Internal globals and fixed objects are stored in areas directly accessed by the virtual machine, although many of their elements are interfaced to the higher-level environment as bona fide objects. The state of execution is rooted in internal globals (used as registers) but largely contained in the objects of the active context. The running system makes no distinction between the initial image and user extensions.*

the user to specify the current hardware configuration—mouse, screen, extended-memory types, and slots. A set configuration can be saved for future booting. A second disk loads the initial virtual image, which requires a minimum of 256K bytes of RAM. It is possible to configure additional RAM from within the system, but saving and loading extended virtual images may require multiple disks.

The initial image (see photo 1) displays the system screen, a logo, and elementary instructions. The system screen provides entry to the rest of the system through a pop-up menu that accesses a dictionary of system-task windows and the user-project screens.

THE USER INTERFACE

In the default user-interface configuration, the middle mouse button (or the one on the right on a two-button mouse) invokes a pop-up menu. Moving the mouse through the menu with the button depressed changes entries to inverse video. Releasing the button at a dictionary entry schedules and runs the process associated with that entry. Usually a framed window then appears. Data elements or ranges in a window or its frame are selected by clicking or dragging the button on the left. Pop-up menus, usually in combination with a data selection, invoke actions. Pop-up menus at the frame of a window offer the functions common to all windows—closing, positioning, and growing. Pop-up menus within the frame contain functions specific to the type of the window.

A project screen is a window that fills the whole screen, has no frame, and behaves much like the system screen, but contains a user-defined environment.

The fundamental pane and window types include options to configure the user interface according to personal preferences. For example, action selection can appear in PopUpMenus (as in later Xerox Smalltalks), in MenuBars at the top of the screen (as in the Lisa or Macintosh), or at the bottom (as in Visi On); TitleBars can appear at the top or bottom; ScrollBars can appear at the top, bottom, left, or right.

The user can configure the mouse to deliver the select, pop-up, execute (or do-it), and help functions from any choice of buttons (1, 2, 3, or simultaneous combinations).

The user can also configure key assignments for cursor and button control and assign up to 10 special-function keys as either soft interrupts that result in running processes or as pollable switches.

SYSTEM FEATURES

The task windows residing in the system screen provide interactive settings for dealing with system resources. One task window, for example, permits the reconfiguration of hardware and software features.

You can use Scanner windows to look around in hierarchically categorized dictionaries, and you can use an Examiner window to investigate the state of any object. For example, by nesting Scanner and Examiner windows, virtually anything in the system can be reached and viewed

Photo 1: *The Smalltalk-PC initial screen. This picture shows a text window with which instructions displayed on the screen can be modified. The selected text (inverse) is about to be captured for copying by means of the edit pop-up menu.*

Photo 2: *A sampling of Smalltalk-PC windows. There is a scanner in the upper left showing class categories (left pane) and their classes (right pane). There is a form of class editor in the lower right. In the lower left is a text window, and in the upper right is a list, out of which the scanner was called. The two-line inverse window in top center is the pop-up menu of the screen (mouse button 2 is being held).*

Toolkits are used in Smalltalk-PC to implement word processing, database processing, and spreadsheets.

in detail (the open-system concept).

A special window form supports the viewing, modifying, and adding of classes. Together with general-purpose workspaces and tracing and error windows, this special window form constitutes the programming environment. Photo 2 shows a screen full of typical windows.

You can create a project screen, which can be filled with task windows usually related by some application concept. Project screens use the same general tools as the system screen, including class programming, and you can install tools developed in a project screen in the system screen.

At almost any time, you can invoke a system task to save the current state of the virtual image on disk or to replace the current image by reading another. Alternatively, invoking automatic saving could periodically back up the system. An internal file and directory system provides file storage and retrieval on a special Smalltalk-PC disk format. Smalltalk-PC supports reading and writing of files in other formats, like Apple DOS, CP/M, MS-DOS, and the p-System.

For applications that do not need the full flexibility of the Smalltalk-PC environment, project screens can lock in specific tasks in much the same way as standard applications packages. Moreover, a feature called "visibility layering" can lock dictionaries at specific levels to prevent access beyond the scope of an application, and a special error-report control feature with a similarly layered structure can inhibit error messages from advanced system levels. These features are provided to protect application models from accidental disruption, but programmers could also use them to offer a degree of user programmability appropriate to the application, without requiring the user to master the full Smalltalk environment.

Smalltalk-PC Toolkits

"Toolkits" are generalized, modular functions that support a family of application-oriented tasks. They are the best approach to applications programming in Smalltalk. In principle, they are extendable to other tasks, and they are used in Smalltalk-PC to implement word processing, database processing, and spreadsheets.

The word-processing toolkit has document windows providing page, margin, header, and other formatting controls. The database-processing toolkit has extensions to interface relational database functions to hard-disk- and network-based information systems.

Spreadsheet representation uses Smalltalk's object orientation to allow creation and maintenance of complex document forms whose elements are produced by arbitrarily complex processes. The capability called "Active Data Modeling" services documents (text, charts, tables, etc.) whose contents are produced by information structures that can be viewed and manipulated at various levels of abstraction.

This spreadsheet format is free-form rather than a matrix of cells, and the order of evaluation is determined freely rather than by rows or columns. Data elements represented in the final document are not copied literally but remain linked to their source objects or processes. The data models therefore remain "active" in that they dynamically reflect changes from anywhere in the underlying structure.

Implementation Aspects

Methods implemented in machine code are important for the development of efficient application toolkits. These "object modules" can be compiled from a high-level language (for portability) and are installed into the virtual image as objects.

The coding of object modules uses table-pointed name strings to refer to system objects, both externally (other objects) and internally (the module itself and its entry points). An automatic installation procedure changes the string pointers to object identifiers of Smalltalk-PC symbols, binding the module into the virtual image. With this feature, interpreted Smalltalk code can be used for development, flexibility, and high-level control, and use of optimized machine code at strategic points can improve performance.

Smalltalk-PC does not run under a host operating system but drives the hardware directly from the virtual machine (VM), about 95 percent of which is portable across systems with the same microprocessor. The other 5 percent consists of the screen, keyboard, mouse, and virtual-memory management tailored to each host system. The system image (including user extensions and applications) is, in principle, portable across any system.

The memory system is fully object-oriented and supports up to 254 classes and 30K-byte objects in up to 4 megabytes of resident RAM. (IBS in West Germany and Legend Industries build 1-megabyte single-slot cards for the Apple II.) The object-memory system is largely derived from the OOZE system (see reference 4) but abandons those aspects directed at optimizing object swapping from disk. Reference counting is used to manage virtual memory, which is treated in 64K-byte segments to make scattered free space compact.

Object identifiers are used as direct indexes into a table containing virtual addresses and flags. Message lookup

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is done by hashing the class code and message selector into another large table.

The VM routines are optimized and shared to conserve space in main memory. Both the data-structure (collection) primitives and many of the user-interface primitives have a range of types and options specially encoded in their object structures, providing flexibility while conserving resources like space and classes.

Given the VM support for matrices as a form of collection, another technique to conserve object identifiers and to facilitate exploitation of the large virtual memory is to encourage the use of larger objects with complex but regular structures. The implementation of a matrix can then be a single object rather than an array containing additional array objects for each row. Otherwise, it would be possible to use up the object identifiers with a large portion of memory unused.

HARDWARE

I am implementing the Smalltalk-PC virtual machine for the 6502, 8088/8086, and 68000 microprocessors. The first version runs on Apple II-type systems (Apple II+, IIe, and compatible systems) with at least 80-column capability, an uppercase and lowercase keyboard, a 48K-byte motherboard RAM, one floppy-disk drive, and 256K bytes of memory on RAM card(s). (The Basis Computer BAS RAM, Legend Industries' S'Card, the Synetix Flashcard, the BAM-128 from Mikrotek, the Saturn/Titan card, and the RAM cards from IBS are supported.)

The 8088/8086 versions (IBM-class systems) require one floppy-disk drive and 256K bytes of memory. The 68000 version is currently installed on a new system from the German manufacturer, Triumph-Adler.

Apple II graphics resolution is inadequate for 80-column text displays, so my first version of Smalltalk-PC used a memory-mapped 24-line by 80-column alphanumeric format rather than bit-mapped graphics. The choice helps performance (bit-mapped graphics are known to consume up to 50 percent of raw processing power), and adequately supports windowing, menus, and mouse control.

A medium-resolution mouse with at least two (preferably three) buttons is a necessity (Smalltalk-PC currently supports DePraz, Logitech, Mouse-House, Rikei Oku-MS mice with parallel interfaces, and the MSC serial mouse), although the pointing function is available through the keyboard. The minimum hardware configuration for the Apple II+ would include a Legend S'Card, a PIA-card for the mouse, and an 80-column card. ■

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THE SMALLTALK PROGRAMMING LANGUAGE

BY JIM ANDERSON AND BARRY FISHMAN

An introduction to object-oriented programming

During the past year, we have used Smalltalk for application prototyping and system-software development. For us, Smalltalk simplifies programming and is fun. On the other hand, Smalltalk's new terminology and concepts generally complicate learning of the language, especially for experienced programmers (including ourselves). In this article we have attempted to demystify Smalltalk by relating it to other languages and by solving a moderately difficult problem in what we think is a straightforward and readable way.

Most people perceive Smalltalk as a "Macintosh-like" user interface with windows, mice, and bit-mapped graphics, but the Smalltalk group at Xerox PARC actually pioneered and blended together several technologies, including raster graphics, integrated environments, and object-oriented programming.

The last of these is our main concern.

Like FORTH, Smalltalk's core is small but its vocabulary can be extended. Like LISP, it has automatic memory management and capabilities for manipulating arbitrary data structures. Like Modula-2 and Ada, it encapsulates abstract data types (in objects).

The Smalltalk developers solved several interesting problems in graphics, text processing, simulation, and concurrency. Therefore, simply by reading Smalltalk programs, you may improve your programming ability in other languages. Fred Masterson has suggested that simplicity, power, compatibility, and cognitive richness are key attributes in a programming language (see reference 1). Except for Smalltalk, we don't know of a language that has all of these attributes while also being a practical tool for solving a wide range of problem types.

Smalltalk is well suited to rapid prototyping, the construction of software models that explore both the problem and its solution. This is especially important in interactive applications where perceptions of the problem can change after seeing a prototype solution (see reference 2). (Of course, a good programming environment is a big help here, too.)

A CLOSER LOOK AT OBJECTS

The Smalltalk-80 programming language (see references 3 and 4) is object-oriented in that all data is contained in record structures called objects. For translations of Smalltalk terminology, see table 1. The individually accessible components of an object (i.e., the fields of the record) are called instance variables, which either contain integer values in the range 0 to 255 or contain object identifiers.

Instance variables can be both named and indexed. For example,

1. An object of class Point has named instance variables x and y, which identify the coordinates of the point. A point has no indexed instance variables.
2. An object of class Array contains only indexed instance variables. These are identified with the integers 1 through the number of instance variables in the array.
3. An object of class Set has indexed instance variables and a single named instance variable tally, which totals the number of indexed instance variables that are not nil (the name for the special undefined object).

Objects are simpler than Pascal record structures in that either they contain all integer values or they contain all identifier values. Objects with integer instance variables define elementary data values like numbers and strings. Objects with identifier instance variables consist of pointers to other objects. The pointers organize the universe of all objects into a single directed-graph structure. Like a pointer value in Pascal, an identifier distinguishes each object.

Objects are "self-describing." They include information defining their size (number of instance variables) and the class to which they belong. Computing in Smalltalk involves changing the instance variables of existing objects, creating new objects, and destroying objects (turning them into "garbage") by removing them from the graph structure. (See the text box on page 162 for a summary of Smalltalk statements.) The Smalltalk system automatically reclaims space for garbage objects.

Table 1: *Some Smalltalk terminology translations.*

Method	a function definition
Message	the invocation of a method, i.e., a function call
Protocol	the specification of how a message is sent to a method, including the method name and parameters
Object	a record of fields
Instance Variable	a field of a record
Class	a record type and all the functions that may be applied to the record type

Classes are the program modules of Smalltalk. Like the "abstract data types" provided by the modules of Modula-2 and the packages of Ada, a class specifies the instance variables contained in the objects of the class and the methods (functions) that operate on the objects. The internal details of an object are not visible from methods outside its class; therefore you cannot directly access its instance variables. Instead, you send a message to (invoke a function on) the object requesting the desired information.

Smalltalk classes are organized into a hierarchy with the class Object at the top. Superclasses are more generic; subclasses are more specialized. A class inherits the named instance variables and methods of its superclasses. Consider, for example, part of the Smalltalk hierarchy for class Magnitude:

```
Magnitude
  Character
  Date
  Time
  Number
    Float
    Fraction
    Integer
```

(continued)

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The generic class Magnitude contains methods for computing maximums and minimums in terms of comparison operators. The subclasses define more specialized functions, like doing the comparisons. Inheritance is a powerful abstraction technique that allows software to be reusable (see reference 5).

Inheritance is supported by "run-time binding," the dynamic determination (based on the class of the receiver, the object to which the message is sent) of which method responds to a message. Consider the method, implemented in class Magnitude, for taking the maximum of two magnitudes:

```
max: aMagnitude
  self < aMagnitude
    ifTrue: [^aMagnitude]
    ifFalse: [^self]
```

This generic method works for operands of any subclass of Magnitude if the subclass implements the "less-than" (<) method. The class of self (the receiver of less-than) determines the choice of which less-than method to use. Thus we can take the maximum of two dates or two fractions, even though the max: method is not defined in either the date or fraction classes. Therefore the code works for operands that exhibit a generic behavior (here, comparing less-than), regardless of the details of the calculation.

SMALLTALK SYNTAX AND SEMANTICS

The syntax of Smalltalk methods has three parts: the message pattern, temporary variables, and statements. The message pattern defines the method name, method arguments, and the syntax for invoking the method with a message. Temporary variables are the method's local variables. Instance variables, method arguments, and global variables are the other variables accessible within a method. Global variables begin with uppercase letters. The others begin with lowercase letters.

A SUMMARY OF SMALLTALK STATEMENTS

A Smalltalk statement either assigns a value to a variable, exits a method and specifies the result, sends a message to an object, or does some combination of the three.

The following are three examples of assigning values to a variable:

```
a := true
```

In this example, the identifier of the object true is assigned to the variable a.

```
answer := index
```

Here, the identifier contained in the variable index is assigned to the variable answer.

```
i := j := 0
```

In this expression, the identifier of the object for the integer 0 is assigned to i and j.

To exit a method, Smalltalk uses the following syntax:

```
^answer
```

In this example, the object whose identifier is contained in answer is returned as the result of the method.

```
^'january'
```

In this expression, the identifier for String 'january' is returned as the result of the method.

To send a message, there are several possibilities:

```
a size
```

This is the syntax for a unary message. The message size is sent to the object in variable a.

```
count + 1
```

This is a binary message. The message + is sent to count with argument 1.

```
a at: index
```

This is a keyword message. The message at: is sent to a with argument index.

```
a at: index put: count
```

In this multiargument message, the message at:put: is sent to a with arguments index and count.

There are several combinations of the above statements:

```
^count + 1
```

In this expression, the result of the message count + 1 is returned as the result of the method.

```
x := a at: index
```

Here, the result of the message a at: index is assigned to the variable x.

```
^(a := b max: c + 1)
```

This statement is evaluated in the following steps. First, + is sent to c with argument 1. Second, max: is sent to b with the result of the c + 1 message as the argument. Third, the result of max: is assigned to a. Finally, the value assigned to a is returned as the result of the method.

The syntax of Smalltalk methods has three parts: the message pattern, temporary variables, and statements.

A block, the part of a method enclosed in square brackets, is an object even though it represents executable code. Therefore, it is possible to assign a block to a variable or pass it as a message argument. The following example uses a block argument in a message to implement control structures:

```
[inputStream atEnd]
  whileFalse:
    [outputStream nextPut: input Stream next]
```

The message whileFalse: is sent to the first block; the second block is an argument that will execute repeatedly until the first block returns true. If inputStream is of class ReadStream and outputStream is of class WriteStream, all the characters in inputStream will be copied to outputStream. (See references 3 and 4 for a complete description of control structures and blocks.)

SMALLTALK SYSTEM CLASSES

The Smalltalk language is a simple expandable core. The system is the core extended with several classes, including Collection, Stream, Magnitude, DisplayObject, Point, and Rectangle. (For a full discussion, see reference 4.)

Collection classes implement arrays, sets, dictionaries, and linked lists using common protocols for data-structure access. Stream classes implement external files as a sequence of randomly addressable bytes and, again with common protocols, streaming over arbitrary collections of internal objects. The Magnitude classes provide extensive facilities for date, time, and numeric calculations. The DisplayObject classes implement the representation and manipulation of graphical images (which are supported by classes Point and Rectangle, used respectively for representing graphical positions and areas).

In our example (which follows), we use system classes Set, Dictionary, and FileStream. Class Collection, of which Set is a subclass, allows its subclasses to create new collections, to add and delete collection elements, and to iterate over the elements of a collection while a block executes for each element. Instances of Set are efficiently searchable containers of unordered elements, which may not be duplicated.

Dictionary, a subclass of class Set, looks up values based on keys. An instance of class Dictionary associates pairs of keys and related values. Keys in a dictionary are unique.

The class Dictionary method at: aKey ifAbsent: aBlock returns the associated value if there is an entry in the dictionary with key equal to argument aKey. Otherwise the argument aBlock executes and determines the result of the at:ifAbsent: message. Consider

```
employees at: employeeNumber ifAbsent: [nil]
```

If employees contains a dictionary where each key is a number representing an employee's number and each value is an object representing all employee data, then the example message returns nil if the employee is not in the dictionary. Otherwise the employee object is returned.

The class Dictionary method at: aKey put: aValue places an entry for the pair aKey, aValue into the dictionary. This message always returns aValue as the result. For example, the message

```
employees at: employeeNumber put: employeeData
```

adds a value employeeData for the key employeeNumber to the dictionary employees.

The class Dictionary method do: aOneArgumentBlock iterates over the elements in the dictionary. The argument block is evaluated once for the value part of every key/value pair in the dictionary. In the next example,

```
employees do: [:employee |
  employee site = localSite
    ifTrue: [localEmployees add: employee]]
```

the message do: is sent to the dictionary employees with the block as argument. The block is executed once for each employee and builds a collection of local employees.

A SMALLTALK EXAMPLE— A DOCUMENT RETRIEVAL SYSTEM

Our Smalltalk example, which will run under Methods (see "Methods: A Preliminary Look" by Bruce Webster and Tom Yonkman, page 152) is a new class WordIndex, a simple document-retrieval system. An instance of WordIndex allows the retrieval of a list of all documents that contain a group of words. For example it could request a list of candidates whose résumés contain the words UNIX, 68000, and C.

Our system maintains documents as ASCII files, one file per document. Queries that supply a list of words get back the names of all the documents that contain all the words. An instance of class WordIndex contains the document database for one application or category of documents. We have used classes Collection and Stream and their subclasses. Class WordIndex has instance variables documents, words, and noiseWords.

Instance variable documents contains a set of strings that identify the documents by their file pathnames. Instance variable words contains a dictionary representing the words in all documents. Each key is a word repre-

(continued)

sented as a string; the associated value is a set of all the documents that contain the word. Instance variable noiseWords contains a set of noise words, which reduce the size of the database. A word will not be entered in the words dictionary if it is included in the set of noise words.

The message addDocument: adds a document to the database by scanning the document as an instance of class FileStream. The message nextWord is sent repeatedly to the file stream to extract the next word as a string. Each word is entered into the words dictionary with the associated document included in the set of documents for the word.

The locateDocuments: message performs database queries with a collection of words as an argument. Each word is looked up in the words dictionary. The query returns a sorted collection of all documents appearing with all words.

The complete implementation of class WordIndex contains the following eight methods.

The method initialize initializes an instance of WordIndex by assigning empty sets to instance variables documents and noiseWords and an empty dictionary to instance variable words.

```
initialize
    "Initialize the instance variables
    of the WordIndex"
  documents:= Set new.
  words := Dictionary new.
  noiseWords := Set new
```

(Note: The symbol ":=" replaces the "←", the conventional Smalltalk-80 notation.)

The addDocument: aDocument method adds the words in aDocument to the receiver word index. The method first tests if aDocument, the file pathname of the document, is already in the set of documents. If so, removeDocument: deletes the old version of the document. Directory Disk then opens the file, and a file stream on the file is assigned to temporary variable wordStream. The document name is added to the set of documents (instance variable documents). The while loop does the major work of the method. The next word, obtained as a string from the file stream, is converted to lowercase and added to the dictionary with the message addWord:for:.

```
addDocument: aDocument
    "Add all words in aDocument to word Dictionary"
  | aWord wordStream |
  (documents includes: aDocument)
    ifTrue: [self removeDocument: aDocument].
  wordStream := Disk file: aDocument.
  documents add: aDocument.
  [(aWord := wordStream nextWord) == nil]
    whileFalse: [
      self addWord: aWord asLowerCase for: aDocument].
  wordStream close
```

The addWord: aWord for: aDocument method records aWord if it appears in aDocument unless aWord is a noise word. If the word is not in the dictionary, the word and an empty set are entered. Finally, aDocument is added to the set of documents for the word. Note that we are able to deal simply with exceptional conditions by supplying a block of code in the at:ifAbsent: message.

```
addWord: aWord for: aDocument
    "Add aWord to aDocument if it is
    not a noise word"
  (noiseWords includes: aWord) ifTrue: [^nil].
  (words at: aWord ifAbsent: [words at: aWord put: (Set new)])
    add: aDocument]
```

The locateDocuments: aWordList method queries the database. Given a collection of words in aWordList, it returns a sorted collection of all the documents that contain all the words. Note that aWordList can be any kind of collection, e.g., Array, Bag, LinkedList. The select: message described earlier under Sets continually removes documents that do not contain all words in aWordlist from a temporary variable, answer, which starts as the set of all documents.

```
locateDocuments: aWordList
    "Answer a SortedCollection of all documents
     containing all words in aWordList"
  | answer |
  answer := documents.        "start with all documents"
  aWordList do: [:aWord|      "iterate over words"
    answer := answer select: [:aDoc|
      (words at: aWord asLowerCase ifAbsent: [#()])
        includes: aDoc]].
  ^answer asSortedCollection
```

The string addNoiseWord: aWord method adds aWord to the set of noise words.

```
addNoiseWord: aWord
    "Add aWord string to noise words"
  noiseWords add: aWord
```

The removeNoiseWord: aWord method removes aWord from the set of noise words. If aWord is not a noise word, nothing happens.

```
removeNoiseWord: aWord
    "Remove aWord string from noise words"
  noiseWords remove: aWord ifAbsent: []
```

The removeDocument: aDocument method scans the words dictionary to remove from every set all occurrences of aDocument. (Note that a set can have only a single occurrence of a document. This code also works for bags, which can have multiple occurrences.) Finally, the message removeUnusedWords is sent to the word index to remove dictionary words with empty document sets.

```
removeDocument: aDocument
    "Remove aDocument from all words that contain it.
    If a word has no documents, remove it"
  words do: [:docs|  "docs is Set or
  Bag of documents"
     (docs occurrencesOf: aDocument)
        timesRepeat: [ docs remove: aDocument]].
  self removeUnusedWords
```

The removeUnusedWords method replaces the words dictionary with a new dictionary containing only those entries in words that have nonempty document sets.

```
removeUnusedWords
    "Remove all words that have empty document collection"
  | newWords |
  newWords := Dictionary new.
  words associationsDo: [:anAssoc |
     anAssoc value isEmpty
        ifFalse: [newWords add: anAssoc]].
  words := newWords
```

For an example of class WordIndex, we have treated the sections of this paper (the article itself, the table, the text box, and the list of references) as separate documents. First we make the index:

```
ArticleIndex := WordIndex new initialize.
```

Then we add the figures to it:

```
#('article' 'table' 'textbox' 'reflist')
  do: [:section | ArticleIndex addDocument: section]
```

The query

```
ArticleIndex locateDocuments: # ('Smalltalk' 'argument')
```

returns the list

```
article textbox
```

Smalltalk is powerful, simple, and fun. Because object-oriented programming may be new to you, it may not seem simple at first. We hope this article helps to show that it is. Now that Smalltalk is available for popular microcomputers, a lot more of us can experience the fun. ■

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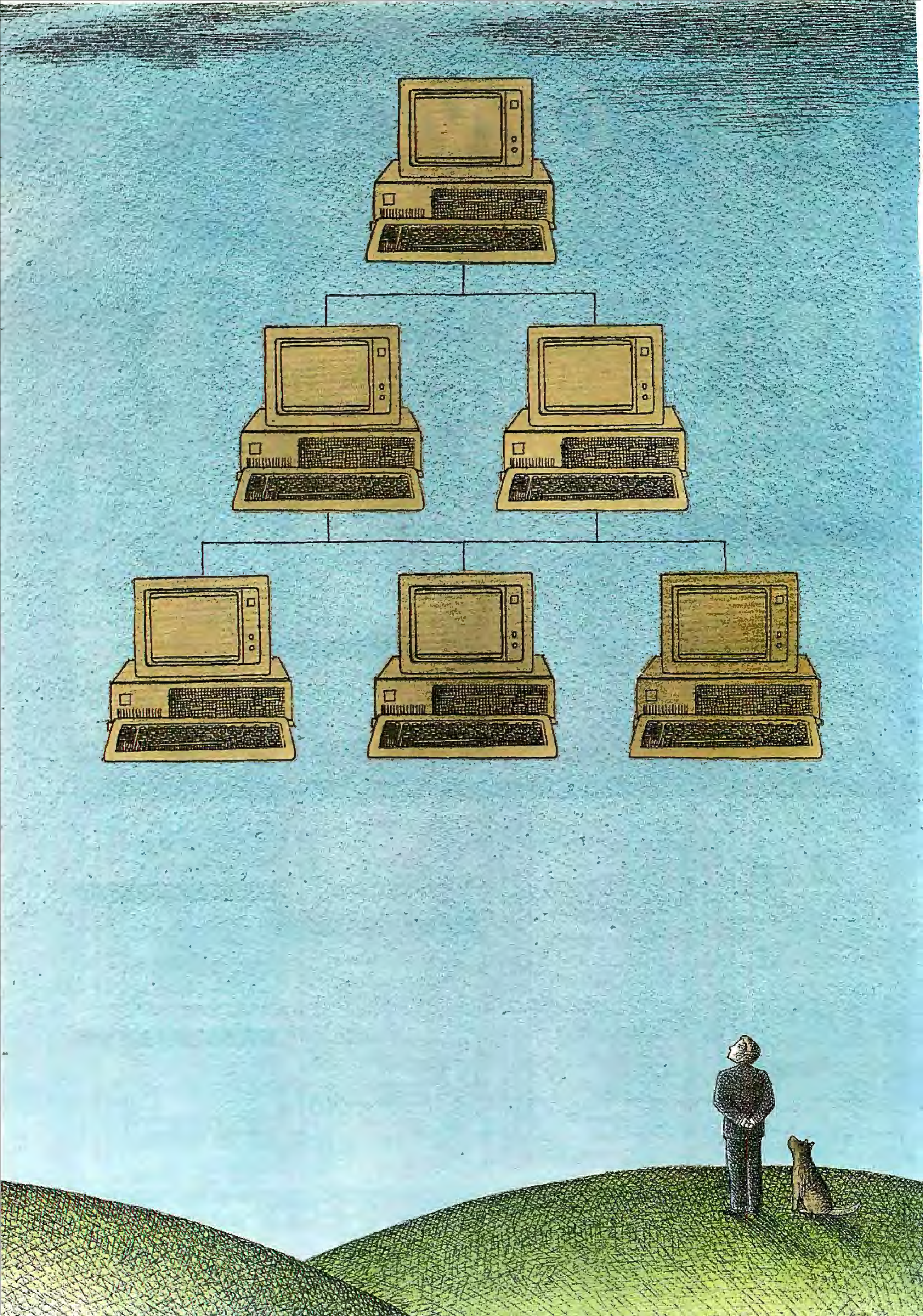

Multiprocessing

"*The machine can be brought into play so as to give several results at the same time, which will greatly abridge the whole amount of processes.*"—*General Menabrea*, 1842

THESE WORDS BY NINETEENTH-CENTURY military engineer Luigi F. Menabrea concerning Charles Babbage's Analytical Engine may well have constituted the first recorded proposal of automated multiprocessing in history. Multiprocessing, the processing of more than one computer instruction or item of data at once, is the underpinning of much of the new development in computers. Without the ability to process several tasks at once, the usefulness of computers cannot grow for long. Most of the big, glamorous advances in computing, such as artificial intelligence, speech recognition, and image processing, will depend on the speed granted by multiprocessing.

In this issue, we examine some of the concepts of multiprocessing, beginning with my article, "Multiprocessing: An Overview." We also examine some ideas that, strictly speaking, aren't part of multiprocessing but are thought to be by the public—for example, coprocessors. Coprocessors are specialized processors that perform certain tasks for the master microprocessor, such as floating-point operations or string comparisons. The master processor will wait for the result rather than continue to operate, so the arrangement is not strictly within our definition of multiprocessing. Gary Beals explores coprocessors in "Extending Microprocessor Architectures" to nail down the difference between multiprocessors and coprocessors.

William Paseman's article, "Applying Data Flow in the Real World," is a look at one kind of true multiprocessor, the data-flow parallel processor. This is the area where much of the money is riding in the race to increase computer speed.

The best architecture for parallel processors is still being sought, but a convenient means to achieving that architecture may be the Transputer, a microprocessor that was designed for parallel processing. Paul Walker gives a closer look at this device than we have had before in these pages.

Finally, "Data-Movement Primitives" by J. Eric Roskos and Ching-Dong Hsieh demonstrates a method of sharing data on a $450 three-processor system. This is a system that we hope will inspire some of our readers to experiment in this important area.

I wish we could have published more articles about multiprocessing in this issue, but unfortunately we ran out of space. However, we plan to do more about multiprocessing in the future. Let us know what you'd like to see.

—Rich Krajewski, Technical Editor

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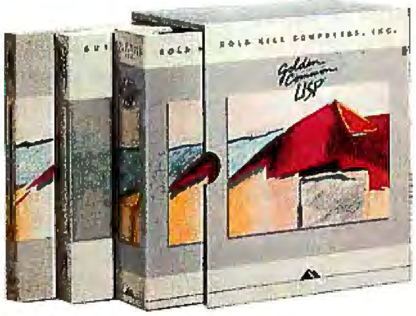

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MULTIPROCESSING: AN OVERVIEW

BY RICH KRAJEWSKI

A brief look at the latest quest for computer speed

MICROPROCESSORS HAVE MADE the development of multiprocessing possible by providing cheap, compact processing power. When electronic computers were first developed, single-processor architecture was inevitable because of the enormous cost and unreliability of the processing unit. Even into the 1960s and early 1970s, computers were too costly to easily combine on any massive scale. Now multiprocessors containing several thousand processing units are not unheard of.

Multiprocessing is a frustrating word because it can mean several things. To one person it may mean two independent Z80 computers sharing only the same hard disk; to another, it may mean two million 68000s sharing everything from resources to the same program. This causes confusion, especially when inventors and manufacturers use the same term to describe wildly different machines. To compound the misunderstanding, many of the celebrated benefits of multiprocessing are misstated, or at least not well explained. A manufacturer might tell you that multiprocessor *x* has one-tenth the power of a Cray-1 for one-hundredth the price, which is exciting, until you realize that the measurement applies only to a limited class of programs. In fact, with programs that can't readily be written as parallel processes, multiprocessor *x* may perform worse than your average desktop computer.

To remove some of the confusion, I'll try to define multiprocessing and classify its different forms. I'll save the discussion of actual multiprocessor computers for another time, when we can devote an entire article or review to them.

WHAT IS MULTIPROCESSING?

Multiprocessing can be broadly defined as the use of several microprocessors to perform a single task or several tasks, usually at the same time. The typical desktop computer fits into this definition if you call its CRT (cathode-ray tube) controller, disk controller, and peripheral interface all specialized processors. These specialized processors make your computer run faster by freeing the microprocessor from housekeeping chores and giving it more time to work on your program.

On the more obvious and less debatable side, a computer with a million microprocessors all working on the same problem is also a multiprocessor. It's plain to see that, since such a wide range of machines fall under the category of multiprocessing, we need some method of subdividing the category.

WHAT IT IS NOT

Before we go into the classes of multiprocessing, we ought to decide what it is not. A few folks have the idea that all multitasking and multiuser systems are multiprocessing systems. But as I see it, the emphasis in a multiprocessing system is on the number of processors rather than on the number of processes or users. Besides, high numbers of processes would choke a single microprocessor, so we won't consider single-processor multiuser or multitasking systems.

CLASSIFYING MULTIPROCESSORS

There are almost too many ways to classify multiprocessors. Some of the classifications we'll consider are those of structure, communications, and

(continued)

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data and instruction streams.

The classifications of multiprocessor structure are pipeline, coprocessor, array processor, and parallel processor.

PIPELINE PROCESSORS

Most processors, micro or otherwise, perform several tasks in the execution of an instruction. For instance, in multiplying decimal numbers (say 340 and 2.6), imagine that the computer represents the numbers in scientific notation (3.4×10^2 and 2.6×10^0). The computer then multiplies the mantissas ($3.4 \times 2.6 = 8.84$) and adds the exponents ($2 + 0 = 2$). The scientific representation of the number (8.84×10^2) is then "normalized" so that the power of 10 is removed and the decimal point is placed in its proper position (884.0).

Three circuits could perform the three tasks—multiply mantissas, add exponents, and normalize the result. Rather than let the mantissa and exponent circuits do nothing while normalizing is going on, we can give those two circuits another set of numbers to work on. Now, twice as many floating-point operations are taking place as before.

This is pipelining, the simultaneous execution of different parts of different instructions in an assembly-line fashion. One of the first examples of pipelining was the look-ahead, or prefetch. In this arrangement, the processor begins execution of one instruction while simultaneously obtaining the next instruction. The text box "The Z80000 Pipeline" describes a modern microprocessor pipeline.

THE Z80000 PIPELINE

BY ROBERT ANDREWS

The instruction cycle of the Z80000 is divided into six stages. Each of these stages is subdivided into two minor cycles according to the following breakdown:

1. Instruction Fetch:
Cycle 1: Increment the program counter.
Cycle 2: Compare cache tags and initiate the instruction fetch.

2. Instruction Decode:
Cycle 1: Instruction is available (assume cache hit).
Cycle 2: Generate microword.

3. Address Calculation:
Cycle 1: Calculate effective address of operands.
Cycle 2: Compare logical address with TLB tags for physical address.

4. Operand Fetch:
Cycle 1: Read the physical address from TLB (assuming TLB hit) and compare it with cache tag for operand.
Cycle 2: Operand is available into temporary register (assuming a cache hit).

5. Execution (may have multiple cycles):
Cycle 1: Read from register and start execution.
Cycle 2: Write to register and set flags.

6. Operand Store:
Cycle 1: Check the results and write to memory.
Cycle 2: Write to cache.

Consider a sequence of instructions as shown below:

```
LDL     RR0,@RR2
ADDL    RR0,FP[INDEXB]
SUBL    RR0,FP[INDEXC]
CPL     RR0,FP[INDEXD]
JR      RR0,FP[INDEXD]
LDL     FP[INDEXD],RR1
```

Assuming instructions and operands are in cache, figure A shows the flow of instructions in several stages of the pipeline.

The result is faster throughput in the microprocessor than if the instructions were executed sequentially.

	0	1	2	3	4	5	6	7	8	9	10	11
O.W.												LD
EXE.						LD	ADD	SUB	CP	JR	LD	
O.F.					LD	ADD	SUB	CP	JR	LD		
A.C.				LD	ADD	SUB	CP	JR	LD			
I.D.			LD	ADD	SUB	CP	JR	LD				
I.F.		LD	ADD	SUB	CP	JR	LD					

Time →

Figure A: *Instruction flow in the* Z80000 *pipeline.*

COPROCESSORS

Many microcomputers have multiprocessing in the form of specialized slave processors, or coprocessors. These coprocessors, such as floating-point processors or string comparators, help speed execution time by handling certain complex instructions that the central microprocessor can't handle or can't handle well. Most microcomputer coprocessors, however, don't operate simultaneously with the central microprocessor, so calling the arrangement multiprocessing may be stretching things. Steve Ciarcia's Trump Card is an example of a processor that makes the IBM PC's microprocessor into a slave I/O (input/output) processor (see "Trump Card, Part I: Hardware," May 1984 BYTE, page 40, and "Trump Card, Part II: Software," June 1984 BYTE, page 115).

ARRAY PROCESSORS

Array processing takes place when a collection of processors performs the same instruction simultaneously on an array of data. Sometimes the processors themselves are arranged in an array, but sometimes they are pipeline processors.

PARALLEL PROCESSORS

Parallel processors are collections of independent processors that work together. They can run different but related programs. There are several types of parallel processors (Charles

(continued)

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THOUGHTS ON PARALLEL PROCESSING

BY VIPIN KUMAR

Parallel processing is important for several reasons. There is an insatiable demand for faster and cheaper computers. Sequential computers have been becoming faster due to the advances in hardware technology, but there are indications that limits imposed by solid-state physics may soon come in the way, and the only way out might be parallel processing. With the emergence of VLSI (very large scale integration) technology, it is becoming easier and cheaper to construct large parallel-processing systems as long as they are made of fairly regular patterns of simple processing elements, and thus parallel processors should become cost-effective. Many applications have real-time constraints, e.g., real-time speech understanding, warning systems, navigation, etc. For these tasks, high-speed requirements should be met at any cost. A warning system would not be of much use, for example, if it warned of a nuclear attack after the missiles had exploded.

Parallel processing may be especially necessary for artificial intelligence (AI). Very little success has been achieved in AI in representing and using large bodies of knowledge and in dealing with recognition problems. The human brain can perform these tasks remarkably well using a large number of slow neurons in parallel. This suggests that conventional architectures may be ill suited for these tasks and some kind of parallel architecture may be needed. You could argue that the conventional architectures are theoretically as powerful as any parallel machine (i.e., any task that can be done by a parallel machine can also be done by a conventional machine, although slowly). But architectures can significantly influence the way we program them, and perhaps if we had the right kind of architecture, programming it for perception and knowledge representation would be easy and natural.

In the last several decades many parallel variations of the von Neumann architecture have been developed. The idea behind them has been to take several processing units and memory modules and connect them in some network configuration. One prominent example of such systems is C.mmp, a multiprocessor system developed at Carnegie-Mellon University. C.mmp consists of 16 processors connected to 16 memory modules via a crossbar switch. The crossbar switch permits communication between any memory modules and any processor. The existence of common memory permits close coupling between processors and thus reduces communication costs. But the complexity of the crossbar switch grows quite rapidly with the number of processors and memory modules involved, making it difficult to build these systems for more than 20 or 30 processors. In some systems each processor is allowed to have private memory, and these processor/memory pairs are connected to each other via a common bus. These systems are easy to build for hundreds of processors. But the processes can talk to each other only by sending messages over a common bus, which makes interprocess communication very expensive. Hence, these systems cannot effectively exploit fine-grain parallelism in an application. TRAC, the Texas Reconfigurable Array Computer, developed at the University of Texas at Austin, provides a middle ground. TRAC connects a number of processors to a number of memory elements via a Banyan network, which is far less complex than the crossbar switch but provides reduced connectivity (as compared to the crossbar switch) between processors and memory elements.

The biggest problem with all these machines is that to exploit parallelism it has to be explicitly specified, something that has turned out very hard to do in practice. Furthermore, parallelism achieved using these machines has been quite limited, rarely reported above 10. Hence it seems hopeless to believe that these machines could be used to get speedups of thousands or even hundreds. Due to limited success with these kinds of parallel processors and to some inherent problems with the traditional von Neumann model of computing, many researchers have started investigating data-driven and demand-driven architectures, as opposed to von Neumann architectures, which are control-driven.

In a data-driven (e.g., data-flow) system, an instruction can be executed as soon as the input data it requires is available. After the instruction is executed, its result is made available to the successive instructions. In a demand-driven (e.g., reduction) system, an instruction is triggered when the results it produced are demanded by other instructions. These demands cause further demands for operands unless the operands are locally available, in which case the instruction is executed and the results are sent back. The advantage of a demand-driven system over a data-driven system is that only instructions whose results are needed are executed. The disadvantage is in those computations in which every instruction always contributes to the final result; propagating demands from top to bottom is a wasted effort.

In both of these systems, as a result of data- or demand-activated instruction execution, many instructions can become available for execution at once, and it is possible to exploit all of the parallelism in the program. Furthermore, parallelism does not have to be explicitly specified; it is automatically extracted as long as the program is written in an applicative language (e.g., pure LISP). It is expected that these architectures can efficiently exploit concurrency of computation on a very large scale.

A number of such systems are being developed around the world. Most notably, the Japanese have chosen data flow as the underlying architecture for the fifth-generation machines. Dataflow and reduction architectures hold great promise, but there are some important problems to be solved before they can be used effectively to provide large-scale parallelism.

The realization that the human brain performs many difficult cognitive tasks effortlessly using neurons, which are quite slow in comparison to today's microelectronic devices, has led researchers to look into massively parallel architectures. The earliest computational models along these lines were inspired by neurophysiology. Most well known of these is "perceptron," developed by Frank Rosenblatt in the late 1950s. A pattern-recognition system that is able to learn from experience, perceptron's basic building block is an element that is intended to be a model of a neuron. The element accepts a number of inputs, takes their weighted sum, and produces an output of 0 or 1 depending on whether or not the sum exceeds a threshold value associated with the element. Inputs to the element are features extracted from the patterns to be recognized. A perceptron can be used to distinguish between two given sets of patterns, and its design involves adjusting the weights and the thresholds of its elements. Rosenblatt gave a procedure for training perceptrons, by which a perceptron can automatically adjust its weights to cause correct classification of patterns. Initial success of perceptrons started a flurry of activity in this area, but the excitement waned when the models based upon neuroscience were found to be too simple for most problems of interest. In particular, Marvin Minsky and Seymour Papert proved that perceptrons have serious limitations and can be used to recognize only very simple kinds of patterns.

NETL, developed by Scott Fahlman at Carnegie-Mellon University, represents a different approach to building a massively parallel machine. NETL represents real-world knowledge in the form of a hardware semantic network. It consists of nodes that are used to represent concepts and links that are used to represent the relationship between the concepts. Each node can store a few distinct marker bits, and a link can propagate these markers from node to node in parallel. Nodes and links are connected via a common bus to a central computer that controls the marker propagation. By moving markers from node to node in parallel, NETL can perform certain deductions and searches (e.g., property inheritance) very quickly. On a uniprocessor these operations can take a long time.

The biggest problem with NETL is its actual hardware implementation. It is easy, with the current hardware technology, to put thousands of nodes and links on a chip. But the problem is in forming connections between nodes and links as new knowledge is added. These connections must be private lines between nodes and links; otherwise, all of the parallelism will be lost. Fahlman has recently proposed a solution to this using a hashnet scheme and has sketched a design for a million-element machine.

Another problem with NETL is locality. A concept is represented by only a node, and if this node is damaged, it will be hard to reconstruct the associated information. The Boltzmann machine being developed by Geoffrey Hinton (see "Learning in Parallel Networks" by Geoffrey E. Hinton, April BYTE, page 265) and many other researchers attempts to solve this problem. In the Boltzmann machine, a concept is represented by a pattern of activity in a large number of units. Each unit is a probabilistic processing element. The failure of a unit has little effect because each piece of information is distributed throughout the network of units. Preliminary simulation results of the Boltzmann architecture are encouraging, but there is a lot to learn about its limits and capabilities.

We've looked at only a few of the dozens of parallel architectures that various researchers have proposed. Many of them are being tested via simulation or actual implementations. Most of the work is primarily exploratory in nature and is meant to find out which architectures might be suited for which problems. Parallelism holds great promise for AI not only in terms of cheaper and faster computers but also as a novel way of viewing computation. "What form will it take?" is a question that can be answered only with time.

Babbage's contemporaries talked about making one in 1842 out of several of his Analytical Engines), but we'll discuss only data-flow machines. (See the "Thoughts on Parallel Processing" text box for a discussion of other kinds of parallel processors.)

Traditional methods of processing execute a program by calling the instructions one by one with a program counter. The instructions then call the data they need from memory. But data flow has the data calling for instructions when the data needs them.

Figure 1 is a block diagram of the Manchester University data-flow architecture. The "data packet" you see in the diagram contains a data value and a control field. (The control field, or message, tells the computer which instruction is to act upon the data.) This data packet is matched—by the packet matcher, of course—with another data packet that has the same control field. These two packets become one "data-data" packet (which sounds like something from a 1950s rock-and-roll song). The new packet goes to the instruction fetcher, which retrieves the instruction that the packet needs by using the address supplied in the control field. We now have a "data-data-instruction" packet. But that's not all. The fetcher's last duty is to check its data-flow graph to see to which new operation the result of the current operation should go. This address is added to the packet, and away it goes to the processing units, where the packet is assigned to a free processor. The processor produces a result packet, which is just a data packet. The new data packet goes to the packet matcher to start the process all over again.

In this system, many processors are working at the same time, and many packets are circulating through the system. There is no need in this arrangement to worry about one processor communicating with another, so high task-execution speeds should be possible.

Notice that there is no program counter here, as in a von Neumann computer. Instructions are not called

(continued)

first and data next. Just the opposite happens.

The advantage of working this way is that we can more easily see the data dependencies between processes, so it is easier to program parallel routines. Figure 2 shows a data-flow graph of the simple calculations

A = B + C − F
D = B * C − F
E = A − D

In the data-flow graph, we show the input data (the data with no dependencies on other data) first, as many times as necessary, depending on how many different operations require the data. Then they are combined as the calculations specify, and the new values, which are dependent on the original values, are combined again until all data items are combined.

With this kind of system, the dependencies of one value on another are obvious, and the parallelisms stand out. Of course, the drawback here is that the data values have to be repeated several times in data-packet memory, each time with a different control field. For instance, there are two B data packets, but one specifies a multiplication operation and the other specifies an addition operation.

Figure 3 shows how these calculations might be first specified on an ordinary computer. Here, we start simply with the first calculation rather than with all the initial data. Instructions call data rather than the other way around, so data need only be

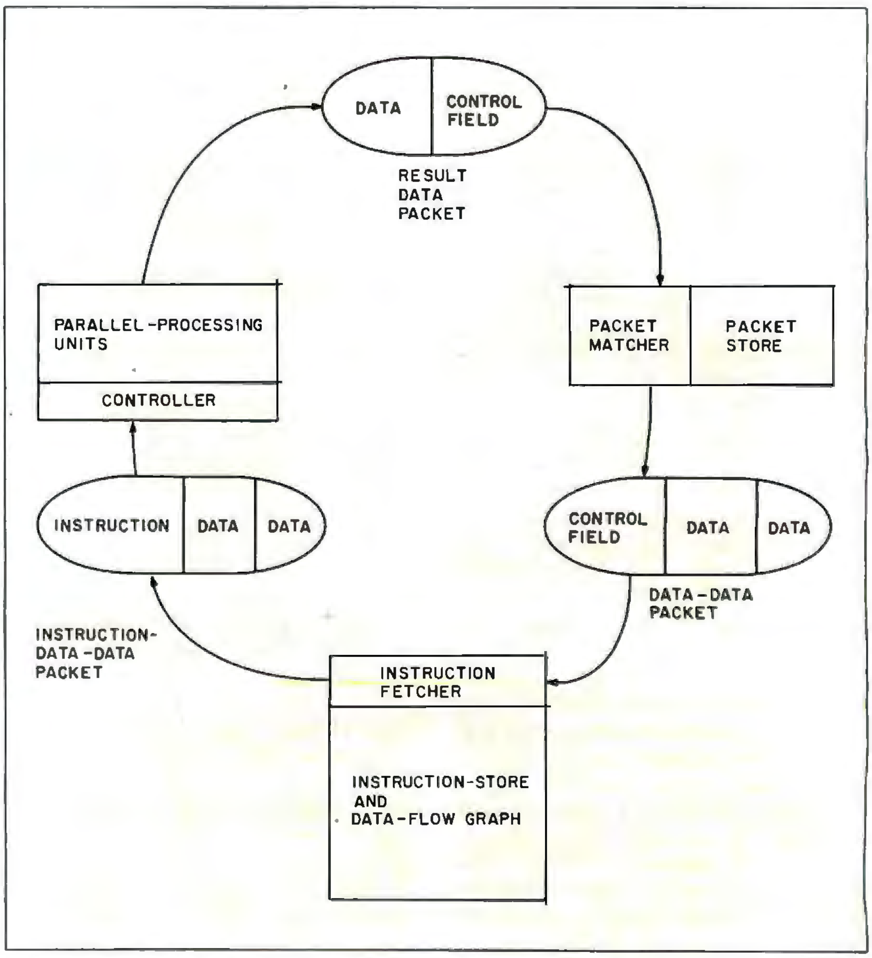

Figure 1: *The Manchester data-flow architecture. How packets are allocated to processors is not shown.*

listed once in memory and called as needed. But the data dependencies are not obvious, and finding ways to execute instructions concurrently becomes more difficult. It can be done, but perhaps not as well.

COMMUNICATION METHODS

Another classification of multiprocessors is their communication method. This is a crucial issue in multiprocessors because as the number of processors increases, so does the communication problem.

We will examine three communication methods: bus, circuit switch, and packet switch.

BUS

Figure 4 shows a bus-connected parallel processor. In the diagram, all communications are broadcast on the bus. Unfortunately, with a large number of processors, even high-speed buses can't handle all of the communications traffic.

Because all communications between processors are handled sequentially on the bus, it becomes a bottleneck as the number of processors grows, since only one transfer of information can occur at any one time. The answer is to have several buses or another communication technique.

CIRCUIT SWITCH

Circuit switching is the direct connection of one processor to any other processor through a switch (see the "Crossbar Circuit Switch" text box on page 180 for a discussion of a type of circuit switch). Your phone company's central office uses a circuit switcher to switch your calls.

This method has problems at high volume and high speeds. In a parallel processor, with perhaps millions of processors, a single circuit switcher would be hard-pressed to keep up. Perhaps the answer will be to use several switchers.

PACKET SWITCH

In a packet-switched system of parallel processors, the processors not only process their own programs but relay programs and data to other processors. Figure 5 shows a system like this. There are two kinds of packets in this system: instruction and data packets. A packet consists of an address, its contents, and a checksum or some other error-checking mechanism.

The instruction packets are addressed to specific processors if there is a central controller processor to keep track of processor usage. If the packet is unaddressed, it is taken up by the first available processor that receives it. Data packets may be addressed to specific processors or to the processes, depending on how processes are assigned to processors. When a process or processor receives a packet, it must tell the sender that the message was properly received. This requirement doubles the traffic that the system must handle.

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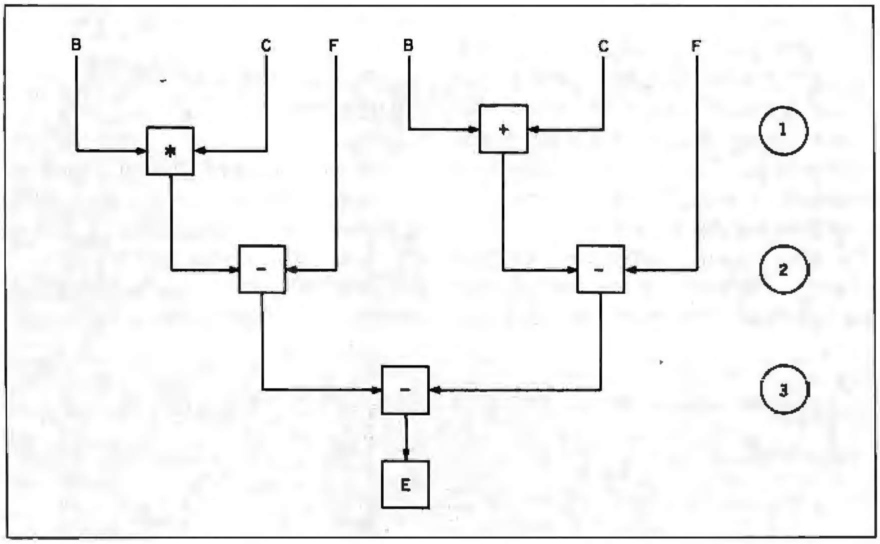

Figure 2: *The data-flow graph. Notice the duplication of input data.*

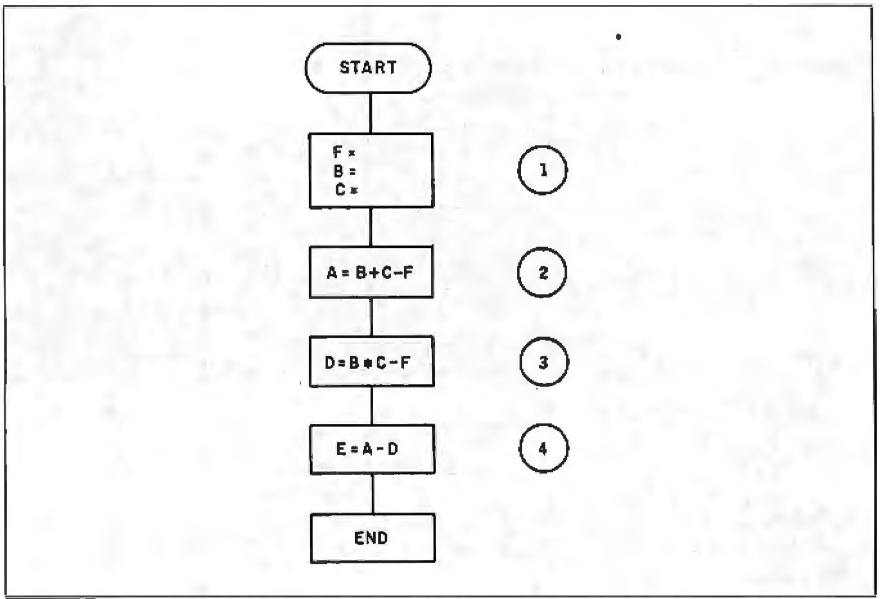

Figure 3: *An ordinary flow chart. Notice that, without the parallelism of data flow, the number of execution steps is greater.*

In the figure, processors are connected to their nearest neighbors in three dimensions, for a total of six connections. How much of a processor's time is devoted to relaying information? It has to be enormous, when you realize that the processor is not only receiving and transmitting but checking the address of the packet to see if it should be acted on rather than retransmitted. And which direction should the processor send the packet, if it should be sent? If the addresses are to a specific processor, then the direction can be computed. But if the address is to a process on some unknown processor, the direction must be random. It's conceivable that a packet can wander forever in a network, looking for its process.

Communications will of course be a large problem in large parallel processors. I believe bus technology will be ruled out; how is a single bus going to carry the load of a million processors when the communications must be sequential? There will be a lot of idle processors in a system like that. And what kind of circuit switcher will be able to handle the millions of processor connections at once? Moreover, if processors are really independent of processes, how will a packet-switched message quickly find its target process in a vast net of processors? I can imagine the packet playing hide-and-seek with its target process forever.

Data and Instruction Streams

Classes of processors arranged according to "streams" follow a convention called Flynn's taxonomy, where a stream is a flow of either instructions or data. This taxonomy consists of SISD, SIMD, MISD, and MIMD. SISD stands for single-instruction, single-data stream computer, which is a von Neumann machine. SIMD stands for single-instruction, multiple-data stream, which is an array processor. MISD stands for multiple-instruction, single-data stream, which is a pipelined processor. MIMD stands for multiple-instruction, multiple-data stream, which is a parallel processor.

Some people prefer a convention called Shore's taxonomy because it subdivides the Flynn's array processor class.

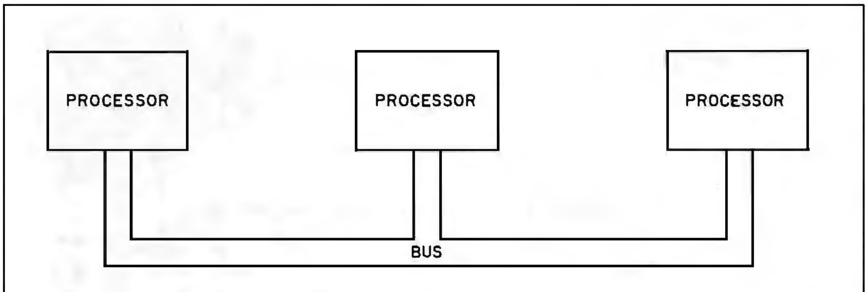

Figure 4: *A bus-connected parallel processor.*

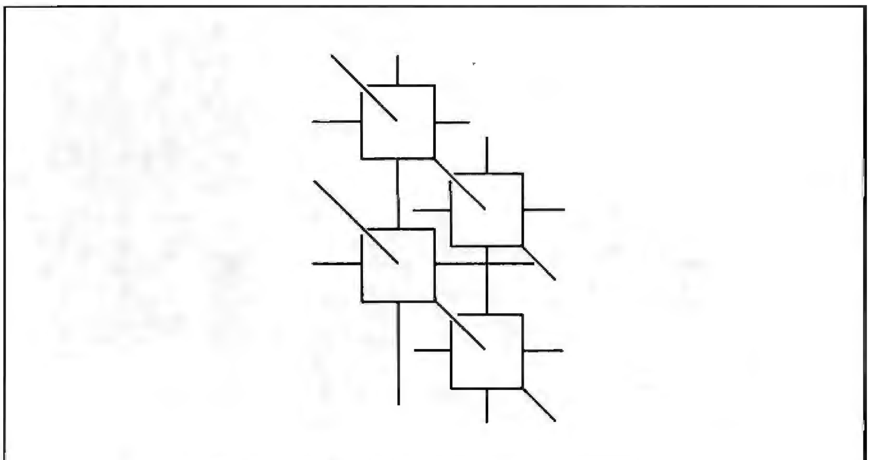

Figure 5: *A section of a packet-switched parallel processor. Packets of instructions and data are passed from one processor to the next.*

Software

The real problem in parallel processing is not the hardware but the software. The problem in software, to my mind, will not be partitioning applications programs into independent modules but scheduling those modules onto available processors and providing communication between the modules. These tasks are part of the job of an operating system, which is responsible for managing the resources of the computer.

The software problem raises a sticky point in the whole philosophy of multiprocessing. From the beginning in multiprocessing, the driving motivation has been that if one processor can do a certain amount of work, then two can do twice as much, and so on. The situation is analogous to building a house. If you were to build a house by yourself in one year, then the job should take two people half a year and three people one-third of a year. And every so often you hear about a team of hundreds putting up a house in an afternoon. Multiplicity of effort is the idea behind some of civilization's great achievements. So, the reasoning goes, why not require computers and microprocessors to work in similar harmony?

Unfortunately, as the software shows, there's a problem with this idea. First of all, more doesn't always mean better. Just as too much medicine can harm you, so can too many processors actually slow down the processing of information. Communication between processors can become a bottleneck, as can all of the

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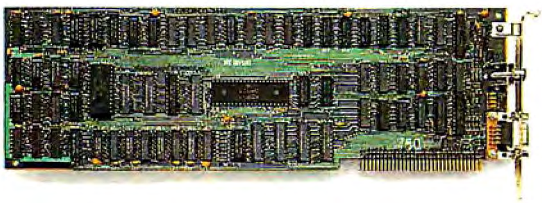

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CROSSBAR CIRCUIT SWITCH

BY HOWARD W. JOHNSON

The interconnection problem, in one form or another, is a vital part of every parallel-processing design. It is not enough to postulate the existence of "*n* processors" and explain how they will divide up the work on some task. The actual interconnection scheme used must also be carefully laid out. The failure of most parallel-processing algorithms to scale well up to implementations involving more than a few processors is usually attributed to a glut of communications overhead. That is another way of saying that the interconnection scheme did not work as planned.

SPATIAL SOLUTIONS TO INTERCONNECTION

Historically, the "*n* by *n* Space Switch" was the first solution to the interconnection problem. This solution was used for decades, in many forms, in the telephone industry to interconnect callers. Because this method is closely related to the "crossbar switch," we will discuss them both. Neither is used in large data-switching installations because the complexity of such an implementation grows as the square of the number of devices interconnected. For instance, doubling the number of devices served would necessitate quadrupling the total hardware involved in the interconnection process, as we will see later.

The basic tenet of the *n* by *n* space switch method is that if you could run a separate wire from each source to every destination and then somehow switch on only the wires corresponding to the connection pattern desired at a given point in time, the problem would be solved.

Here are three equivalent forms of this basic idea:

1. There is a separate wire leading from each source to every sink. Each source continuously transmits all of its data onto all wires leading from that source. At each sink, there is a large switch to select only the wire leading to the desired source.
2. There is a separate wire leading from each source to every sink. At each data source, place a large switch, which will send the output of that data source onto one and only one of the wires leading from that source. At every sink, tie together all of the wires leading to that sink in a wired-OR fashion. This solution is the opposite of the first solution.
3. Start with a regular square grid of *n* wires running horizontally and *n* wires running vertically (see figure B). At each juncture, place a switch that can either be open or closed. Start out with all the switches open. Next, permanently connect the first source to the first horizontal wire, the second source to the second wire, and so forth, until all the sources have been connected. Then connect the sinks one at a time to vertical wires, starting with the first sink on the left-hand side and working to the right. This arrangement has traditionally been called the *n* by *n* space switch. Closing the switch at the juncture of the first column and first row will connect source 1 to sink 1.

All three methods accomplish virtually the same thing. One exception worth noting is that in methods 1 and 3 one source may be broadcast to several sinks, while in method 2 this is impossible unless the switch is designed to permit multiple simultaneous closures. I have seen many small computer installations that successfully use either method 1 or method 2 for interconnecting terminals to a limited variety of computers.

In all methods, the number of switching junctures required is proportional to the number of sinks times the number of sources. Therefore, for large problems it is generally not acceptable.

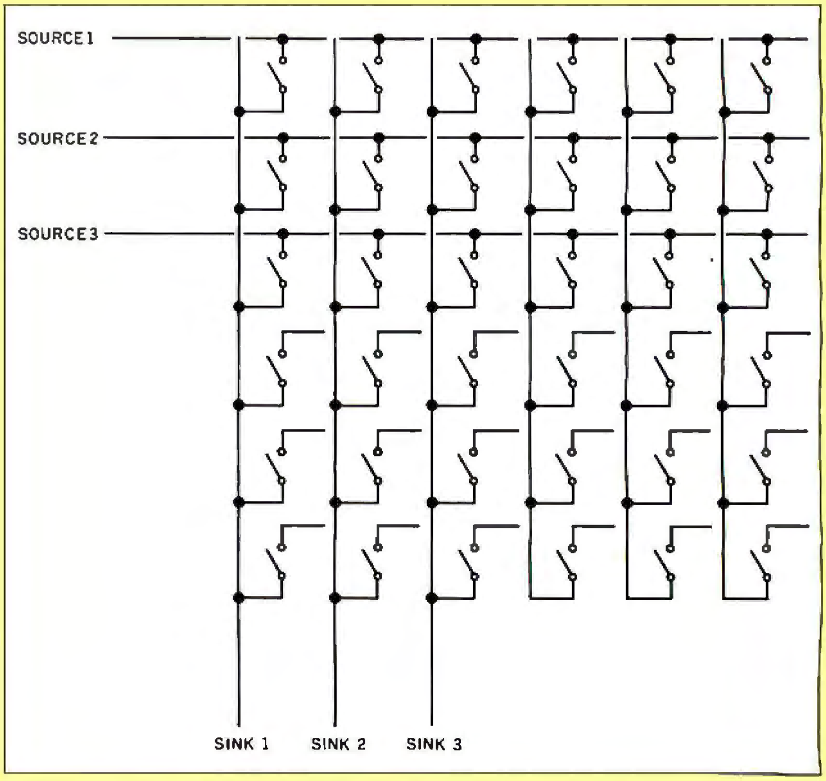

Figure B: *Part of an n by n space switch. This architecture can connect any pattern of input to outputs.*

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other resource-allocating tasks of the operating system.

HARDWARE PROBLEMS

In large memory banks, the failure of a single bit in the memory can be detected easily. However, how easy will it be to detect a malfunctioning processor in a bank of a million parallel processors? This disadvantage of multiprocessing hasn't been fully addressed yet because computers of sufficient complexity haven't been built yet. The operating system of the parallel processing computer, if you can call many independent simultaneously operating programs a single operating system, will have to be able to tell if its neighbors are acting all right. This, of course, adds overhead that takes away from the applications program.

CONTROVERSIES

How do you measure the increase in speed of the multiprocessor? A computer with 10 processsors may execute 10 times as many instructions as a computer with a single processor. But if 50 percent of those instructions are overhead—housekeeping and communications instructions—the real increase is less than 10 times.

There is also controversy over how to justify the design of multiprocessors. If, for instance, a new and faster design requires difficult and slower programming time, is the efficiency in execution outweighed by the higher cost in programming? Interested parties such as the military are willing to pay the cost of programming because the goal is worth the additional cost.

CONCLUSION

There's not much use for a million-processor computer in running the kind of programs we microcomputer users are most familiar with. After all, how many processors do you need to move a paragraph? But if the million processors edit the paragraph as well as move it, then what you have is not a faster way to do old things but a new way to do new things. And that is the promise of multiprocessing, if only we should live so long. ■

For instance, a 200 by 200 processor array would require, for full flexibility, 40,000 individual switches, or 200 switch boxes with 200 switch settings each.

The network can be pared down somewhat to limit its complexity, but at the expense of a loss in generality. A direct method is to assess which sources might ever need to be connected to which sinks and wire only those data paths that might ever be used. The problem with this approach is that one never knows with certainty how a particular network will be used, so it is difficult to predict which connections to eliminate.

In the crossbar method, it is assumed that although there are n sources and n sinks, only t percentage of them will be active at any given moment. This is the same sort of traffic-limiting assumption used in local-area network design. The crossbar method uses a cascade of two space switches to achieve any interconnection pattern involving less than $n * n$ total connections. The first space switch connects the n sources onto a total of $n * t$ intermediate wires. The intermediate wires are then run into a second space switch, which can connect its $n * t$ inputs to any of the n sinks. As long as there is an intermediate wire available, the first section can switch a source on to it and the second section will forward that data on to the appropriate sink. The total interconnection hardware is proportional to the sum of the two sections. The first section has n inputs and $n * t$ outputs, and the second has $n * t$ inputs and n outputs, making a total of $2 * n * n * t$ switches. This may be compared to the $n * n$ switches required for a one-stage design. If t is less than $\frac{1}{2}$, then the crossbar design is preferable. In office telephone applications, t is on the order of $\frac{1}{6}$, so c oss-bar switches were used successfully for many years. Space switches may be used in small parallel processors, but as the number of processors increases, so must the complexity of the switching network, until it becomes impractical to build such a large space switch.


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EXTENDING MICROPROCESSOR ARCHITECTURES

BY GARY D. BEALS

Extended-processing units can significantly broaden a microprocessor's instruction set

BECAUSE MOST microprocessors are designed to meet the widest possible range of applications, they use a very general purpose set of instructions. Unfortunately, microprocessors are also limited by the size of the silicon wafer used to make them. Every instruction takes up "silicon real estate" on the chip and must be justified. Much time and effort goes into selecting the best possible instruction set that uses the least amount of silicon.

Additional instructions are expensive in terms of the space used to implement them because the cost of building the central processing unit (CPU) is directly linked to the size of the chip. The more CPU chips on a single silicon wafer, the cheaper CPUs will be to manufacture.

In order to avoid limiting the instruction set and still conserve silicon, many of the more advanced microprocessor designs incorporate custom instructions that the user can modify.

Most coprocessors were designed to extend the processor instruction set by using a separate chip, or extended-processing unit (EPU). The CPU uses its custom instructions to pass information to and from the EPU as if it existed on the same chip. This means that if specialized instructions are not implemented on the CPU but are required in a design, an EPU can be built to execute those instructions. A good example is floating-point mathematics instructions, which are not required by all microprocessor designs but are critical for some. Floating-point instructions also tend to be very costly in terms of silicon space.

Intel, Motorola, National Semiconductor, and Zilog have implemented extended-processing architectures (EPAs) on their more advanced CPU chips. The devices used to extend the CPU are called coprocessors, slave processors, and sometimes numeric data processors. I will refer to them as EPUs.

I will focus on four different extended-processing architectures and discuss their similarities and differences.

INSTRUCTION TEMPLATES

All of the extended-processing architectures in this article use an instruction "template" to implement custom instructions. This is usually a set of reserved op codes identified by the CPU as a particular bit pattern at a particular location. In the example in figure 1, an F-line code, or a word that begins with all 1s in the most significant bits, is used to decode a template instruction.

The CPU recognizes four 1s in bits 15 though 12 as an EPU instruction and allows the user to use the remaining bits for custom instructions. Of course, the extended-processing architecture for each manufacturer specifies how the rest of the bits should be structured. In some architectures, this includes specifying an ID code to identify which specific EPU should decode the template. This allows for multiple EPUs. In figure 1, the 3-bit ID field allows up to eight separate EPUs.

Once a template instruction has been detected by the CPU, it must be detected and decoded by the specif-

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Gary D. Beals is a senior field applications engineer at Zilog Inc. (Suite 23, 2885 Aurora Ave., Boulder, CO 80303).

ically identified EPU. The most popular method is to have the EPU directly connected to the address and data bus of the CPU and watch for the template itself. The EPU takes advantage of whatever status information and timing signals the CPU has to offer to allow the EPU to detect the template op code at the proper time. This tightly coupled system requires little or no extra decoding logic. The EPU performs all the decoding.

Another method produces a particular status code when a template instruction is executed and uses external hardware to decode a separate EPU address space. This requires additional hardware but does not require the EPU to do the decoding. Either way, the template instruction is decoded as an EPU instruction and the information is passed to or from the EPU.

The actual information transfer differs from one architecture to another, but it generally takes one of two forms. In the first, the CPU provides all the addressing and the EPU takes the data and manipulates it in an appropriate manner. In the second, the EPU gets an address from the CPU, then takes control of the CPU bus and directly accesses memory.

All of the architectures support the first method, some better than others. The second method, direct memory access (DMA), is supported by the CPU itself and is not generally included in an extended-processing architecture. DMA transfers can be useful for some applications but cause the CPU to lose control of the bus. This is contrary to the architecture-extension idea and can cause some problems.

In short, all of the CPUs mentioned here support DMA transfers, although DMA transfers may not be part of a particular CPU extended-processing architecture.

SOFTWARE EMULATION

Another requirement for an extended-processing architecture is the ability to emulate the EPU in software if the hardware chip is not present in the CPU.

The EPU trap is a bit in a CPU control register that is set if the EPU chip hardware is in the system or reset if it is not. Any time the CPU uses an extended instruction when the bit is reset, a software trap is activated. This means that the CPU will jump to a specific address where software routines are located that will emulate the EPU instructions.

The hardware and software are interchangeable, so they can be used to debug each other in the initial design or replace each other in the final system, depending on the requirements.

If there is no provision for a software trap, the designer must know before code is compiled or assembled if an EPU is not in the system. A jump instruction replaces each EPU instruction, and the software routines are placed at the end of the jump. If this is not done, the EPU instructions become NOPs, or no-operations, and do not execute.

CONCURRENT OPERATION

There are a couple of buzzwords associated with EPUs. They are nonconcurrent, or synchronous, mode, and concurrent, or asynchronous, mode of operation in an EPU.

Nonconcurrent mode means that the CPU will always wait for the EPU before it begins another instruction. This could also be called serial execution. Concurrent mode, or parallel execution, means that the CPU and EPU can be processing simultaneously. This has an obvious performance advantage over nonconcurrent mode. However, if the CPU modifies memory before the EPU has a chance to read it, or if the EPU modifies memory without informing the CPU, synchronization problems can occur. If the CPU is always in control of the bus, this does not happen. However, if the EPU requires DMA in order to modify memory, provisions must be made to synchronize the EPU and CPU or pre-

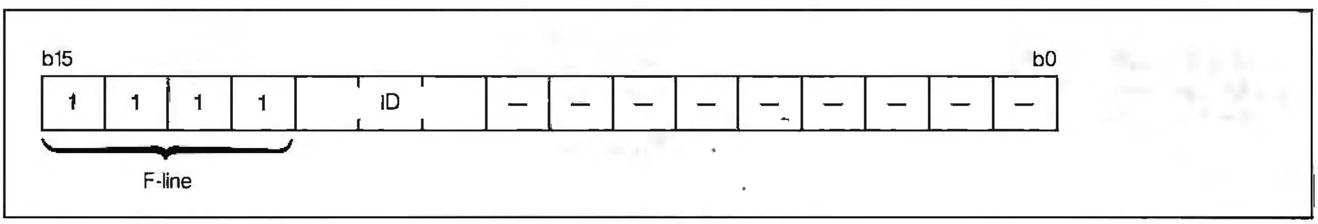

Figure 1: *A sample template for an* EPU *instruction. The* CPU *will recognize the pattern of four* 1s *in the high bits as an indicator of an* EPU *instruction (called an "*F-line*" since a binary* 1111 *equals* F *in base* 16*). The* ID *field can be used to select among eight* EPUs*, and the remaining bits are available to the* EPU *designer for custom instructions.*

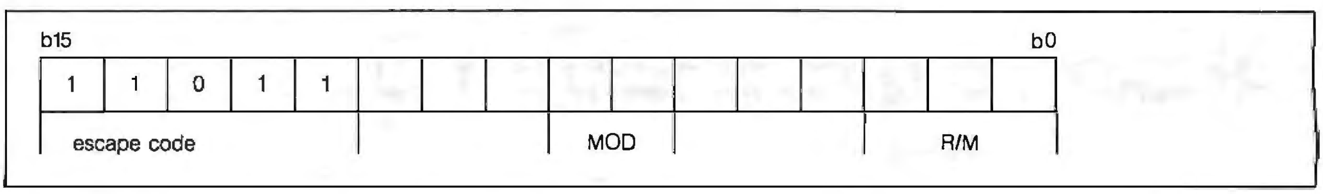

Figure 2: *The format of an* Intel 8086/8088 EPU *instruction.*

vent one or the other from using invalid data. Forcing temporary nonconcurrent operation in software is one way of solving the problem.

As mentioned, by not allowing DMA in concurrent mode, synchronization problems are avoided. Another requirement for concurrent mode is a method of determining if the EPU has finished execution. This is done with either a hardware EPUBUSY line or a software register. If a register is used, some precautions in software must be followed to prevent problems.

The following sections give more detailed information on each manufacturer's extended-processing architecture. They are listed in the order in which they were first implemented on a chip.

INTEL 8086 COPROCESSOR INTERFACE

The Intel 8086 Coprocessor Interface is implemented in the 8086/8088 and 80186/80188 microprocessors, although there are slight hardware differences between the implementations. The two coprocessors designed for this interface are the 8087 numeric data coprocessor and the 8089 I/O processor. The 80286 has its own coprocessor interface and a numeric data coprocessor, the 80287, designed for it.

In the Intel system, the EPU is tied directly to the address/data bus, the CPU status lines, and the queue status lines. It uses the same clock as the CPU and also sends busy and interrupt signals to the CPU. Because the 8086 has an internal instruction queue, the EPU must use the CPU and queue status lines to track this queue internally in order to decode an EPU instruction.

The 8086 has two prioritized lines, rq/gt0 and rq/gt1, called request/grant lines. These allow two EPUs to request the CPU address/data bus. (The number is not limited to two, but additional hardware is needed to resolve EPU priority.) The 8087 and 8089 have a daisy-chain priority scheme that allows them to pass bus control to an EPU tied to their request/grant (rq/gt1) line.

Table 1: *An example of synchronization using* 8087 *instructions.*

	Unsynchronized	Synchronized
case 1	FISP I	FISTP I
	MOV AX,I	FWAIT
		MOV AX,I
case 2	FILD I	FILD I
	MOV I,5	FWAIT
		MOV I,5

To execute an EPU instruction, the architecture uses an escape code, 11011, in the most significant bits of the instruction. The format for the instruction is shown in figure 2. There are 64 memory-reference op codes and 512 nonmemory-reference op codes available. The 8087 uses 57 of the memory-reference and 406 of the nonmemory-reference op codes. If there is a requirement for both a custom EPU and an 8087, the designer should not use any of the 8087 op codes for the custom device.

The escape code identifies the escape (ESC) instruction, and the MOD and R/M bits determine the addressing mode used by the 8086. The rest of the bits are available for EPU instructions.

If the EPU only needs to read memory values of 16 bits or less, the host CPU performs all of the necessary addressing. The EPU simply latches the data value as it appears on the bus during the CPU-generated memory read cycle.

To write to memory or read values of data greater than 16 bits, the EPU must latch the 20-bit address placed on the address/data bus during the T1 clock cycle. It then becomes bus master through the request/grant line and operates as a DMA device, accessing the memory on its own.

Because the CPU and EPU can operate concurrently, when the EPU uses direct memory access there is a synchronization problem. In other words, the EPU can modify memory without informing the CPU. This means that, with some instructions, the CPU must wait to be sure that the EPU is finished and that the final value has been transferred to or from memory.

The reverse is also true if the CPU is loading a value into the EPU that is larger than 16 bits. The CPU could modify memory before the EPU had a chance to read it. To prevent this, the WAIT instruction is used. WAIT causes the CPU to monitor the EPU Busy line and will not allow the CPU to continue until the EPU is finished processing and accessing memory.

Intel's numeric data processor application note (reference 1) gives several examples of how to avoid synchronization problems. Synchronization can be done explicitly by the programmer, or the compiler can be written to add necessary code automatically. In the latter case, WAIT instructions are automatically inserted after every ESC instruction.

Table 1 is an example of synchronization using 8087 instructions. In the unsynchronized case 1, the CPU might move the value of I before the EPU could modify it. The FWAIT instruction forces the CPU to wait until the EPU is done with the value I. In case 2, the CPU could replace the value of I with 5 before the EPU could read the original value.

One more problem in the 8086 associated with synchronization is known as deadlock. This occurs when the CPU is executing a WAIT instruction and the interrupt path from the CPU to the 8087 is broken. If the 8087 needs to interrupt the CPU for the current instruction, it cannot, and both the CPU and the 8087 sit and wait for each other. Intel's application note on the numeric data processor details ways to avoid deadlock.

There are some special control in-

(continued)

The CPU *performs all transfers to and from the* EPU.

structions in the 8087 that do not require synchronization. The 8087 takes exclusive control of the memory bus and prevents the host CPU from interfering with the data values. These instructions do not require a WAIT instruction and cannot cause a deadlock.

The Intel implementation of concurrent processing has some drawbacks, but they can generally be taken care of by the compiler or assembler. The user can either implement concurrency for improved performance or remove it by adding a WAIT after every EPU instruction. Concurrency's major advantage is its inherent performance improvement when both the CPU and the EPU operate in parallel.

If there is no EPU in the system, the host will execute an ESC instruction as if it were an NOP. Although an address is output, the data returned is ignored. This ensures that the CPU will continue to execute the program if the EPU is not there. It also means that the EPU instructions will be ignored.

Because there is no trap mechanism in the EPU architecture for the 8086/8088 and 80186/80188, a decision must be made at compile or assembly time whether to use a hardware EPU or to emulate the function in software. Emulation software for the 8087 is available from Intel. The 80286 does implement an EPU software trap.

ZILOG EXTENDED-PROCESSING ARCHITECTURE

The Zilog extended-processing architecture is supported on the Z8000, the Z800, and the Z80000 CPUs. Zilog has implemented an extended-processing architecture with templates for the custom instructions and a software trap available in case the EPU hardware is not in the system. The first Zilog EPU is the Z8070 arithmetic processing unit (APU).

The Zilog architecture does not consider memory management an EPU function. The Z8000 implemented memory management is in a separate privileged I/O space, and the Z800 and Z80000 have memory management on chip. Some of the memory-management provisions and exception handling of other architectures are therefore not required.

The general instruction template format is illustrated in figure 3. The first word of the instruction contains a code that identifies it as an EPU instruction and mode information about the data-transfer direction. It also has a 2-bit field defining which of four EPUs will decode the instruction. The blank areas in the template are available for custom EPU instructions. The $n-1$ value means that up to $16n$ words or bytes of data will be transferred. The transfers can take advantage of the 32-bit bus of the Z80000 by transferring two 16-bit words at a time.

Templates include EPU to memory, memory to EPU, EPU to CPU, CPU to EPU, FCW (flag and control word) to EPU, FCW from EPU, and EPU internal operation.

The templates include all of the transfers shown above. This allows the designer to implement memory transfers, EPU to CPU communications, flag test and branch instructions, and internal EPU calculations. Figure 4 shows some sample Z8070 APU instructions. Note that they follow the templates exactly and that only the blank area of the template is used specifically for the custom instruction.

The EPU operates by sitting on the address/data bus and watching the instruction stream. When it sees a bit pattern that it recognizes as an EPU instruction, it will decode it and act accordingly. The EPU uses the CPU status lines in order to determine when to look for its instruction templates.

To allow concurrent operation, the EPU does not do any addressing or data passing on its own. The CPU is in control of the bus and provides all of the address information to the memory and EPU. This means that within this extended-processing architecture, the EPU cannot operate on its own. It also means that the CPU can respond to interrupts and bus requests and continue to execute other instructions while the EPU is operating on the data. As long as the CPU does not request data from the EPU before it is ready, the CPU continues to operate normally.

If the CPU tries to use an EPU that is busy, in most cases the EPU will respond by temporarily halting the CPU until it finishes its current tasks. This is taken care of by a line coming from the EPU called EPUBUSY. On the Z8000, the CPU STOP pin is connected to EPUBUSY, and the processor can continue only when the EPU comes free or a CPU reset occurs. The Z800 has a PAUSE pin that should be connected to EPUBUSY. A PAUSEd Z800 can continue to respond to refresh requests, bus requests, and CPU resets.

The Z80000 CPU samples the EPUBUSY line, and although it cannot execute instructions, it can accept bus requests and interrupts. If an interrupt or bus request occurs, the CPU saves the address of the extended instruction. The Z80000 also has an EPU Overlap Mode Bit, which can be set or reset by software to enable or disable concurrent operation. This is useful for debugging.

Because the CPU performs all transfers to and from the EPU, all transactions are done at the maximum CPU memory bus speeds. The EPU can also take advantage of any special transfer modes in the CPU, such as "burst mode." Burst mode means that if a single burst memory location is addressed, several data transfers can be made from consecutive addresses. For example, the CPU could send one address to the memory, and the memory would transfer back several consecutive words of data, as opposed to one word of data, for each address. This requires added intelligence in the memory and is taken advantage of by the Z80000 and Z800.

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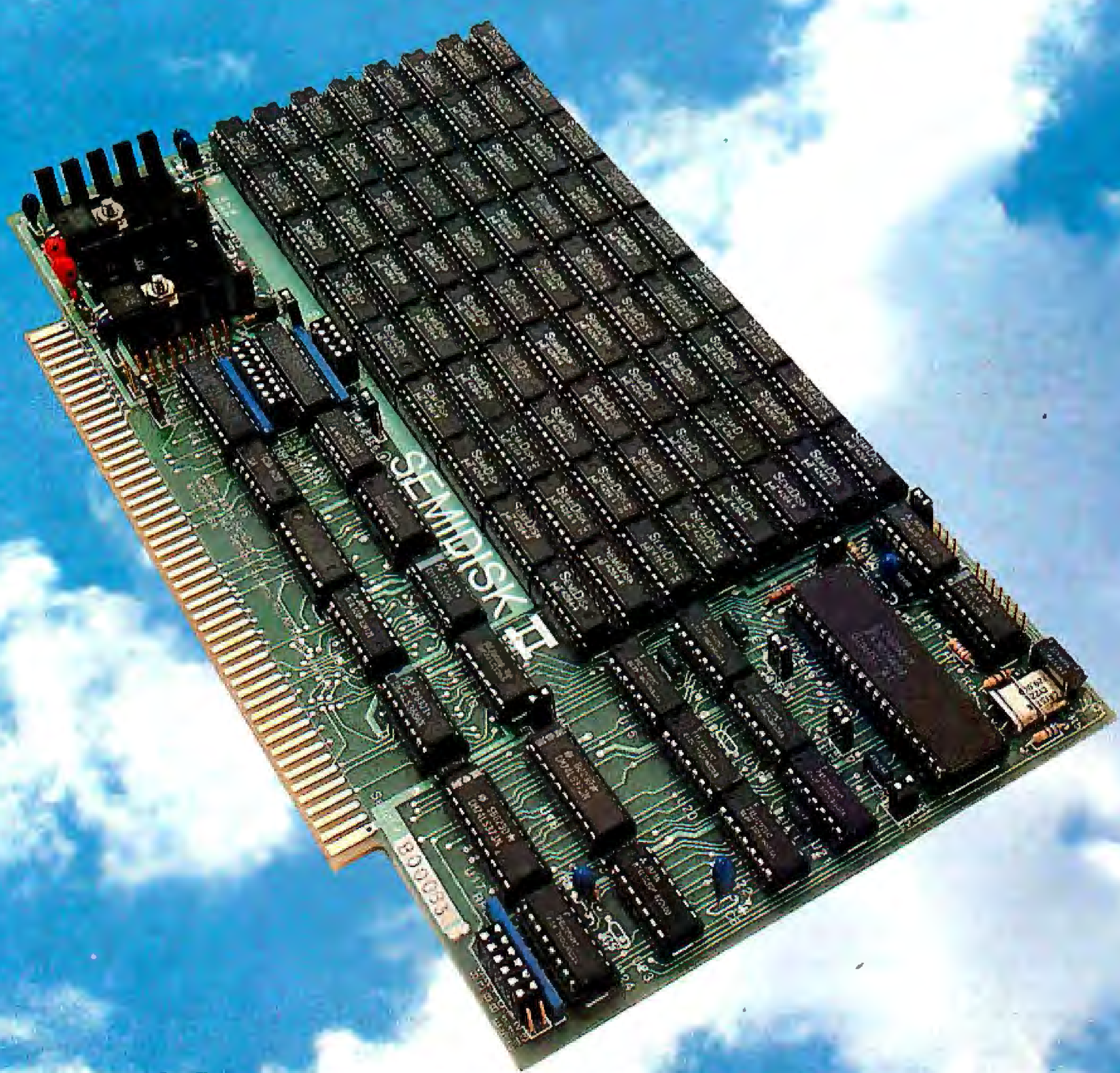

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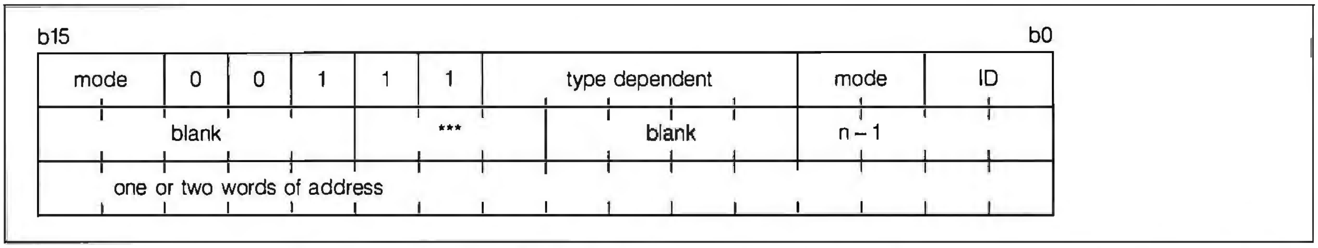

Figure 3: *The format of a Zilog EPU instruction. ID selects among four EPUs. n–1 specifies number of words or bytes loaded, and *** contains source or destination information.*

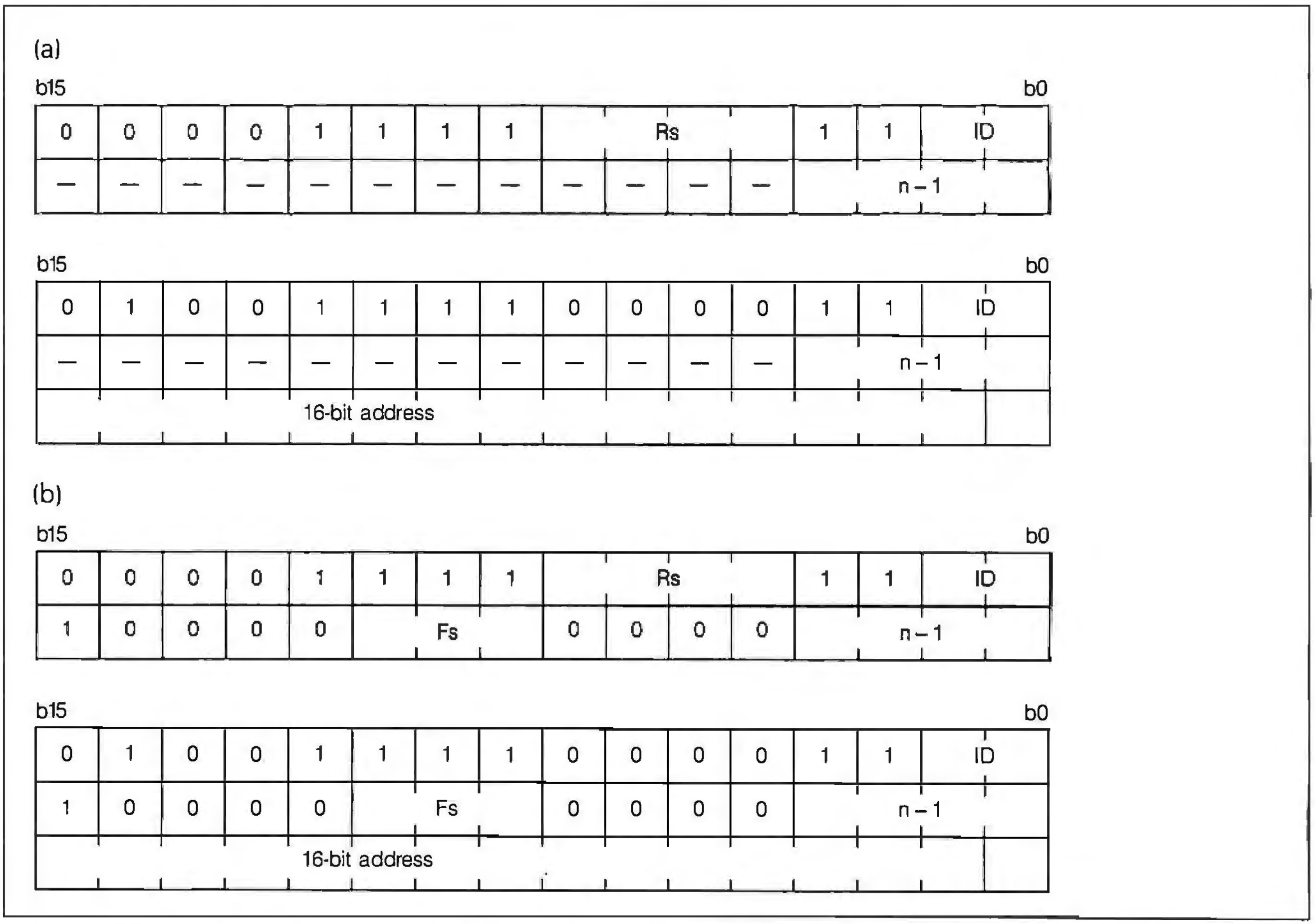

Figure 4: *(a) A Zilog EPU-to-memory transfer instruction template for indirect register (IR) addressing mode (above) and direct addressing (DA) mode (below). Rs is the CPU register used in the IR addressing mode. (b) Actual Z8070 instructions using the templates in (a). This is a floating-point number load (FLD) instruction. Fs is the EPU register loaded; n–1 indicates the floating-point number's precision—single, double, or double-extended.*

The Z8070 APU will have some speed advantages of its own. It will have two simultaneous clock speeds, one for its bus interface and one for its internal operation. This means that the APU will operate internally at its maximum speed while transferring data at a speed that the CPU and memory can handle. It also will allow the CPU to load data while the APU is executing instructions. This feature is very handy for matrix calculations and speeds up the total execution time.

The Z8070 also will have four separate interfaces, which are selectable by two input lines. These include the Z8000, Z80000, and Z800 as well as a universal interface. The universal interface makes the Z8070 look like a peripheral on the CPU bus. The Z8070 is not yet available, although it should be out in 1985.

(continued)

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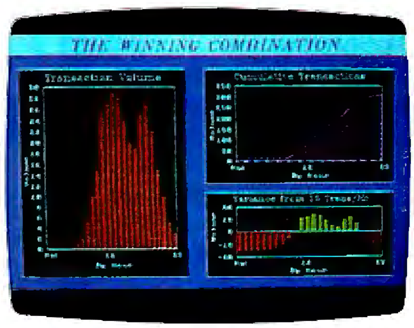

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The Z8000, Z800, and Z80000 all have this extended-processing architecture implemented in their instruction sets. Except as noted on the Z80000, they are very similar. Although the Z8070 APU for floating-point math will be the first EPU from Zilog, almost any custom chip can be designed to work with the EPU architecture.

In addition, the EPU interface can be used for non-EPU applications. The interface can be used to provide a separate workspace outside of memory or I/O space and implement multiple stacks, slave buffers, or a high-speed block-transfer mechanism. (See reference 14.)

National Semiconductor's Slave Processor Interface

National Semiconductor has implemented an extended-processing architecture for the Series 32000 microprocessor family. It is designed to support floating-point operations, memory management, and custom processors. In addition, it will allow compatibility with a later version device, which will integrate some or all of the functions on one chip when the technology is feasible.

National refers to its EPU as a "slave" processor because the host CPU performs all addressing and data trans-

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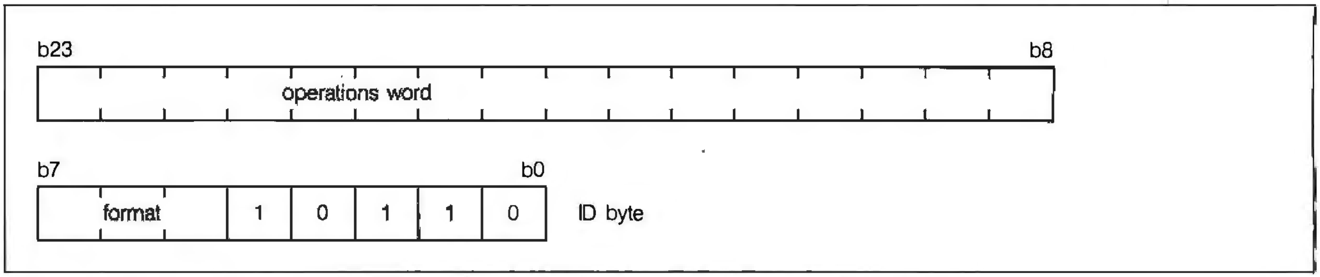

Figure 5: *The format of a National Semiconductor Series 32000 microprocessor EPU instruction.*

Table 2: *The National EPA protocol.*

Step	Status	Action
1	1111	CPU sends ID byte
2	1101	CPU sends operation word
3	1101	CPU sends required operands
4	—	EPU starts execution; CPU prefetches
5	—	EPU pulses AT/SPC low
6	1110	CPU reads status word
7	1101	CPU reads results, if any

fers. The EPU sits on the address/data bus and watches for the ID byte that identifies an EPU instruction, the operand word format, and (in case of a multi-EPU system) which EPU will manipulate the data. The host CPU routes the data to the specified EPU, and the EPU then performs whatever action the instruction specified. Each instruction consists of 24 bits—the ID byte and an operation word that specifies size and number of operands, addressing modes, and the type of operation (see figure 5).

The 32032 CPU contains 3 bits in its configuration (CFG) register that correspond to custom (C), memory-management (M), and floating-point (F) EPUs. The bits are set on initialization of the CPU, using the SETCFG command. If EPU hardware is in the system, the appropriate bit should be set and the EPU instructions will execute. If the bit is reset, an EPU instruction will trap to a software routine.

In order to maintain software compatibility with a future device, which could integrate memory-management and floating-point math functions on a single chip, National has specified both floating-point and memory-management operation codes in its instruction set. These instructions each have separate ID byte codes.

National also specifies a set of custom EPU instructions, including those to calculate, move, compare, convert, and load and store status registers. Three privileged instructions can be executed only in supervisor mode: test, and custom register load and store. The designer can specify the op codes and data types for these instructions in the operand word. Operand transfers can use any of the addressing modes.

The actual EPA protocol uses the host CPU status lines and a line called slave processor control (AT/SPC). Four status codes are used for the protocol:

Send ID	1111
Xfer operand	1101
Read status	1110
Waiting for EPU	0011

The AT/SPC line is bidirectional and pulsed low for transactions.

The EPA protocol shown in table 2 is documented in reference 8. In step 1, the CPU starts to execute an EPU instruction and outputs the ID byte on the address/data bus and status 1111 on the status lines. The EPUs decode the ID, and only the appropriate EPU continues to talk to the CPU. In step 2, the CPU outputs the operand word, with 1101 on the status lines.

At this point, both the CPU and the EPU have decoded the operand word, and the CPU transfers as many operands as were specified, with 1101 on the status lines. Once all the operands are transferred, the EPU begins execution, signaling this by pulsing the AT/SPC line.

The CPU can continue to fetch instructions into the 8-byte prefetch until it is filled. At that point, the CPU waits for the EPU to finish and places 0011 (waiting for EPU) on the status lines. The CPU and EPU do not execute concurrently.

When the EPU is finished or wants to communicate with the CPU, it will pulse the AT/SPC line and the CPU will read a status word in the EPU by placing 1110 on the status lines. The status word contains a number of flags set depending on the results of the EPU's operations, including a Q flag that indicates an error detected by the EPU.

In the last step of the protocol, the CPU transfers any results from the EPU to their destinations and places 1101 on the status lines. There are two exceptions to this protocol: the load-memory-management-register (LMR) and the load-custom-register (LCR) instructions. These are direct transfer instructions and do not require any acknowledgment or status information from the EPU.

MOTOROLA COPROCESSOR INTERFACE

The Motorola Coprocessor Interface is implemented in the recently re-

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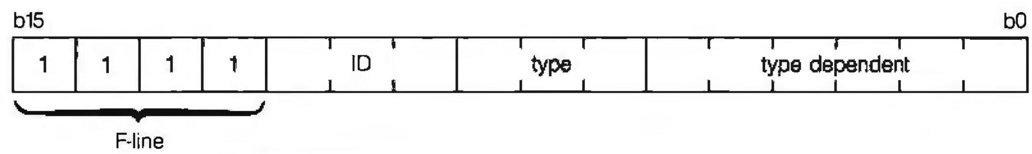

Figure 6: *The format of a Motorola EPU instruction for the 68020 microprocessor. "Type" and "type dependent" are defined for each specific instruction.*

Table 3: *The 11 registers in the Motorola EPU architecture register space.*

Register	Description
Response	16-bit, used by the EPU to request action
Control	16-bit, used to acknowledge or abort an EPU instruction
Save	16-bit, used to initiate save operation
Restore	16-bit, used to initiate restore operation
Operation	16-bit, saves EPU operation word
Command	16-bit, used for general instructions
Condition	16-bit, used for branch and conditional instructions
Operand	32-bit, passes data operands
Register	optional, used for register primitives
Instruction	optional, instruction address
Operand Address	optional, operand address

leased 68020 32-bit microprocessor. It is not implemented in the 68010, 68012, 68000, or 68008, but a software trap is available in those processors to allow software emulation of the coprocessor instructions.

In the Motorola system, the EPU is a peripheral on the bus but operates in the CPU address space. An EPU instruction will automatically access this address space by producing the status code 111 on the processor status lines. Decoding logic is required to recognize the status 111 and differentiate among up to eight EPUs. Two of the eight EPU identity codes are reserved for user-definition; one specifies the 68851 Paged Memory-Management Unit, and one is for the 68881 Floating Point Coprocessor. The remaining four are reserved by Motorola. The EPU must also decode address lines A4 through A0 to specify the register set.

Externally, the 32 bits of address are as follows:

A31–A20	xxx	Don't care
A19–A16	0010	EPU operation
A15–A13	ID	EPU identity
A12–A5	0..0	Operation as an EPU
A4–A0	R	EPU register

In addition to the status lines indicating a CPU space access, address bits A19–A16 define an EPU operation. Bits A15–A13 define which EPU, and A4 through A0 tell which register (specified in the EPU architecture). The first 16 bits of each instruction are shown in figure 6.

The CPU recognizes an EPU instruction in the microcode and will go to supervisor, or privileged, mode. The 68020 will then produce the status code 111 and expect to receive a data transfer and size acknowledge signal (DSACKx) if there is an EPU resident in the system. If no acknowledgment is received, a bus error occurs. The CPU then generates a software trap and jumps to a specific address where the EPU function can be emulated in software. This trap is completely automatic and does not require any system-initialization software.

The EPU instruction set is defined by the "type" code in the EPU instruction. This 3-bit code defines eight different instruction formats, including the following:

- general instructions that are used for passing EPU specific commands in a template format
- conditional and branch instructions, including word and long word branches, set conditional and decrement-and-branch conditional, and trap conditional instructions
- save and restore instructions to save and restore the internal state frame of the EPU, a variable size block of status, or other information in the EPU on demand (see reference 9 for further information)

The EPU architecture specifies 11 registers in the register space, 8 of which are required by the EPU instructions. Table 3 lists the 11 registers.

There are also 18 EPU primitives, or responses and commands, passed from the EPU to the CPU. These include exception handling, synchronization, instruction stream manipulation, and operand and register transfer. These primitives use the response register to talk to the CPU.

The transfer of operands to and from memory and between the CPU and EPU is made using the operand register. CPU and EPU transfers simply read and write to the operand register. Memory and EPU transfers require that the operand pass through a temporary register in the CPU and use the CPU to EPU transfer. If the EPU has DMA capability, it can transfer data directly to and from memory after first taking control of the memory bus.

In addition, the instruction stream manipulation primitive allows a kind of block move; up to 256 bytes can be transferred to and from memory

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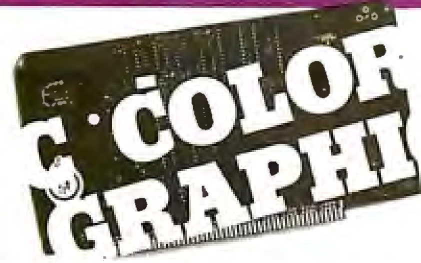
MARCH INTO SPRING WITH....



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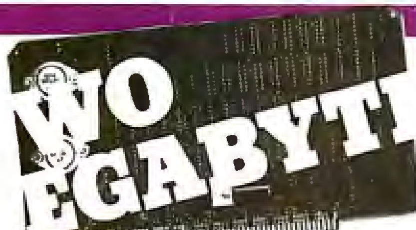

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with a single instruction.

The architecture is designed to support nonconcurrent operation and does not address the synchronization problems of a concurrent system. However, some concurrent extensions are provided. For example, although there is no hardware "busy" line from the EPU, the CPU can monitor the response register to determine if the EPU has finished executing. Of course, this requires some provisions in software for full implementation.

The architecture also covers exception handling of protocol violations, illegal instructions, bus errors, reset, and trace instruction execution on the main processor. These are generally handled by using the DSACKx signals and the trap mechanism of the 68020.

CONCLUSION

It is only fair to note that the architecture that has the most problems was also the first implementation. The Intel 8086/8088 architecture is the most primitive and the least general purpose. It does support some concurrent operation, but not easily. However, some of the problems have been addressed on the 80286, including a software-trap provision.

The Zilog architecture is general purpose enough for custom applications but also tightly coupled to allow high performance. Placing the EPU on the address/data bus with its own decoding capability allows a very transparent operation, with a minimum of external hardware. This does require that any custom EPUs have some intelligence. In addition, it is the only architecture that supports true concurrent processing transparently.

The National implementation was designed to allow later integration of its EPUs on the same chip with the CPU without requiring software modification. It specifies three separate sets of EPU instructions, including floating-point, memory-management, and custom. The design, which is also tightly coupled with the CPU bus, requires fairly intelligent EPUs. The architecture does not support concurrent operation.

Motorola has the most elaborate set of instructions, including compare and branch instructions and a general-purpose instruction. It is probably also the most general purpose of the four architectures, because it uses a separate address space and does not place many requirements on the EPU. It is not as tightly coupled with the CPU and lacks hardware definitions. Introduced on the 68020, it is not implemented on any other CPU, although Motorola notes that it can be emulated in software. It does not directly support concurrent operation.

Extended-processing architectures, in their various forms, serve to extend a general-purpose processor instruction set for specialized applications. Many newer EPAs offer both transparency and concurrency; strong trends toward these features can be expected in future development. ■

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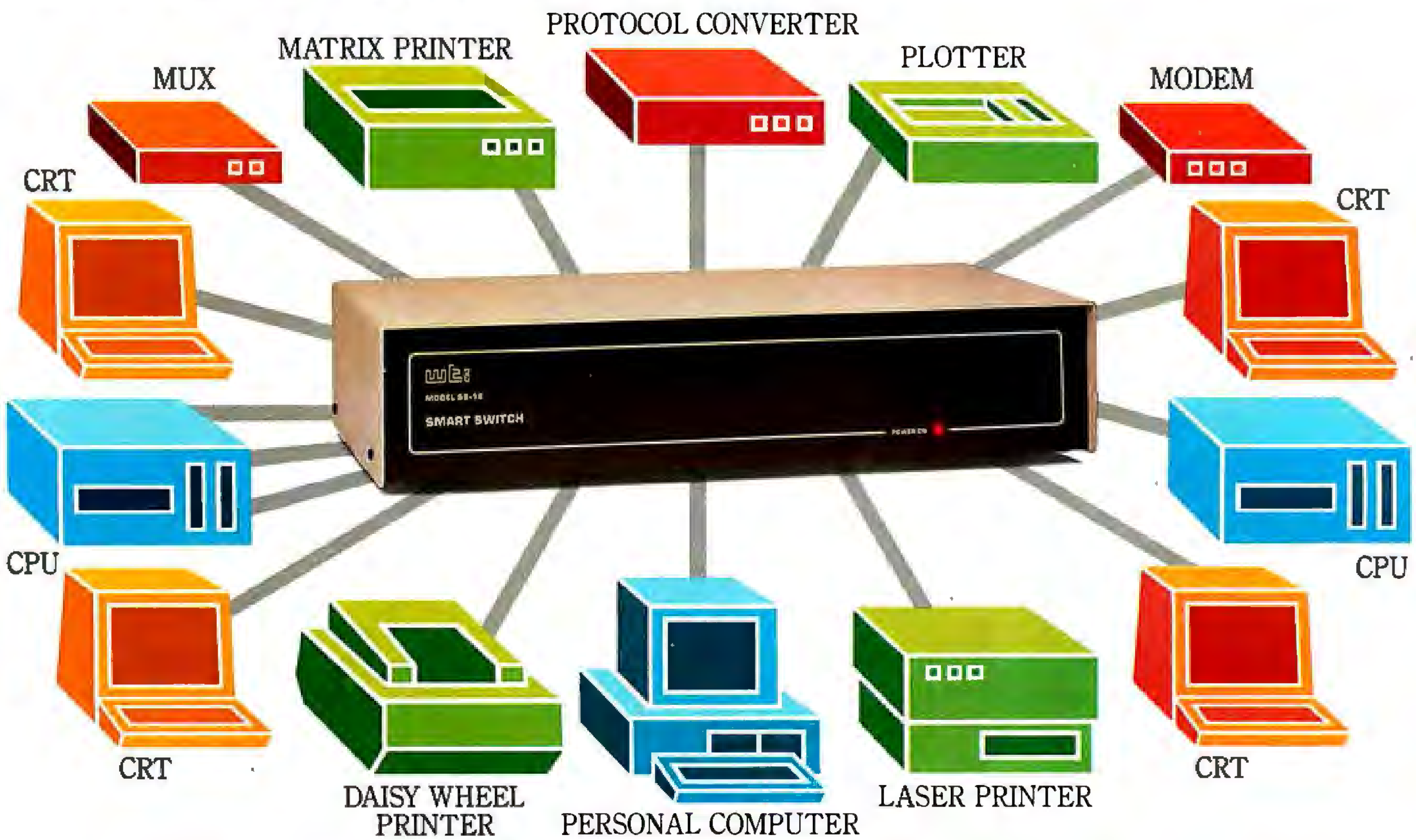

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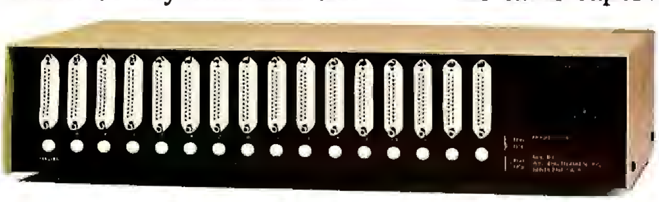

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APPLYING DATA FLOW IN THE REAL WORLD

BY WILLIAM GERHARD PASEMAN

This model for parallel processing is finding its way into commercial applications

VON NEUMANN MACHINES support a paradigm, a way of thought, that has been used successfully for 35 years. (See the text box entitled "The Von Neumann Paradigm" on page 214.) In a world in which thousands of PCs are sold in a month, the von Neumann computational model is not going to be replaced by an alternate model any time soon. However, valid reasons exist for using architectures based on alternatives to the von Neumann model of computation.

One reason is that many algorithms perform better and more inexpensively on other architectures than on von Neumann machines. It is not simply raw horsepower that produces this performance increase; it is horsepower that is tailored to the operations that the algorithm uses. Algorithms that can be expressed easily and coherently using the set of operations that the architecture provides usually perform better than those that cannot.

When algorithms and architectures mesh well together, we say that the architecture supports the algorithm. When an architecture makes implementation of the algorithm feasible, but not convenient, we say that the architecture weakly supports the algorithm. The better the mesh between the two, the better the price/performance ratio of the combination will be.

The von Neumann paradigm supports many algorithms well and weakly supports others. In this article, we will briefly review the relationship between several non-von Neumann paradigms then examine one non-von Neumann paradigm, data flow, in detail. Finally, we will look at some commercial architectures that support this model.

WHY WE SHOULD CARE ABOUT PARALLELISM

There are many ways to decrease the time an algorithm takes to complete on a given processor. If the processor is a general-purpose computer, one good way is to put the part of the algorithm that takes the most time into hardware. This is called *functional specialization*. An example of this is the Z80 IX,IY register instruction set. The instructions in this group were added to support procedure parameter passing.

Another method of speeding things up is to break the algorithm into parts and devote a separate processor to each part. This type of parallelism is called *functional decomposition*. It works well only if the processors have the work divided evenly among them. If the work is not divided evenly, one processor will become a bottleneck.

Finally, you can break the algorithm's input data into parts and have a set of identical processors handle each part. This type of parallelism will not work on all algorithms.

Of course, all these methods potentially can be used at the same time. Functional specialization usually provides the greatest speedup; however, that speedup usually is very specialized. Parallelism provides less speedup, but it is applicable to a broader range of problems.

Computer architectures that effec-

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William Gerhard Paseman is a software manager at Daisy Systems. He can be reached at 330 Sierra Vista, Apt. #3, Mountain View, CA 94043.

tively use processor parallelism possess linear price/performance curves over a wide performance range. For example, if a given algorithm takes 4 minutes to complete with $1000 worth of fifth-generation hardware, then it should take 2 minutes to complete with $2000 worth of hardware and 1 minute to complete with $4000 worth of hardware. (See the text box entitled "Linear Price/Performance and Incremental Performance," page 212).

Conventional (von Neumann) computer architectures do not have linear price/performance curves over a wide performance range. In order to make a conventional computer perform general algorithms faster, you don't simply add more components. Instead, you make its individual components faster. (There are some special cases in which you can improve performance by adding components; for example, adding more memory to a demand-paging environment.) Another way of saying this is that von Neumann architectures are not designed to be scaled over a wide range with respect to performance.

The price/performance relationship between the two approaches is illustrated in figure 1. The graph indicates that von Neumann computer architectures will experience a performance cutoff at some point. This point will occur when all the components reach the theoretical performance limit of the technology upon which they are based.

Parallel architectures will also experience a performace cutoff at some point. This point will occur when the cost of coordinating two pieces of work between two components exceeds the cost of having one component do both pieces of work. In the general case, this point must eventually occur regardless of the size or speed of the components, regardless of the speed of communication, and regardless of the complexity of the work that the components must do.

Until they reach the von Neumann cutoff, von Neumann machines probably will perform better than their parallel counterparts. This is because parallel architectures usually have a communication overhead that von Neumann architectures lack.

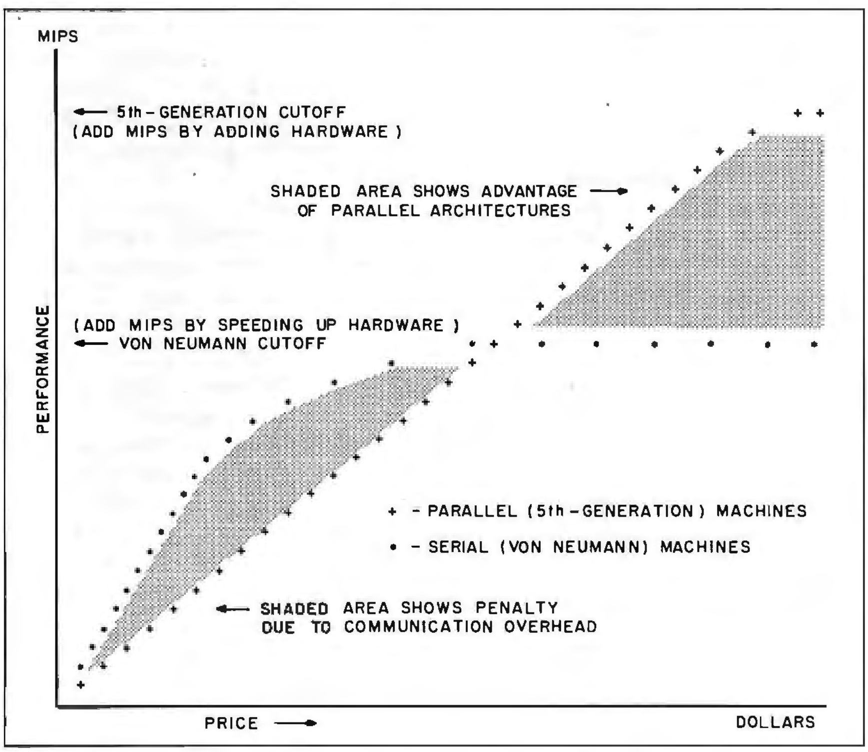

Figure 1: *A comparison of the price/performance aspects of serial and parallel computing architectures.*

Models of Computation That Support Parallelism

There are several paradigms for which it is currently popular to design parallel machines. The oldest is the control-flow paradigm.

The control-flow paradigm assumes that two or more processors share common memory. A control-flow architect usually views algorithmic parallelization and processor synchronization as being the programmer's problem. The architect supports the programmer by providing machine instructions that allow the programmer to do explicit processor synchronization in his code. Due to the wide interface between processes (i.e., the common memory), it is easy to write poor code that uses the interface in an undisciplined way. As a result, such systems have gotten bad press from many in the research community.

Most of the other paradigms are based around a weaker, more theoretically tractable concept in which, conceptually, memory sharing is not required. This concept is called message passing. Message-passing architectures allow programmers to structure their programs into islands of computation. These islands process asynchronously and communicate by passing messages to one another.

The data-flow paradigm is a message-passing model in which each island of computation is very small and usually performs the same operation repetitively on streams of values. Data-flow computation is data-driven, which means that each island starts processing whenever all data necessary to its computation is available.

The reduction paradigm is similar to the data-flow paradigm, except that a strong separation is made between the spawning of a computation and the computation itself. Here, computation is demand-driven, which

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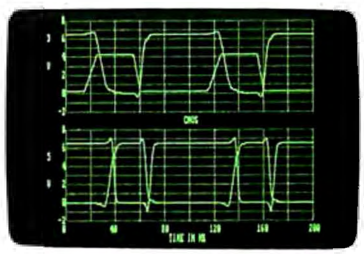

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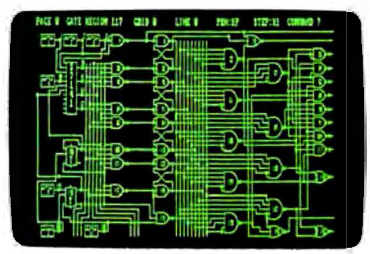

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means that the requirement for a result triggers the island that will generate it.

THE DATA-FLOW PARADIGM

The basic concepts of data flow were originally developed in the 1960s by compiler writers. Compiler writers used data-flow graphs to do performance optimization on standard serial programs. A data-flow graph is a directed graph in which the nodes represent primitive functions such as addition and subtraction, and the arcs represent data dependencies between functions. It was realized in the early 1970s that if data-flow graphs were executed directly, the architectures that executed them could be massively parallel.

A picture of a data-flow graph for the function 3 * (y + F(x)) is shown in figure 2. In this model, nodes are viewed as stations in an assembly line. The stations are connected by conveyor belts (called arcs). The conveyor belts carry containers (tokens) that hold contents (values). At each node is a person (processor) who operates the station's function. When the first token hits the F node, the processor takes its value, operates on it, and passes a new token with the result to the + node. As F was processing the first value, + could do nothing, since it required two tokens in order to operate and had only one available. Now, however, + has two values: 1 from F and 9 from y, so it adds them together and passes a token with the result to *. As + was operating on its first set of tokens, F was operating on its second token. Thus, parallel operation is achieved by pipelining values through nodes that execute fixed functions.

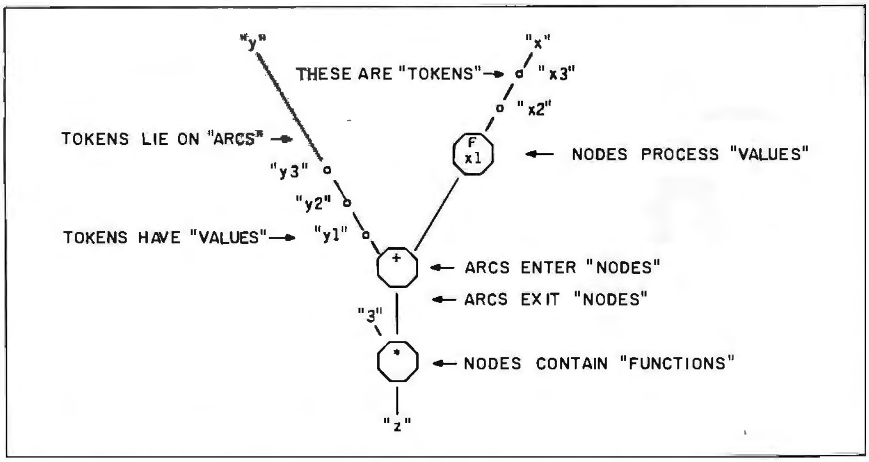

Figure 2: *A simple data-flow graph of the function z = 3 * (y + F(x)).*

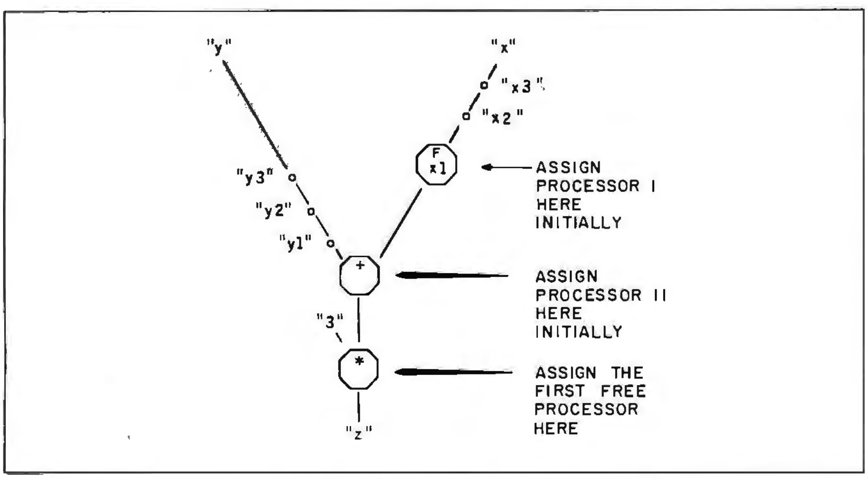

Figure 3: *A data-flow graph of the function z = 3 * (y + F(x)) illustrating static processor allocation; processors are assigned to nodes at compile time.*

DATA-FLOW EXECUTION MODELS

Normally, a data-flow graph has many more nodes than processors. Therefore, an execution model, a method of allocationg nodes to processors, is needed. We will briefly describe two models, the static and dynamic models of execution.

Figure 3 depicts the static model, in which the processors run to the nodes, where all input tokens are present and no tokens are on the output arcs.

However, this method leads to situations like that mentioned above, where the + node was bottlenecked by the F operation. In order to rectify this problem, the dynamic model was invented. In the dynamic model, instead of waiting idle, the processor at the + node would help the F processor by processing its second token for it. Figure 4 depicts the dynamic model.

DATA-FLOW ARCHITECTURE

It is still unclear exactly how to construct expandable hardware to support any of the above execution models.

One common data-flow architecture is shown in figure 5. Here, the data-flow machine consists of three stages—a matching unit, a fetch/update unit, and a processing unit (perhaps more than one). Let's see how these parts interact on the previous example. Let's refer to the nodes by symbolic name. We will call the + node PLUS and the * node MUL. At some point in the calculation, the matching unit has two tokens passed to it by the processing units. The first token indicates that the left (L) arc of the PLUS node has been set to 10 (a). Later, it receives a token indicating that the right (R) arc of the

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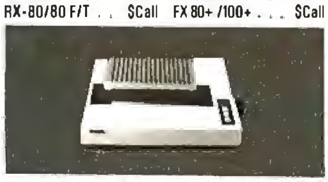

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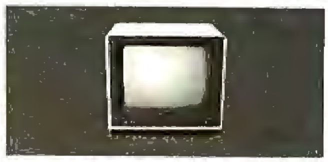

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PLUS node has been set to 7 (b). The match unit knows that PLUS has only two inputs, so at this point it sends a token set to the fetch/update unit for processing (c). The fetch/update unit knows that PLUS performs the + function and that it fans out to MUL's arc L, so it sends this information to an arbitrary processing unit (d). The processing unit performs the addition and sends the result to the match unit (e).

If the system allows more than one instantiation of an instruction to be active at a time (this would occur if the machine were executing the same instruction for the i and $i+1$ instantiations of a loop simultaneously), then the descriptors must also be tagged with a process ID. This is done in a dynamic data-flow system.

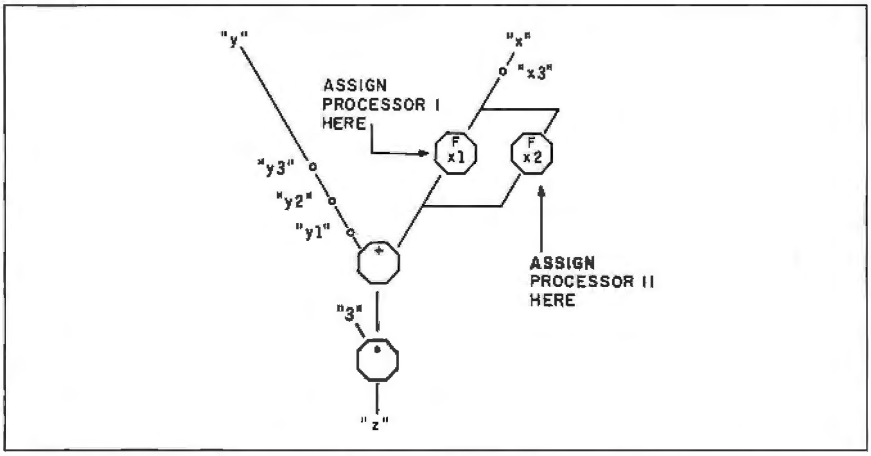

Figure 4: A *data-flow graph of the function* $z = 3 * (y + F(x))$ *illustrating dynamic processor allocation; processors are assigned to nodes at run time.*

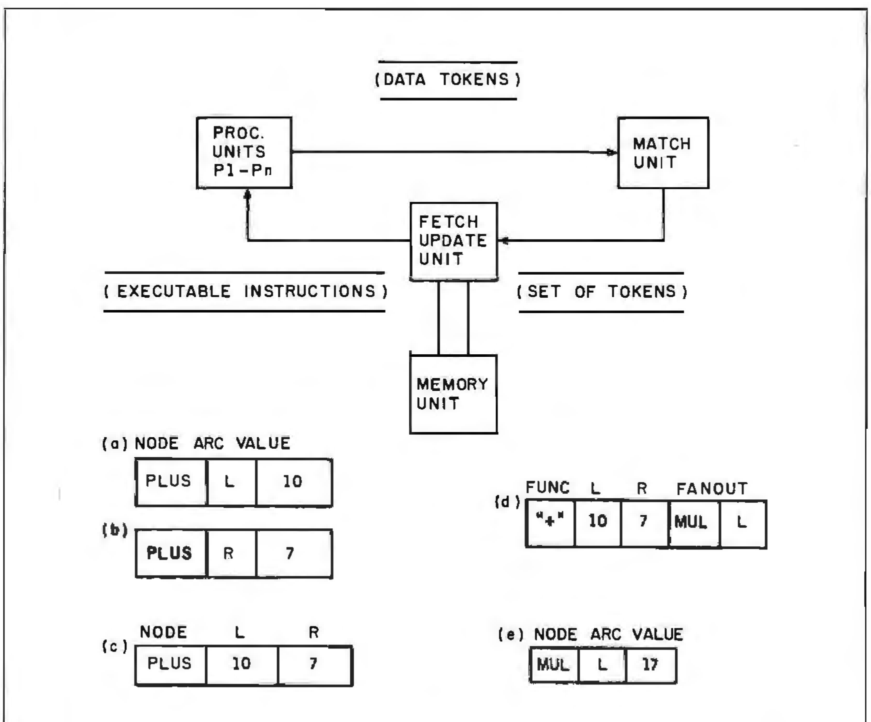

Figure 5: A*n example of data-flow architecture, with packet communication and token matching.*

PROPERTIES OF THE DATA-FLOW PARADIGM

The data-flow model makes many assumptions about the nature of the algorithms it runs. Some are:

- All information needed to execute the algorithm must be contained in its data-flow graph. That is, the paradigm does not use any structures other than the data-flow graph in order to execute the algorithm that the graph represents. The graph is the data-flow machine's "machine language" for the algorithm. The machine takes advantage of the graphical nature of the program in order to produce the speedup.
- The algorithm should not have a single locus of control. That is, the data-flow graph should allow more than one node on the graph to be executed at a time. If the algorithm has a single locus of control, it will run slower on a data-flow machine than on a von Neumann machine (due to the communications overhead).
- The data-flow graph must have a high degree of granularity. In other words, the graph nodes must contain things like + primitives and not "sort" primitives. One reason this is important is that graphs with granular primitives contain the potential for more parallelism. Note that this implies that the time for a "context switch," which is the time for a processor to switch from processing one node to processing another, must be small.
- The data-flow graph must have locality of effect. This means that the nodes do not fan out to a large number of other nodes. This is important, since nonlocality would stress the communication network of the data-flow machine.

These assumptions can be used to judge whether or not an algorithm matches well with the data-flow paradigm. If the algorithm to be executed does not have the above

(continued)

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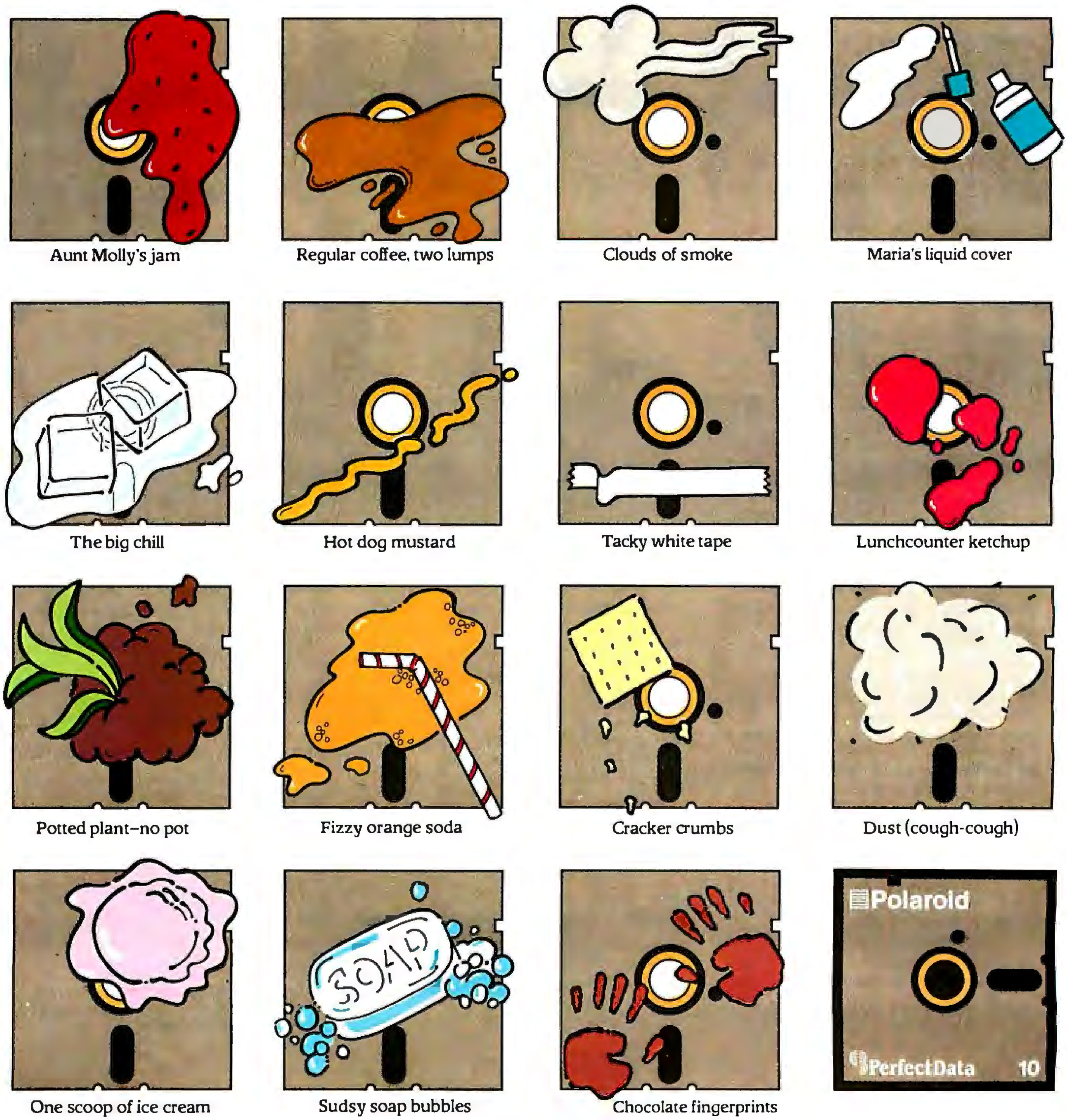

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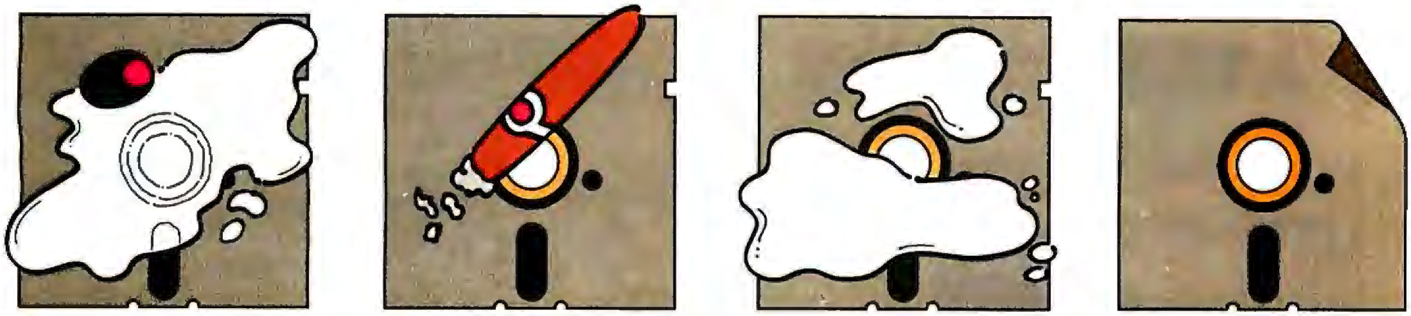

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properties, then the data-flow model is not the one to use to execute it.

COMMERCIAL POSSIBILITIES OF DATA FLOW—TEXAS INSTRUMENTS

Texas Instruments was one of the first companies to investigate the viability of data flow all the way to the hardware prototype stage. TI's research was done between 1975 and 1980. The company's architecture consisted of four "simple processors" and a host, connected in a ring architecture. TI has not yet released a commercial product based on this research.

TI's hardware/software effort was called a Data Flow Testbed. The testbed could accept a program written in a conventional programming language, compile it, link it, and automatically partition it to run on any number of processors. The people at TI did this in a relatively straightforward way. They took an existing commercial compiler/linker that generated data-flow graphs in its optimization phase. If the resulting graph completely described the algorithm, they could automatically partition the graph onto a number of processors and run it.

TI recognized that it is currently very difficult (i.e., commercially impractical) to generate data-dependence graphs for most real programs written in standard languages. The company knew this meant that "pure" data-flow processors cannot run standard software. Therefore, TI's system used a mixture of data-flow and classical control-flow techniques. That is, the computer was not a "pure" data-flow machine but rather used data-flow constructs where appropriate.

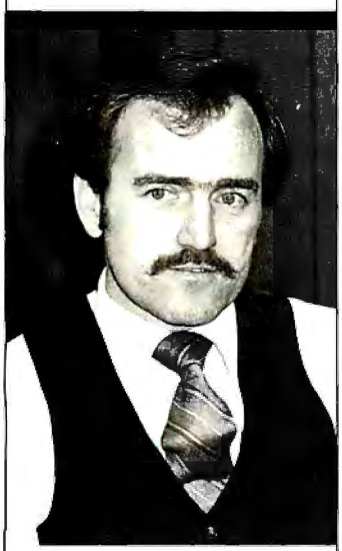
TI's primary interest was the application of data-flow concepts to large-scale machines running standard (unmodified) high-level language programs. The company investigated whether compilers could extract enough of the latent parallelism in standard programs to produce significant speedup in a data-flow architecture. One of TI's most interesting results was that the average amount

(continued)

"... innovation, not compatibility, is what we think microcomputers are all about."

(This is one of a series of design philosophy discussions with Rod Coleman, President of Stride Micro (formerly Sage Computer))

RC: When the 68000 microprocessor was first introduced, many saw it as a minicomputer replacement. They rolled up



a disk drive unit, plugged in a bunch of terminals and ported a mainframe operating system like UNIX.™ At Stride, we had a completely different perspective. We saw the 68000 at the center of a dream MICROcomputer; we envisioned (pardon the expression) a turbocharged Apple.™

Q: What's the real difference between the two approaches?

RC: It's reflected in both our product mix and our design. To begin with, price has always been a key point. The pioneers in the micro world were simply not ready to jump from a $2,000 machine to a $25,000 system overnight, leaving behind everything they'd come to admire about micros. That's why the price/performance ratio plays such a major role in every design decision we make.

Q: Such as?

RC: When we evaluated local area networks for the new Stride 400 Series we looked at everything available. From reading the press clips, Ethernet™ and ARCNET™ looked like the sure bets. Upon closer examination, we found that OMNINET™ was at least comparable, and sometimes superior in actual performance. But when we figured in the factor of cost, it was suddenly no contest. OMNINET uses twisted pair cabling instead of expensive coax, and the per node cost was so low that we could offer the transport hardware on every system as a standard feature. With other LANs, this runs $700 to $3000 per station! So when you talk price/performance, OMNINET clearly emerges as a better solution for microcomputer folks.

Q: Does the same philosophy apply to software?

RC: You bet. I mentioned UNIX above as a standard multiuser solution for 68000-based systems. We agree that UNIX will certainly be one of the prominent multiuser applications, but not for everyone. UNIX was designed on systems with fast disks and slow processors; that's the opposite of what micros are all about. Our approach to multiuser is somewhat unique. We sought a way to use the traditional single user microcomputer operating systems in a multiuser mode. Our solution was to create a MU.BIOS (multiuser basic input/output system) that resides below the operating system. Thus the user continues to use familiar software, but can also take advantage of the multiuser benefits of hardware cost-efficiency and software features such as shared data.

Q: Can you give me an example?

RC: Sure. Advanced DB Master™ from Stoneware is a leading single user DBMS package that is popular on a number of systems including the IBM™ PC. On the Sage and Stride 400 Series machines, this database is also a true multiuser solution with complete file and record locking. Better yet, the MU.BIOS even allows you to combine these

"...we sought a way to use the traditional single user microcomputer operating systems in a multiuser mode."

users on a single terminal. That means you could have different users residing in foreground/background, accessing each with a keystroke. The effect is concurrent multitasking. This even works with different operating systems in residence at the same time. For example, you could have your favorite CP/M-68K editor in the foreground, while a p-System compiler is cranking away at low priority in the background. The same holds true in the office environment where you can switch from a standard word processor to a spreadsheet instantaneously. The user has the ability to set priorities, time slicing, access, etc.

Q: So why are traditional multiuser operating systems like RM/COS™ and UNIX and Idris™ on your price list?

RC: Actually that's another of the key ingredients in being a leader in microcomputers: flexibility. There's no doubt that UNIX, or the UNIX-like Idris, will be right for many users. And RM/COS, for instance, is an excellent solution for serious business and COBOL customers. We actively support these and 10 other operating systems, adding some of our advantages of performance and price to each one. But we're also convinced that the ultimate operating system is still years in the future, and that's why we continue to encourage research and development in new environments such as Modula-2, LISP, and APL. Innovation, not compatibility, is what we think microcomputers are all about. That's why when we switched our name from Sage to Stride, we made sure there was no doubt as to our roots: Sage *Computer* became Stride *Micro*.

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NEC's chip is oriented toward image processing.

of parallelism available in standard FORTRAN programs was between 5 and 20. This meant that the maximum theoretical speedup TI could achieve (using "off the shelf" hardware) in these cases was 5 to 20 times. (Data flow can take advantage of parallelism only where it exists. If the programmer writes an algorithm so that no parallelism can be extracted from it, then a data-flow version of the algorithm will run no faster than a von Neumann version of the algorithm.) Currently, using high-performance hardware in a von Neumann machine affords a much greater speedup.

NIPPON ELECTRIC CORPORATION

Of the three companies discussed here, NEC's approach comes closest to the pure data-flow paradigm. The company's approach is based on a single chip that can contain up to 64 nodes and 128 arcs. Systems can incorporate up to 14 of these chips by connecting them into a ring in a very straightforward way. (It is possible to extend the limit beyond 14 chips, but the arrangement is much more complex.) A complete standard system, then, could run up to 896 two-input nodes distributed across 14 processors.

NEC's chip is oriented toward image processing. In the company's own words, "Because the majority of application programs for image processing execute iterative operations for large volumes of data, image-processing programs are relatively small compared to general data-processing programs." Although NEC's machine has a relatively small number of arcs and nodes in its system, each node can execute a high-performance operation.

NEC's initial focus is not on running existing high-level language programs but rather on running small, easy-to-rewrite programs that require high performance. That is not to say that NEC does not address these issues; rather, that the company is first entering the market where data flow's

(continued)

LINEAR PRICE/PERFORMANCE AND INCREMENTAL PERFORMANCE

Suppose a salesman sells you a processor for $1000 and tells you that it will run your favorite program in just eight hours. He then tells you that due to the marvels of fifth-generation computing technology, you can bolt in another processor for another $1000 and your program will run twice as fast. It will now take only four hours to complete. You happily buy two processors. Still, four hours is a long time, so you call your salesman and tell him that you want to halve the time to two hours. The salesman now sells you not one but two more processors in order to do this. You realize that for each processor you buy, you incrementally increase performance by (P+1)/P. For one processor, this is (1+1)/1 = 2x, or a 100 percent speedup. For two processors, this is (1+2)/2 = 1.5x, or a 50 percent speedup. For three processors, this is (1+3)/3 = 1.33x, or a 33 percent speedup.

This is an extremely attractive situation for the salesman, of course, since he gets an order of magnitude increase in commissions every time you want to get an order of magnitude increase in performance. It is, of course, not a very good situation for you.

benefits are the strongest. In fact, NEC is now working on an integrated system in which to embed its chips. How the company approaches system-level problems (language definition, translation, and debugging) remains to be seen.

In summary, NEC was able to use the data-flow model by applying it to a domain in which

- The algorithms are easily expressed in terms of a data-flow graph.
- The algorithms contain a great deal of inherent parallelism.
- The architecture can run small, easy-to-program algorithms.
- There is a great need for fast execution. (Image processing is computer-bound.)

DAISY SYSTEMS CORPORATION

Daisy Systems started selling a commercial data-flow architecture in the first quarter of 1984. The company's approach is based on a set of board-level processors connected in a ring. The basic configuration consists of three or four processing units plus a host processor. The units are capable of processing 65,000 to 1,000,000 nodes, depending on the level of modeling. Each node can have up to 256 inputs.

Daisy Systems' data-flow architecture is the first to respond to the customer's need for high-speed discrete logic simulation. In essence, a discrete logic simulator runs an algorithmic description of a piece of hardware. By their very nature, these algorithms are expressed in terms of graphs in which each node is a simple operation.

The hardware designer of these algorithms consciously works to make his design exhibit a high degree of parallelism. Therefore, Daisy did not have to worry about the algorithm "running out of parallelism" of which to take advantage. Even better, the parallelism is very great at the machine-instruction level.

Like TI, Daisy recognized that the "pure" data-flow paradigm did not completely address all of simulation's problems satisfactorily. For example, the "pure" data-flow model has no way of handling stored state (side effects). Daisy addressed this and other similar problems by extending the paradigm.

At the programming level, Daisy recognized that the programming task in advanced architectures is difficult and error-prone. In many approaches, the user must adapt to a paradigm that is unfamiliar, unintuitive, and difficult to use. Daisy overcame this problem by allowing users to communicate in the languages that they have always used: graphics, Boolean expressions, and a standard behavioral language. Daisy was able to do this well because the primitives that the designer uses map easily to the primitives that Daisy's architecture supports. The mapping process (compilation, linking, and code generation) is totally automatic.

Daisy Systems' data-flow architecture is the first to respond to the customer's need for high-speed discrete logic simulation.

Daisy was able to use data flow by applying it to a domain in which

- The algorithms are naturally expressed in terms of a data-flow-like graph.
- The algorithms contain a great deal of inherent instruction-level parallelism.
- There is a great need for fast execution. (Logic simulators implemented on von Neumann machines may take days to run big simulations.) Daisy's machine runs approximately 100 times faster than most software simulators.

SUMMARY

NEC and Daisy have successfully used data flow to solve two different commercial problems in an appropriate manner. Both problems are easily expressed using data-flow graphs, have a great deal of instruction-level parallelism, and require scalable execution and high performance.

As more companies discover problems for which data flow is the best solution, the repertoire of practical parallel algorithms using the data-flow model will grow. ■

THE VON NEUMANN PARADIGM

Mathematicians have been proposing computational paradigms, or "models of computation," since the time of Charles Babbage (witness Turing machines, Makov productions, and Church's Lambda calculus). However, the most well known paradigm was pioneered by John von Neumann. Von Neumann's model is based on the concept of a single central processing unit that accesses a linear array of fixed-size memory cells. These cells can contain either instructions or data. Instructions are relatively low-level. They perform simple operations on elementary operands. In the von Neumann model, program control is sequential and centralized. It is upon this paradigm that most commercial computer architectures are based.

Strictly speaking, a non–von Neumann paradigm is one that departs from any of these concepts. For example, a machine that keeps its data and memory in two separate banks is not a von Neumann machine. Recently, however, "non–von Neumann" has come to mean a paradigm that differs primarily in the last of the above properties, that of sequential, centralized program control.


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THE TRANSPUTER

BY PAUL WALKER

A building block for parallel processing

THE TRANSPUTER is a small but complete computer that can be used as a building block with other Transputers to construct extremely high performance computing networks. A BYTE article by Dick Pountain (see reference 1) introduced the idea of the Transputer and its programming language, Occam. (Occam is a trademark of the INMOS group of companies.) In this article we'll take a look at Transputers and how they can meet the computing requirements of the future.

A rough yardstick of performance is given by the more recent personal computers, which run at around a million instructions per second (MIPS). By contrast, supercomputers offer the equivalent of around a thousand MIPS. Tomorrow's applications, such as the Japanese Fifth Generation Project, require up to a million MIPS. The needs of home and personal computers are more modest. But as the performance requirements in low-end systems evolve, the price/performance benefits of small clusters of Transputers will begin to attract small-system designers.

Advances in semiconductor technology are improving performance. But it takes 10 years for technology to improve the processing power of current architectures by an order of magnitude. At that rate, it will be well into the 21st century before the current architectures provide the performance required. But the applications need the performance now. A different architecture is needed to provide the performance with today's technology.

THE EVOLUTION OF COMPUTER ARCHITECTURES AND LANGUAGES

One of the first architectures of a general-purpose computer was the von Neumann architecture, in which a single central processor is connected by a single data bus to memory. This has been adapted in various ways over the years, but even today almost all computers conform to the basic von Neumann architecture; they have merely added processing power and memory. As the processing power and memory of the computer are increased, however, the bus becomes a bottleneck. And when processing power is further increased by the utilization of multiple processors and DMA (direct memory access) controllers sharing the bus, the effect of the bottleneck is even more pronounced.

Along with the evolution of computer architectures, computer programming languages have evolved to make programming more reliable and cost-effective. The languages, however, have been constrained by the computer architecture. Computers obey instructions in sequence and can do only one job at once, and this is reflected in the languages. The real world, however, has many activities, or "processes," happening concurrently, and programming languages should be capable of modeling the behavior of these concurrent processes.

THE TRANSPUTER ARCHITECTURE AND OCCAM

Although the von Neumann architecture is limited by its bus, it is an excellent architecture for a small, single-processor computer. A Transputer is a small but complete von Neumann computer (figure 1a). The difference between a Transputer and an ordinary

(continued)

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An Occam process is a black box that works with its own local information.

microcomputer is that Transputers can readily be built into networks and arrays (figure 1b). Each Transputer works on its own job, using its own local memory. A system with many Transputers has as many buses as it has Transputers, so the bus throughput is multiplied by the number of Transputers in the system. Another gain in bus throughput is achieved by putting the processor and memory on the same chip.

The Transputers in a system need to communicate with each other so that they can cooperate. Transputer chips therefore have four link interfaces, each with an input signal and an output signal. The output signal of a link interface on one Transputer is connected to the input signal of a link interface on another Transputer, and vice versa. The two-wire, point-to-point connections between two Transputers (figure 2) are described as "links."

The programming language Occam (see reference 2) is designed to handle the mixed sequential and concurrent nature of real-world processes. Such processes are modeled as Occam processes, each of which can be regarded as a black box that works with its own local information. A process cooperates with other processes using point-to-point communication channels. A collection of Occam processes is itself a process, so a hierarchy of processes can be built up to reflect the structure of the real-world process.

The Occam model is suitable for mapping onto an array of computers, each of which has its own local memory and communicates with other computers via point-to-point links. It is particularly appropriate, therefore, for a network of Transputers.

The Transputer Chip

The Transputer, then, is a single-chip computer with a processor, local memory, link interfaces for linking to other Transputers, and all the necessary system services such as reset and clock.

When Transputers are programmed in Occam, each Transputer implements an Occam process and each link implements an Occam channel in each direction between two Transputers.

Particular examples of Transputers are the IMS T424 (see reference 3) and the IMS T222, which are 32-bit and 16-bit Transputers, respectively. Both devices have four links and 4K bytes of on-chip RAM (random-access read/write memory). In addition, they have interfaces to external memory for applications in which 4K bytes are not enough; T424 addresses up to 4 gigabytes, T222 up to 64K bytes. Both have high-performance processors, achieving 5 to 10 MIPS.

To fit a processor, link interfaces, and RAM onto a single chip, the processor must be small. The Transputer processor (see reference 4) is indeed small, occupying about a quarter of the chip. Being small, in some ways like a reduced instruction set computer (RISC), it is fast. Unlike some of the RISCs, however, the Transputer processor has short, 8-bit instructions and uses an evaluation stack of three registers rather than a register file. Both of these improve performance. The short instruction format efficiently encodes the most frequently accessed instructions and data. Infrequent instructions, large constants, and nonlocal variables are accessed by short sequences of 8-bit instructions. The use of an evaluation stack means that instructions do not have to specify the registers for operands; the instructions always work on the top of the stack.

The performance of the processor is shown by the Occam assignment

(continued)

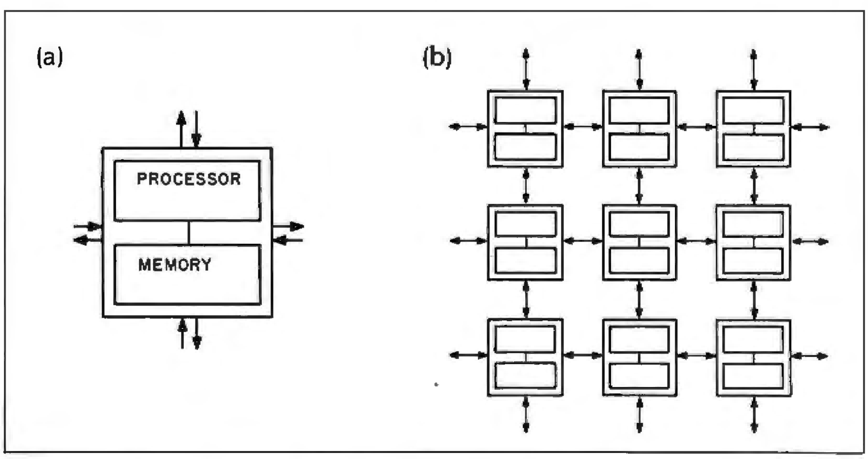

Figure 1: *(a) A Transputer is a von Neumann computer with link interfaces. (b) Transputers can be readily built into networks and arrays.*

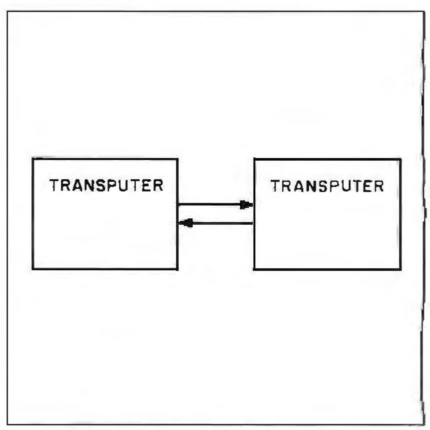

Figure 2: *A link consists of two wires, one in each direction, between two Transputers.*

A hardware kernel implements Occam processes and communication.

x := y + 10. This compiles into the instructions

```
load local y
load constant 10
add
store local x
```

Each of these instructions is a single byte, and all the instructions except load local are executed in a single processor cycle. The load local instruction takes two processor cycles, one to calculate the address and the other to access the data. The instruction fetch is overlapped with those processor cycles that do not access memory. The above assignment statement takes a total of five processor cycles. The T424-20, with a 20-MHz processor cycling in 50 nanoseconds (ns), takes 250 ns for the statement. Executing four instructions in 250 ns is equivalent to 16 MIPS. The quoted figure of 10 MIPS allows for larger constants, nonlocal accesses, and more complex instructions. The language used for the assignment statement in this example is Occam, but similar statements can be written in many other languages. The high performance, therefore, is not limited to Occam but is available to languages such as C, Pascal, and FORTRAN as well.

The processor includes a small hardware kernel to implement Occam processes and communication between them. Communication is handled directly by instructions, which pass the messages and schedule or deschedule the processes as appropriate. The kernel includes two levels of priority, the higher of which provides minimal latency for response to external events or for routing messages between Transputers that are not linked directly. A timer implements the Occam handling of time.

Use of multiple processes, communication, scheduling, and the handling of time is shown by the Occam program in listing 1. It describes two processes—one outputs a thousand messages and the other inputs a thousand messages. The timer records how long it takes to transfer the thousand messages.

Using on-chip RAM, the program in listing 1 performs approximately 125,000 message passes per second on a T424-10 with a 100-ns processor cycle and 250,000 message passes per second on a T424-20 with a 50-ns processor cycle.

The links are also fast, with a data rate of 10 megabits/second. Communication can occur at this speed simultaneously on all links and in both directions. With the four link interfaces on T424 and T222, this results in a throughput on each Transputer equal to eight full-speed Ethernets.

Listing 1: A *simple input/output program in Occam.*

```
-- Message passes per second
CHAN c:
VAR MPPS, StartTime, EndTime, ElapsedTime:
SEQ
  TIME ? StartTime
  PAR
    SEQ i = [0 FOR 1000] c ! 0
    VAR x:
    SEQ i = [0 FOR 1000] c ? x
  TIME ? EndTime
  ElapsedTime := EndTime - StartTime
  MPPS := (1000000/ElapsedTime) * 1000
```

The link interfaces are autonomous. When a process in one Transputer has output to a link and a process on another Transputer has input from the same link, the link interfaces of the two Transputers transfer data across the link. The data is accessed from each Transputer's memory by a DMA controller within each link interface. While the transfer is taking place, the two communicating processes are descheduled, allowing the processor to execute other processes that are not waiting for communication. When the transfer is completed, the processes are scheduled, without the processor having to poll for transfer completion. If either process has high priority, it is run as soon as the transfer completes. A low-priority process takes its turn with other processes that are ready and able to run.

Communication between processes on a single Transputer is programmed in exactly the same way as communication through links. The only difference is that the channel associated with the link is allocated to a particular link interface. The same instructions are used for internal communication as for external communication, the only difference being the address of the channel.

Both the processor and the link interfaces use very high frequency clocks—up to 80 MHz. It is difficult to supply such a clock to one chip; to distribute high-frequency clocks around a large system is next to impossible. Therefore, the Transputer uses a low-frequency (5-MHz) external clock and generates all the high frequencies internally. Even with a low-frequency clock, it is impossible to ensure that all Transputers "see" a clock edge at the same time. The Transputer, therefore, has been designed so that the only important parameter of the input clock is its frequency, which can be tightly controlled by a crystal.

Similarly, it is difficult to synchronize the clock with the data on the links. So the data reception of the links is asynchronous, as is the case with RS-232C. But unlike RS-232C connec-

(continued)

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tions, the links are fast. They also have a protocol that matches the Occam model of communication between processes.

The on-chip RAM provides local memory that cycles at the same speed as the processor. External memory cycles more slowly: The T222's memory interface cycles in two processor cycles, the T424's in a minimum of three processor cycles. T424 uses a multiplexed 32-bit address/data bus and is optimized for accessing dynamic RAM. A simple configuration is shown in figure 3. Here the T424 is connected to four 8K by 8-bit (such as the IMS 2630) or 32K by 8-bit dynamic RAMs with no interfacing "glue" logic. The T424 generates all the required refresh addresses and cycles. It also generates

RAY TRACING WITH AN ARRAY OF TRANSPUTERS

The ray-tracing algorithm that generated the pictures in photos A and B takes a long time to draw them. For example, the Sage IV takes three hours to draw the 500 by 500 pixels in photo B. The algorithm calculates each pixel independently, so it is eminently suitable for parallel processing by sharing the pixels among a number of Transputers.

We first developed the program as a number of concurrent processes running on a single computer. The Sage, simulating concurrency, takes five hours to draw the picture when the pixels are shared among 64 processes. Photo A shows the picture when it is half complete.

The debugged program can then be mapped on to a network of Transputers. Figure A can be regarded as a block diagram of either the processes or the Transputer network. A Transputer implementing the ray-tracing process can even be regarded as a hardware ray-tracing machine.

The network of 64 (plus one screen driver) Transputers shown in figure A will draw the picture in about half a minute.

As well as calculating their own share of pixels, each of the 64 Transputers routes pixels along the pipeline toward the screen driver Transputer. A diagram of the processes and channels on each Transputer is shown in figure B. An Occam program to describe these processes is

```
CHAN LocalChannel:

PRI PAR
  . . . Routing process
  . . . Pixel calculator
```

The routing process expands to:

```
SEQ k = [0 FOR (NumberOfPixelsRoutedByThisProcess)]
  VAR Pixel:
  ALT
    LinkIn ? Pixel
      LinkOut ! Pixel
    LocalChannel ? Pixel
      LinkOut ! Pixel
```

The expression (NumberOfPixelsRoutedByThisProcess) depends on where the Transputer is in the pipeline. The processes assume that the pixel sent through the pipeline of Transputers includes both the value of the pixel and an iden-

Photo A: *The ray tracing is half done.*

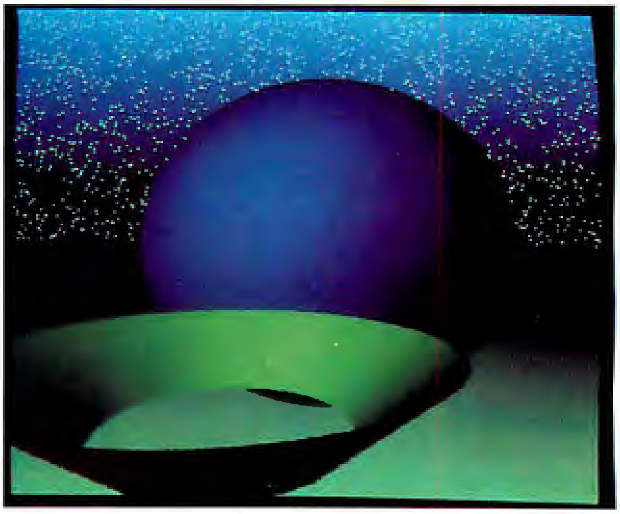

Photo B: *The completed ray-tracing output.*

a number of configurable strobes, which can be used to generate the control signals for dynamic RAMs.

TRANSPUTER SYSTEMS

A system can be built with a single Transputer; some ROM (read-only memory) and perhaps some peripherals can be put on the memory interface—the Transputer then behaves as a high-performance microprocessor. This single Transputer system can be enhanced by adding another Transputer, programmed to do a specialized job, and linked to the first Transputer as a coprocessor. The text box shows a number of Transputers connected in pipelines. Figure 1b shows a number of Transputers linked together in an array.

(continued)

tifier to enable the screen driver Transputer to determine which pixel it is receiving.

Sixteen Transputers are programmed as a pipeline with this program:

```
CHAN PixelPipeline [0 FOR TransputersDeep + 1]:
PAR i = [0 FOR TransputersDeep]
  . . . Pixel calculating and routing Transputer
```

Four of these pipelines hooked up to the screen-driver Transputer are described by the program

```
DEF PixelsWide          = 512:
DEF PixelsDeep          = 512:
DEF TransputersDeep     =  16:
DEF TransputersWide     =   4:
CHAN PixelPipeline [(TransputersDeep + 1)*TransputersWide]:
PAR
  . . . Screen Driver Transputer
  PAR j = [0 FOR TransputersWide]
    PAR i = [0 FOR TransputersDeep]
      . . . Pixel calculating and routing Transputer
```

This program corresponds directly to figure A.

In this example, extensive use has been made of the ". . ." comment facility used by the Occam programming system to hide unwanted detail and help structure the program. The technique, known as "folding," allows quick and efficient navigation through a large program.

It is interesting to consider the communication overhead of the pipeline in this application. Each Transputer linked directly to the screen driver passes along data for 64,000 pixels. The routing process takes about 10 microseconds per pixel, which makes for an overhead of 0.64 second out of 30 seconds—about 2 percent. Grouping the pixels together and sending them in blocks of 32 pixels would reduce this to less than 0.1 percent overhead. The remaining 99.9 percent of each Transputer's processing power can be used for calculating pixels.

The number of Transputers used is defined as a set of constants at the start of the program. Reconfiguring for a different number of Transputers requires no more than changing these definitions. Writing the program this way makes it particularly easy to choose a number of Transputers to provide the appropriate cost/performance for the application.

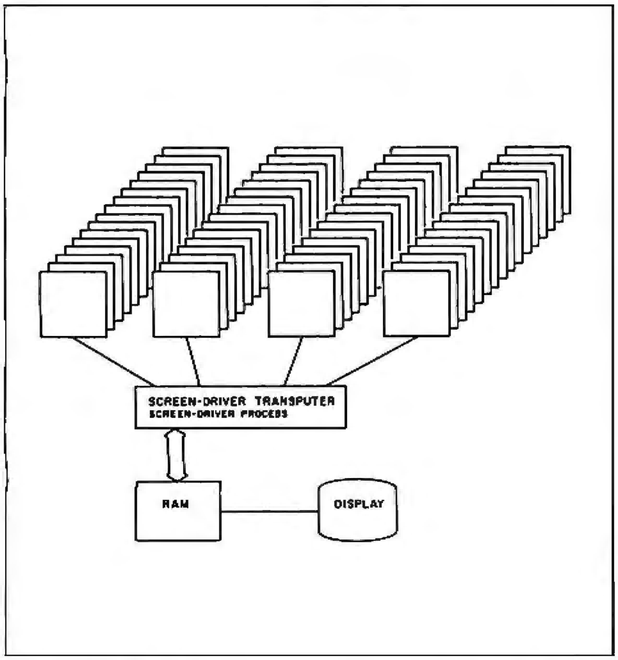

Figure A: *Arrangement of 64 Transputers (plus one screen driver) for ray tracing.*

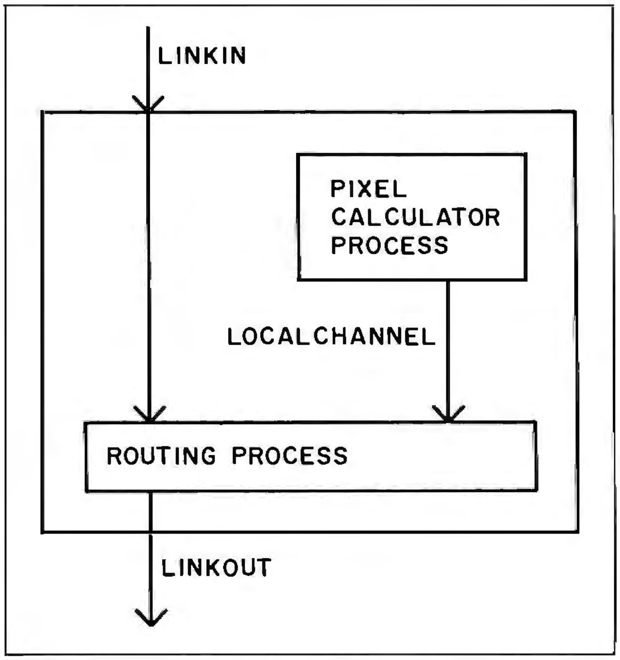

Figure B: *Processes in each of the 64 Transputers shown in figure A.*

There is no limit to the size, function, or shape of a network of Transputers.

Other networks can be built. A functionally distributed network might have random interconnections between Transputers (figure 4). An array could have its ends connected toroidally (figure 5) to simulate an infinite network in a similar way to the Bagel developed by Shapiro (reference 5). Systolic arrays developed by H. T. Kung (reference 6) and wavefront processors developed by S. Y. Kung (reference 7) map naturally onto networks of Transputers. (Incidentally, the systolic and wavefront architectures are easy to model in Occam, even if the final implementation is intended to be special-purpose hardware, as shown by Fujitsu in reference 8.)

There is no design limit to the size, function, or shape of a network of Transputers. Further, provided the network of Transputers is programmed so that they cooperate—rather than one Transputer waiting for another that waits for another, and so on—the performance of a network is directly proportional to the size of the network. For example, the ray tracing described in the text box shows a negligible 0.1 percent overhead of communication between Transputers.

BUILDING BLOCKS

Because Transputers can be built into systems of arbitrary size, function, or shape, they can be thought of as building blocks. Making a link between two Transputers is as simple as joining together the lug and hole on two Lego bricks; both are standardized connections.

Another respect in which the analogy holds is that a network of

(continued)

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SN7442N	16	.45
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SN7445N	16	.69
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SN7472N	14	.39
SN7473N	14	.39
SN7474N	14	.39
SN7475N	16	.45
SN7476N	16	.39
SN7479N	14	4.95
SN7480N	14	.89
SN7482N	14	1.49
SN7483N	16	.55
SN7485N	16	.59
SN7486N	14	.39
SN7489N	16	2.25
SN7490N	14	.49
SN7491N	14	.79
SN7492N	14	.45
SN7493N	14	.45
SN7494N	14	.89
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	3.25
SN74100N	24	1.95
SN74105N	14	1.19
SN74107N	14	.29
SN74109N	16	.39
SN74116N	24	1.49
SN74121N	14	.45
SN74122N	14	.69
SN74123N	16	.55
SN74125N	14	.49
SN74126N	14	.49
SN74128N	14	.79
SN74132N	14	.59
SN74136N	14	.69
SN74141N	16	.69
SN74142N	16	3.95
SN74143N	24	3.95
SN74144N	24	3.95
SN74145N	16	.65
SN74147N	16	1.29
SN74148N	16	.89
SN74150N	24	1.49
SN74151N	16	.49
SN74152N	14	.49
SN74153N	16	.99
SN74154N	24	1.49
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SN74166N	16	.69
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SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.49
SN74196N	14	.75
SN74197N	14	.75
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74273N	20	1.95
SN74276N	14	2.49
SN74279N	16	.79
SN74283N	16	1.39
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

Part No.	Pins	Price
74LS00	14	.29
74LS01	14	.29
74LS02	14	.35
74LS03	14	.29
74LS04	14	.39
74LS05	14	.35
74LS08	14	.35
74LS09	14	.35
74LS10	14	.35
74LS11	14	.35
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.35
74LS26	14	.29
74LS27	14	.35
74LS28	14	.39
74LS30	14	.39
74LS32	14	.39
74LS37	14	.35
74LS38	14	.39
74LS42	16	.49
74LS47	16	.89
74LS48	16	.89
74LS51	14	.29
74LS73	14	.39
74LS74	14	.49
74LS75	16	.45
74LS76	16	.39
74LS85	16	.89
74LS86	14	.39
74LS90	14	.55
74LS92	14	.55
74LS93	14	.55
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.79
74LS125	14	.59
74LS126	14	.59
74LS132	14	.65
74LS133	16	.59
74LS136	14	.39
74LS138	16	.59
74LS139	16	.59
74LS145	16	1.19
74LS147	16	1.95
74LS148	16	1.79
74LS151	16	.59
74LS153	16	.59
74LS154	24	1.49
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.89
74LS165	16	.89
74LS166	16	.89
74LS168	16	1.19
74LS169	16	1.49
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.69
74LS175	16	.69
74LS181	24	2.49
74LS190	16	.79
74LS191	16	.89
74LS192	16	.79
74LS193	16	.89
74LS194	16	.69
74LS195	16	.59
74LS196	14	.89
74LS197	14	.89
74LS221	16	1.09
74LS240	20	1.09
74LS241	20	.99
74LS243	14	1.09
74LS244	20	1.29
74LS245	20	1.49
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.59
74LS273	20	1.49
74LS279	16	.49
74LS280	14	1.95
74LS290	14	.95
74LS293	14	.95
74LS322	20	3.95
74LS323	20	3.95
74LS347	16	.79
74LS353	16	1.09
74LS364	20	1.95
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.49
74LS374	20	1.49
74LS375	16	.69
74LS386	14	.49
74LS393	14	1.19
74LS399	16	1.49
74LS490	16	1.49
74LS533	20	1.49
74LS534	20	1.49
74LS540	20	1.49
74LS541	20	1.49
74LS640	20	2.19
74LS641	20	2.19
74LS644	20	2.19
74LS645	20	2.19
74LS670	16	1.49
74LS682	20	2.95
74LS688	20	2.49
81LS95	20	1.49
81LS96	20	1.49
81LS97	20	1.49
81LS98	20	1.49

74S/PROMS*

Part No.	Pins	Price
74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.35
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S37	14	.99
74S38	14	.89
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S85	16	1.99
74S86	14	.55
74S112	16	.55
74S113	14	.55
74S114	14	.55
74S124	16	2.75
74S132	14	1.89
74S133	16	.45
74S135	16	.89
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.69
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.29
74S169	16	4.29
74S174	16	1.09
74S175	16	1.09
74S188*	16	1.75
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	1.95
74S241	20	1.95
74S242	14	2.19
74S243	14	2.19
74S244	20	2.19
74S251	16	.99
74S253	16	.99
74S257	16	.99
74S258	16	.99
74S260	14	.79
74S273	20	2.39
74S280	14	1.89
74S287*	16	1.79
74S288*	16	1.79
74S299	20	5.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	4.95
74S472*	20	4.95
74S473*	20	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95

CA—LINEAR

Part No.	Pins	Price
CA3010H		1.09
CA3039H		1.29
CA3046N	14	.69
CA3059N	14	2.95
CA3060N	16	2.95
CA3065E	14	1.49
CA3080E	8	.99
CA3081N	16	1.15
CA3082N	16	1.15
CA3083N	16	1.15
CA3086N	14	.85
CA3089N	16	1.95
CA3096N	16	1.75
CA3130E	8	1.19
CA3140E	8	.85
CA3160E	8	1.79
CA3161E	16	1.79
CA3162E	16	6.95
CA3189E	16	2.79
CA3401N	14	.59

CD—CMOS

Part No.	Pins	Price
CD4001	14	.29
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4008	16	.89
CD4009	16	.59
CD4010	16	.49
CD4011	14	.29
CD4012	14	.29
CD4013	14	.39
CD4014	16	.89
CD4015	16	.39
CD4016	14	.39
CD4017	16	.79
CD4018	16	.79
CD4019	16	.49
CD4020	16	.75
CD4021	16	.75
CD4022	16	.75
CD4023	14	.29
CD4024	14	.69
CD4025	14	.29
CD4026	16	1.59
CD4027	16	.45
CD4028	16	.69
CD4029	16	.89
CD4030	14	.39
CD4034	24	1.79
CD4035	16	.79
CD4040	16	.89
CD4041	14	.69
CD4042	16	.69
CD4043	16	.79
CD4044	16	.79
CD4046	16	.89
CD4047	14	.89
CD4048	16	.59
CD4049	16	.39
CD4050	16	.39
CD4051	16	.79
CD4052	16	.89
CD4053	16	.79
CD4056	16	2.95
CD4059	24	3.95
CD4060	16	.89
CD4066	14	.45
CD4068	14	.39
CD4069	14	.35
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4078	14	.49
CD4081	14	.29
CD4093	14	.49
CD4094	16	1.95
CD4098	16	1.95
CD4099	16	1.89
CD4503	16	.69
CD4508	18	1.29
CD4507	14	1.19
CD4510	16	.85
CD4511	16	.79
CD4512	16	.89
CD4514	24	1.49
CD4515	24	1.49
CD4516	16	.89
CD4518	16	.89
CD4520	16	.89
CD4526	16	1.19
CD4528	16	1.19
CD4529	16	1.49
CD4531	16	.89
CD4538	16	1.49
CD4541	14	1.49
CD4543	16	1.49
CD4562	14	6.95
CD4566	16	2.95
CD4583	16	2.49
CD4584	14	.59
CD4723	16	1.19
CD4724	16	1.19
MC14410	16	8.95
MC14411	24	11.95
MC14412	16	9.95
MC14433	24	17.95
MC14572	16	1.19

(More in Catalog)

74F00

Part No.	Pins	Function	Price
74F00	14	Quad 2-Input NAND Gate	.59
74F02	14	Quad 2-Input NOR Gate	.75
74F04	14	Hex Inverter	.89
74F08	14	Quad 2-Input AND Gate	.75
74F10	14	Triple 3-Input NAND Gate	.75
74F32	14	Quad 2-Input OR Gate	.79
74F74	14	Dual D Flip-Flop	.85
74F86	14	Quad Exclusive OR Gate	1.15
74F109	16	Dual JK Positive Edge Flip-Flop	.95
74F138	16	Expandable 3/8 Decoder	1.69
74F157	16	Quad 2-Input Multiplexer	1.69
74F158	16	Quad 2-Input Multiplexer (Inv.)	1.69
74F193	16	4-Bit Up/Down Binary Counter	5.29
74F240	20	Tri-State Octal Line Driver (Inverting)	3.75
74F244	20	Tri-State Octal Line Driver	3.49
74F257	16	Tri-State Quad 2-Input Multiplexer	1.79
74F373	20	Tri-State Octal Latch	3.49
74F374	20	Tri-State Octal D Flip-Flop	4.59

74ALS00

Part No.	Pins	Function	Price
74ALS00	14	Quad 2-Input NAND Gate	.59
74ALS02	14	Quad 2-Input NOR Gate	.59
74ALS04	14	Hex Inverter	.59
74ALS08	14	Quad 2-Input AND Gate	.59
74ALS10	14	Triple 3-Input NAND Gate	.59
74ALS30	14	8-Input NAND Gate	.59
74ALS32	14	Quad 2-Input OR Gate	.59
74ALS74	14	Dual D Flip-Flop	.79
74ALS109	16	Dual JK Pos. Edge Flip-Flop	.79
74ALS138	16	Expandable 3/8 Decoder	1.25
74ALS240	20	Tri-State Octal Line Driver (Inverting)	2.25
74ALS244	20	Tri-State Octal Line Driver	2.25
74ALS245	20	Octal Bus Transceiver (Non-Inv)	2.59
74ALS373	20	Tri-State Octal Latch	2.59
74ALS374	20	Tri-State Octal D Flip-Flop	2.59

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	Pins	Function	Price
D765AC	40	Floppy Disk Controller	16.95 19.95
D3242	28	Addr. Multiplexer & Refresh Counter	7.95
TMS5501	40	Synchronous Data Interface (8080)	14.95
Z80, Z80A, Z80B, Z8000 SERIES			
Z80	40	CPU (MK3880N)(780C) 2.5MHz	2.75 2.95
Z80-CTC	28	Counter Timer Circuit	3.49
Z80-DART	40	Dual Asynchronous Rec./Trans.	8.95
Z80-DMA	40	Direct Memory Access Circuit	12.49
Z80-PIO	40	Parallel I/O Interface Controller	2.95 3.49
Z80-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	11.49
Z80-SIO/1	40	Serial I/O (Lacks DTRB)	11.49
Z80-SIO/2	40	Serial I/O (Lacks SYNCB)	11.49
Z80-SIO/9	40	Serial I/O	11.49
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	2.95 3.49
Z80A-CTC	28	Counter Timer Circuit	3.95 4.49
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-PIO	40	Parallel I/O Interface Controller	3.95
Z80A-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	11.95
Z80A-SIO/1	40	Serial I/O (Lacks DTRB)	11.95
Z80A-SIO/2	40	Serial I/O (Lacks SYNCB)	11.95
Z80A-SIO/9	40	Serial I/O	11.95
Z80B	40	CPU (MK3880N-6) 6MHz	8.95
Z80B-CTC	28	Counter Timer Circuit	4.95
Z80B-DART	40	Dual Asynchronous Rec./Trans.	19.95
Z80B-PIO	40	Parallel I/O Interface Controller	10.95
Z8001B	48	CPU Segmented (10MHz)	79.95
Z8002B	40	CPU Non-Segmented (10MHz)	59.95
6500/6800/68000 SERIES			
6502	40	MPU with Clock (1MHz)	4.95
6502A	40	MPU with Clock (2MHz)	6.49
6502B	40	MPU with Clock (3MHz)	8.95
6520	40	Peripheral Interface Adapter	3.95
6522	40	Versatile Interface Adapter	5.95
6551	28	Async. Comm. Interface Adapt.	6.95 10.95
6800	40	MPU	2.95
6802CP	40	MPU with Clock and RAM	5.95 7.95
6809	40	CPU – 8-Bit (On-Chip Oscillator)	8.95
6809E	40	CPU – 8-Bit (External Clocking)	8.95
68B09E	40	CPU – 8-Bit (Ext. Clocking) 2MHz	14.95
6810	24	128x8 Static RAM (MC6810)	2.95
6821	40	Peripheral Interface Adapt. (MC6820)	2.75 2.95
68B21	40	Peripheral Interface Adapter (2MHz)	5.95
6845	40	CRT Controller (CRTC)	11.95 14.95
68B45	40	CRT Controller (CRTC) 2MHz	14.95 19.95
6850	24	Asynchronous Comm. Adapter	3.95
6860	24	0-600bps Digital MODEM	7.95
68000L8	64	MPU 16-Bit (8MHz)	39.95
68488P	40	General Purpose Int. Adapter	9.95
8000/80000 SERIES			
8031	40	Control Oriented CPU w/RAM & I/O	12.95 14.95
8035	40	MPU – 8-Bit	4.95 5.95
8039	40	CPU – Sgl. Chip 8-Bit (128 Bits RAM)	4.95 6.95
8040N-6	40	CPU (256 bytes RAM)	9.95
8080	40	CPU – 8-Bit NMOS	2.95 4.95
8073N	40	CPU w/Basic Micro Interpreter	29.95
8080A	40	CPU	3.95
8085A	40	CPU	3.95
8085A-2	40	CPU-8-Bit N-Channel (5MHz)	10.95 14.95
8086-2	40	CPU 16-bit (8MHz)	19.95 24.95
8087	40	Arithmetic Processor	169.95 189.95
8088	40	CPU 8/16-Bit	14.95 19.95
8155	40	HMOS RAM I/O Port-Timer	4.95 6.95
8156	40	RAM with I/O Port and Timer	6.95 8.95
8205	16	Hi Speed 1 out of 8 Binary Decoder	3.95
8212	24	8-Bit Input/Output (74S412)	2.95
8224	16	Clock Generator/Driver	2.95
8228	28	Sys. Cont./Bus Driver (74S428)	3.95 4.95
8237-5	40	High Perf. Prog. DMA Cont. (5MHz)	14.95 19.95
8238	28	System Controller (74S438)	4.95
8243	24	I/O Expander for 48 Series	3.95 4.95
8250N	40	Async. Comm. Element	10.95
8251	28	Prog. Comm. I/O (USART)	4.49 4.95
8251A	28	Prog. Comm. Interface (USART)	4.95 5.95
8253	24	Prog. Inter. l Timer	5.95 6.95
8255	40	Prog. Peripheral I/O (PPI)	4.49 4.95
8255A-5	40	Prog. Peripheral I/O (PPI) 5MHz	4.49 4.95
8259	28	Prog. Interrupt Control	5.95
8272	40	Sgl/Dble Density Floppy Disk Cont.	16.95 19.95
8274	40	Multi-Protocol Serial Cont. (7201)	14.95 29.95
8279	40	Prog. Keyboard/Display Interface	6.95
8282	20	Octal Latch	6.49 6.95
8284	18	Clock Generator/Driver	5.49 6.95
8286	20	Octal Bus Transceiver	6.49 7.95
8287	20	Octal Bus Transceiver (Inverted)	6.49 7.95
8288	20	Bus Controller	14.95 19.95
8303	20	8-Bit Tri-State Bi-Directional Trans.	3.49
8304	20	8-Bit Bi-Directional Receiver	3.49
8310	20	Octal Latched Peripheral Driver	3.95
8741	40	8-Bit Univ. Peripheral Interface	19.95 29.95
8748	40	HMOS EPROM MPU	19.95 30.06
8749	40	MPU 8-Bit (EPROM Version of 8049)	24.95 39.95
8755	40	16K EPROM with I/O	39.95
80186-6	68	High Integration 16-Bit MPU	99.95
80188	68	High Integra. 16-Bit MPU (8-Bit Data Bus)	89.95

SPECIAL FUNCTION

Part No.	Pins	Function	Price
DS0026CN	8	Dual MOS Clock Driver (5MHz)	1.95
INS2651	28	Communication Chip	7.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM5321N	18	TV Camera Sync. Generator	9.95
MM54240N	24	Asynchronous Transmitter/Receiver	5.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro Compatible Time Clock	8.95
MM5369AA/N	8	Prog. Oscillator/Divider (60Hz)	1.79
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

DYNAMIC RAMS

Part No.	Pins	Function	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	1.49
4116N-15	16	16,384x1 (150ns)	1.39 — 8/10.95
4116N-20	16	16,384x1 (200ns)	.79 — 8/5.95
4116N-25	16	16,384x1 (250ns)	.69 — 8/4.95
4164N-150	16	65,536x1 (150ns)	5.49 — 8/39.95
4164N-200	16	65,536x1 (200ns)	3.75 — 8/29.95
MM5261	16	1024x1 (300ns)	.35 — 8/1.95
MM5262	16	2048x1 (450ns)	.35 — 8/1.95
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5298-3	16	8192x1 (200ns)	.59
41256-150	16	262,144x1 (150ns)	16.95
41256-200	16	262,144x1 (200ns)	13.95
4128	16	131,072x1 (250ns)	24.95

STATIC RAMS

Part No.	Pins	Function	Price
2101	22	256x4 (450ns) 8101	1.95
2102	16	1024x1 (450ns)	.89
2102-2L	16	1024x1 (250ns) L.P. (91L02)	1.49
2111	18	256x4 (450ns) 8111	2.49
2112	16	256x4 (450ns) MOS	2.49
2114N	18	1024x4 (450ns)	1.29 — 8/9.95
2114N-L	18	1024x4 (450ns) L.P.	1.39 — 8/10.95
2114N-2	18	1024x4 (200ns)	1.39 — 8/10.95
2114N-2L	18	1024x4 (200ns) L.P.	1.69 — 8/12.95
2147HN	18	4096x1 (70ns)	4.49
2148HN	18	1024x4 (70ns)	4.49
TMS4045	18	1024x4 (450ns)	3.95
TMS40L47-45	20	1024x4 (450ns)	3.95
5101	22	256x4 (450ns) CMOS	3.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-2	24	2048x8 (120ns) CMOS	6.95
HM6116LP-2	24	2048x8 (120ns) CMOS	7.95
HM6116P-3	24	2048x8 (150ns) CMOS	3.95 4.95
HM6116LP-3	24	2048x8 (150ns) L.P. CMOS	5.49
HM6116P-4	24	2048x8 (200ns) CMOS	3.75 4.75
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	4.75 5.49
HM6264P-12	28	8192x8 (120ns) CMOS	27.95
HM6264LP-12	28	8192x8 (120ns) L.P. CMOS	21.95 29.95
HM6264P-15	28	8192x8 (150ns) CMOS	19.95 24.95
HM6264LP-15	28	8192x8 (150ns) L.P. CMOS	17.95 22.95
27LS00	16	256x1 (80ns) L.P.	3.95
7489	16	16x4 (50ns) 3101	2.25
74C921	18	256x4 (250ns) CMOS	5.95
74C930	18	256x4 (250ns) CMOS (8518)	5.95
74S189	16	16x4 (35ns) 93405	2.95
74S289	16	16x4 (35ns) 3101	2.95
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

PROMS/EPROMS

Part No.	Pins	Function	Price
1702A	24	256x8 (1µs)	3.95
2708	24	1024x8 (450ns)	3.95
TMS2516	24	2048x8 (450ns) 2716	3.95
TMS2532	24	4096x8 (450ns) MMC2532	5.95
TMS2564	28	8192x8 (450ns)	10.95
TMS2716	24	2048x8 (450ns) 3 voltage	7.95
2716	24	2048x8 (450ns)	3.49
27C16	24	2048x8 CMOS	12.95
2716-1	24	2048x8 (350ns)	4.95
2716-5	24	2048x8 (550ns)	3.79
2732	24	4096x8 (450ns)	3.95
2732A-20	24	4096x8 (200ns) 21V	7.95
2732A-25	24	4096x8 (250ns) 21V	7.18
2732A-45	24	4096x8 (450ns) 21V	4.49
27C32	24	4096x8 CMOS	14.95
27C32A-30	24	4096x8 (300ns) 21V (CMOS)	22.95
2764-20	28	8192x8 (200ns) 21V	8.95
2764-25	28	8192x8 (250ns) 21V	6.95
2764-45	28	8192x8 (450ns) 21V	5.49
27C64	28	8192x8 CMOS 21V	14.95
MCM68764	24	8192x8 (450ns) 24 pin	14.95
27128-25	28	16,384x8 (250ns) 128K 21V	14.95
27256-25	28	32,768x8 (250ns) 256K (14V)	49.95
74S188	16	32x8 PROM O.C. (6330-1)	1.75
74S287	16	256x4 PROM T.S. (6301-1)	1.79
74S288	16	32x8 PROM T.S. (6331-1)	1.79
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	4.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM O.C. (MB7056H)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S476	16	1024x4 PROM T.S.	2.95
74S478	24	1024x8 PROM T.S.	5.95
74S570	16	512x4 PROM O.C.	2.95
74S571	16	512x4 PROM O.C. (6305)	2.95
74S572	18	1024x4 PROM O.C.	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	2.95
82S129	16	256x4 PROM T.S. (27S21)	2.95
82S130	16	512x4 PROM O.C. (27S12)	3.95
82S185	18	2048x4 PROM T.S. (18P24581)	9.95
82S191	24	2048x8 (80ns)	14.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	14.95

DATA ACQUISITION

Part No.	Pins	Function	Price
DC10		Mostek DC/DC Converter +5V to −9V	2.95
ADC0801	20	8-Bit A/D Converter (1/4LSB)	14.95
ADC0803	20	8-Bit A/D Converter (±1/2LSB)	4.95
ADC0804	20	8-Bit A/D Converter (1LSB)	3.49
ADC0808	28	8-Bit A/D Conv w/8-Channel Analog	9.95
ADC0809	28	8-Bit A/D Converter (8-Ch. Multi.)	4.49
ADC0816	40	8-Bit A/D Conv w/16-Channel Analog	14.95
ADC0817	40	8-Bit A/D Converter (16-Ch. Multi.)	9.49
DAC0806	16	8-Bit D/A Converter (0.78% Lin.)	1.95
DAC0807	16	8-Bit D/A Converter (MC1408-7)	1.49
DAC0808	16	8-Bit D/A Converter (MC1408-8)	2.25
DAC0830	20	8-Bit Up D/A Conv. (.05% Lin.)	5.95
DAC0831	20	8-Bit Up D/A Conv. (.10% Lin.)	4.49
DAC1000	24	10-Bit D/A Conv. Micro. Comp. (0.05%)	7.95
DAC1008	20	10-Bit D/A Conv. Micro. Comp. (0.20%)	6.95
DAC1020	16	10-Bit D/A Conv. (0.05% Lin.)	7.95
DAC1022	16	10-Bit D/A Conv. (0.20% Lin.)	5.95
DAC1222	18	12-Bit D/A Conv. (0.20% Lin.)	6.95
DAC1230	20	12-Bit Up D/A Conv. (.05% Lin.)	14.95
DAC1231	20	12-Bit Up D/A Conv. (.10% Lin.)	13.95
AY-5-1013A	40	30K Baud UART (TR1602)	3.95

DISK CONTROLLERS

Part No.	Pins	Function	Price
WS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	24.95
FD1793	40	Single/Double Density (True)	26.95
FD1795	40	Dual Density/Side Select (Inv.)	26.95
FD1797	40	Dual Density/Side Select (True)	29.95
WD2791	40	Single/Double Density (Inv.)	39.95
WD2793	40	Single/Double Density (True)	39.95
WD2797	40	Dual Density/Side Select (True)	39.95

Digitalker™

DT1050— Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc. The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ .... $34.95 ea.
MM54104 Processor Chip..... $14.95 ea.

DT1057—Expands the DT1050 vocabulary from 137 to over 260 words, incl. 2 ROMs and specs.
Part No. DT1057.............. $24.95 ea.

INTERSIL

Part No.	Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit	28	Stopwatch Chip, XTL (Evaluation Kit)	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	10.49
FE0202D	40	4 Digit LCD Display for 7211IPL & 7211MIPL	14.95
FE0203D	40	3½ Digit LCD Display for 7106 & 7116	14.55
7106EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
7107CPL	40	3½ Digit A/D (LED Drive)	10.95
7107EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD.	10.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	14.95
7205EV/Kit	24	Stopwatch Chip, XTL (Evaluation Kit)	16.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit	16	Tone Generator Chip, XTL (Evaluation Kit)	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit	14	Freq. Counter Chip, XTL (Evaluation Kit)	8.49
7211IPL	40	4 Digit LCD Display Decoder/Driver (TTL compatible)	7.95
7211MIPL	40	4 Digit LCD Display Decoder/Driver (Microproc. compat.)	8.95
7215IPG	24	4 Func. CMOS Stopwatch CKT.	16.95
7215EV/Kit	24	4 Func. Stopwatch Chip, XTL (Evaluation Kit)	19.49
7216AIJI	28	8 Digit Univ. Counter C.A.	31.49
7216DIPI	28	8 Digit Freq. Counter C.C.	21.49
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	9.95
7224IPL	40	LCD 4½ Digit Up Counter DRI.	10.95
7226AEV/Kit	40	5 Function Counter Chip, XTL (Evaluation Kit)	99.95

30009 1983 INTERSIL Data Book (1356p.) $9.95

74HC High Speed CMOS

Part No.	Pins	Price
74HC00	14	.59
74HC02	14	.59
74HC03	14	.89
74HC04	14	.59
74HCU04	14	.69
74HC08	14	.59
74HC10	14	.59
74HC11	14	.69
74HC14	14	.89
74HC20	14	.59
74HC27	14	.59
74HC30	14	.69
74HC32	14	.79
74HC42	16	1.09
74HC51	14	.89
74HC58	14	.89
74HC73	14	.79
74HC74	14	.79
74HC75	16	.99
74HC76	16	.79
74HC85	16	1.69
74HC86	14	.75
74HC107	14	.79
74HC109	16	.79
74HC112	16	.79
74HC123	16	2.29
74HC125	14	1.75
74HC132	14	1.29
74HC137	16	1.59
74HC138	16	1.19
74HC139	16	1.05
74HC147	16	1.29
74HC151	16	.99
74HC153	16	1.09
74HC154	24	2.65
74HC157	16	.99
74HC158	16	.99
74HC160	16	1.39
74HC161	16	1.39
74HC162	16	1.39
74HC163	16	1.39
74HC164	14	1.35
74HC165	16	2.15
74HC166	16	2.49
74HC173	16	1.29
74HC174	16	1.09
74HC175	16	1.09
74HC190	16	1.59
74HC191	16	1.59
74HC192	16	1.49
74HC193	16	1.49
74HC194	16	1.19
74HC195	16	1.19
74HC221	16	2.95
74HC237	16	1.49
74HC240	20	2.29
74HC241	20	2.29
74HC242	14	2.15
74HC243	14	2.15
74HC244	20	2.29
74HC245	20	2.59
74HC251	16	.99
74HC253	16	1.09
74HC257	16	.99
74HC259	16	1.69
74HC266	14	.69
74HC273	20	2.79
74HC280	14	4.59
74HC299	20	5.59
74HC366	16	2.59
74HC367	16	2.59
74HC373	20	2.69
74HC374	20	2.69
74HC390	16	1.59
74HC393	14	1.59
74HC533	20	2.69
74HC534	20	2.69
74HC595	16	3.19
74HC688	20	3.59
74HC4024	14	1.75
74HC4040	16	1.49
74HC4060	16	1.49
74HC4075	14	.59
74HC4078	14	.59
74HC4511	16	1.95
74HC4514	24	4.19
74HC4538	16	2.59
74HC4543	16	3.75

74HCU04 is unbuffered
All others are buffered

74C—C/MOS

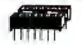
Part No.	Pins	Price
74C00	14	.29
74C02	14	.35
74C04	14	.35
74C08	14	.35
74C10	14	.35
74C14	14	.59
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.19
74C48	16	1.79
74C73	14	.69
74C74	14	.59
74C85	16	1.39
74C86	14	.29
74C89	16	5.95
74C90	14	1.09
74C93	14	1.09
74C95	14	1.19
74C107	14	.79
74C151	16	2.19
74C154	24	3.25
74C157	16	1.75
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.29
74C165	16	1.29
74C173	16	.89
74C174	16	1.19
74C175	16	1.19
74C192	16	1.39
74C193	16	1.39
74C195	16	1.29
74C221	16	1.75
74C240	20	1.95
74C244	20	1.95
74C373	20	2.29
74C374	20	2.29
74C901	14	.59
74C902	14	.79
74C903	14	.59
74C906	14	.59
74C907	14	.89
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	16	5.95
80C95	16	.69
80C97	16	.69

LINEAR

Part No.	Pins	Price
TL071CP	8	.79
TL072CP	8	1.09
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM109K		5.95
LM301CN	8	.39
LM302H		2.49
LM304H		1.95
LM305H		.99
LM307CN	8	.49
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.95
LM311CN	8	.59
LM312H		2.79
LM317T		1.19
LM317K		3.49
LM318CN	8	1.59
LM319N	14	1.49
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320K-24		1.35
LM320T-5		.85
LM320T-12		.85
LM320T-15		.85
LM320T-24		.85
LM322N	14	1.49
LM323K		4.95
LM324N	14	.59
LM329DZ		.65
LM331N	8	3.95
LM334Z		1.19
LM335Z		1.29
LM336Z		1.09
LM337MP		1.15
LM337T		1.89
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35
LM340K-24		1.35
LM340T-5		.75
LM340T-12		.75
LM340T-15		.75
LM340T-24		.75
LF347N	14	1.49
LM348N	14	.69
LM350K		4.79
LF351N	8	.59
LF353N	8	.89
LF355N	8	1.09
LF356N	8	1.09
LM358N	8	.59
LM359N	14	1.79
LM370N	14	4.95
LM373N	14	4.95
LM377N	14	1.95
LM380CN	8	1.09
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.49
LM384N	14	1.95
LM386N-3	8	.89
LM387N	8	1.39
LM389N	16	1.19
LM391N-80	16	1.19
LM392N	8	.59
LM393N	8	.45
LF398N	8	3.95
LM399H		5.95
LF412CN	8	1.95
TL494CN	16	2.79
TL496CP	8	1.59
NE531V	8	1.79
NE544N	14	1.95
NE550A	14	1.95
NE555V	8	.35
XR-L555	8	.69
LM556N	14	.79
NE558N	16	1.59
NE564N	16	1.95
LM565N	14	.99
LM566CN	8	1.49
LM567V	8	.99
NE570N	16	2.95
NE571N	16	2.49
NE592N	14	1.19
LM703CN	8	1.49
LM710N	14	.69
LM711N	14	.79
LM723N	14	.49
LM733N	14	.89
LM739N	14	1.95
LM741CN	8	.39
LM747N	14	.69
LM748N	8	.59
UA760HC		9.95
LM1456V	8	1.95
LM1458CN	8	.59
LM1488N	14	.69
LM1489N	14	.69
LM1496N	14	.99
LM1605CK		9.95
LM1800N	16	2.49
LM1871N	18	2.95
LM1872N	16	3.25
LM1877N-9	14	2.95
LM1889N	16	1.95
LM1896N	14	1.59
LM2002T		1.95
ULN2003A	16	1.49
XR2206	16	3.95
XR2207	14	2.49
XR2208	16	1.79
XR2211	14	2.95
LM2877P		1.95
LM2878P		2.95
LM2901N	14	.79
LM2902N	14	.89
LM2907N	14	2.49
LM2917N	8	1.95
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.89
LM3914N	18	2.39
LM3915N	18	2.39
LM3916N	18	2.39
RC4136N	14	1.25
RC4151NB	8	1.95
RC4195TK		5.95
LM4250CN	8	1.49
LM4500A	16	2.95
NE5532	8	1.69
NE5534	8	1.39
79M05AH		1.29
ICL8038	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19
76477	28	3.95

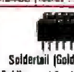
MORE AVAILABLE

30003 1982 Nat. Linear Data Book (1952 pgs.) . $11.95



Low Profile (Tin) Sockets

Part No.	1-9	10-99	100-up
8 pinLP	.16	.14	.13
14 pinLP	.17	.15	.14
16 pinLP	.19	.17	.16
18 pinLP	.26	.24	.23
20 pinLP	.30	.27	.25
22 pinLP	.31	.28	.26
24 pinLP	.33	.30	.28
28 pinLP	.40	.37	.35
40 pinLP	.49	.46	.43



Soldertail (Gold) Standard

Part No.	1-9	10-99	100-up
8 pinSG	.39	.35	.29
14 pinSG	.49	.45	.39
16 pinSG	.55	.49	.45
18 pinSG	.65	.59	.51
20 pinSG	.75	.65	.59
22 pinSG	.79	.69	.65
24 pinSG	.79	.69	.65
28 pinSG	.95	.85	.75
36 pin SG	1.25	1.15	.99
40 pinSG	1.39	1.25	1.15

Wire Wrap Sockets (Gold) Level #3

Part No.	1-9	10-99	100-up
8 pin WW	.55	.49	.45
10 pin WW	.69	.65	.59
14 pin WW	.75	.69	.65
16 pin WW	.79	.72	.65
18 pin WW	.95	.85	.75
20 pin WW	1.19	1.09	.95
22 pin WW	1.29	1.19	1.05
24 pin WW	1.35	1.19	1.09
28 pin WW	1.69	1.55	1.39
36 pin WW	1.89	1.79	1.69
40 pin WW	2.29	1.95	1.79

Header Plugs (Gold)

Part No.	1-9	10-99	100-up
14 pin HP	.65	.59	.55
16 pin HP	.69	.65	.59
24 pin HP	1.15	.99	.89

Header Covers

Part No.	1-9	10-99	100-up
14 pin HC	.15	.13	.12
16 pin HC	.19	.17	.15
24 pin HC	.29	.25	.22

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RS232 Adapter for VIC-20 and Commodore 64

The JE232CM allows connection of standard serial RS232 printers, modems, etc. to your VIC-20 and C-64. A 4-pole switch allows the inversion of the 4 control lines. Complete installation and operation instructions included.

• Plugs into User Port • Provides Standard RS232 signal levels • Uses 6 signals (Transmit, Receive, Clear to Send, Request to Send, Data Terminal Ready, Data Set Ready).

JE232CM $39.95

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APPLICATIONS: • Security Warning • Teaching • Instrumentation • Telecommunication • Handicap Aid • Games

Part No.	Description	Price
JE520CM	For Commodore 64 & VIC-20	$114.95
JE520AP	For Apple II, II+, and *IIe*	$149.95

All Major Manufacturers- Not Micron

Computer Memory Expansion Kits

IBM PC, PC XT and Compatibles

Most of the popular Memory Boards (e.g. Quadram™ Expansion Boards) allow you to add an additional 64K, 128K, 192K or 256K. The IBM64K Kit will populate these boards in 64K byte increments. The Kit is simple to install—just insert the 9 - 64K RAM chips in the provided sockets and set the 2 groups of switches. Complete conversion documentation included.

IBM64K (Nine 200ns 64K RAMs). $33.49

IBM PC AT

Each kit comes complete with nine 128K dynamic RAMs and documentation for conversion

IBM128K (Nine 250ns 128K RAMs). $199.95

APPLE *IIe*

Extended 80-Column/64K RAM Card. Expands memory by 64K to give 128K when used with programs like VisiCalc™. Fully assembled and tested.

JE864. . . . . $99.95

TRS-80 MODEL I, III

Each Kit comes complete with eight MM5290 (UPD416/4116) 16K Dynamic RAMs and documentation for conversion. Model 1: 16K equipped with Expansion Interface can be expanded to 48K with 2 Kits. Model III: Can be expanded from 16K to 48K using 2 Kits. Each Kit will expand computer by 16K increments.

TRS-16K3 200ns (Model III). $6.29
TRS-16K4 250ns (Model 1). $5.49

TRS-80 MODEL IV & 4P

Easy to install Kit comes complete with 8 ea. 4164N-20 (200ns) 64K Dynamic RAMs and conversion documentation. Converts TRS-80 Model IV computers from 16K to 64K. Also expands Model 4P from 64K to 128K.

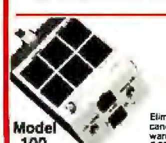
TRS-64K-2. . . . . $29.95
(Converts the Model IV from 16K to 64K or will expand the Model 4P from 64K to 128K)

TRS-64K2PAL (Model IV only). $49.95
(8 - 4164's with PAL Chip to expand from 64K to 128K)

TRS-80 COLOR AND COLOR II

Easy to Install Kit comes complete with 8 each 4164N-20 (200ns) 64K Dynamic RAMs and documentation for conversion. Converts TRS-80 Color Computers with D, E, ET, F and NC circuit boards to 32K. Also converts TRS-80 Color Computer II to 64K. Flex DOS or OS-9 required to utilize full 64K RAM on all computers.

TRS-64K-2. . . . . $29.95



INDUSTRIES

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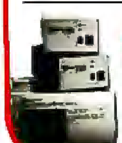
DATASHIELD® Surge Protector

Eliminates voltage spikes and EMI-RFI noise before it can damage your equipment or cause data loss. 6-mo warranty. Power dissipation (100 microseconds): 2,000,000 watts

PART NO.	DESCRIPTION	PRICE
MODEL 75	4 Sockets, On/Off Switch.	$49.95
MODEL 85	6 Sock., Super Filters, On/Off Switch.	$59.95
MODEL 100	6 Sock., Super Filters, Low Volt. Alarm.	$69.95
MODEL 110AMS	6 Sockets, Super Filters, Auto. Master Switch.	$99.95



DATASHIELD® Back-Up Power Source

Protect your computer from black-outs, brown-outs, power surges and line noise. PTI's PC200 is designed for PCs with floppy disk memory, the XT300 for hard disk memory and the AT800 for multi-user systems. A typical compatible PC for each of these standbys will be supported for 15 to 25 minutes after power is lost. Weight (PC200: 24 lbs.) — (XT300: 37.5 lbs.) — (AT500: 83 lbs.) — (AT800: 83 lbs.)

PC200	(200 Watt Rating).	$299.95
XT300	(300 Watt Rating).	$399.95
AT500	(500 Watt Rating).	$699.95
AT800	(800 Watt Rating).	$799.95

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PROMETHEUS

Intelligent 300/1200 Baud Telephone Modem with Real Time Clock/Calendar

The ProModem™ is a Bell 212A (300/1200 baud) intelligent stand-alone modem • Full featured expandable modem • Standard features include Auto Answer and Auto Dial, Help Commands, Programmable Intelligent Dialing, Touch Tone™ and Pulse Dialing & More • Hayes command set compatible plus an additional extended command set• Shown w/alphanumeric display option.

Part No.	Description	Price
PM1200	RS-232 Stand Alone Unit.	$349.95
PM1200A	Apple II, II+ and *IIe* Internal Unit.	$369.95
PM1200B	IBM PC and Compatible Internal Unit.	$269.95
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PM-COM	(ProCom Communication Software). Please specify Operating System.	$79.95
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PMO-16K	(Options Processor Memory – 16K).	$10.95
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KB-A68	68-Key Apple Keyboard only.	$ 79.95
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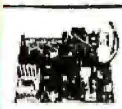

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THE TRANSPUTER

Transputers has the same interface as a single Transputer in much the same way as an assembly of Lego bricks has the same interface (lugs and holes) as a single brick. A big Transputer can be built out of four Transputers, as shown in figure 6a. This Transputer can in turn be used as a building block to make a bigger Transputer (figure 6b), and so on. These big and bigger Transputers present the user with exactly the same four link interfaces as did the original Transputer.

A further analogy with Lego bricks is that they come in different shapes and sizes and with different numbers of lugs and holes. Transputers will have different word lengths, different processor speeds, and different memory interfaces, but they will all use the same links, run off the standard 5-MHz input clock, and be programmable in Occam.

The analogy holds just as well with Occam processes as it does with Transputers.

One respect in which the analogy with Lego bricks does not hold is that Lego bricks are constrained to connect to their immediate neighbors. In many Transputer networks, most of the connections will also be between adjacent Transputers, but the links do

(continued)

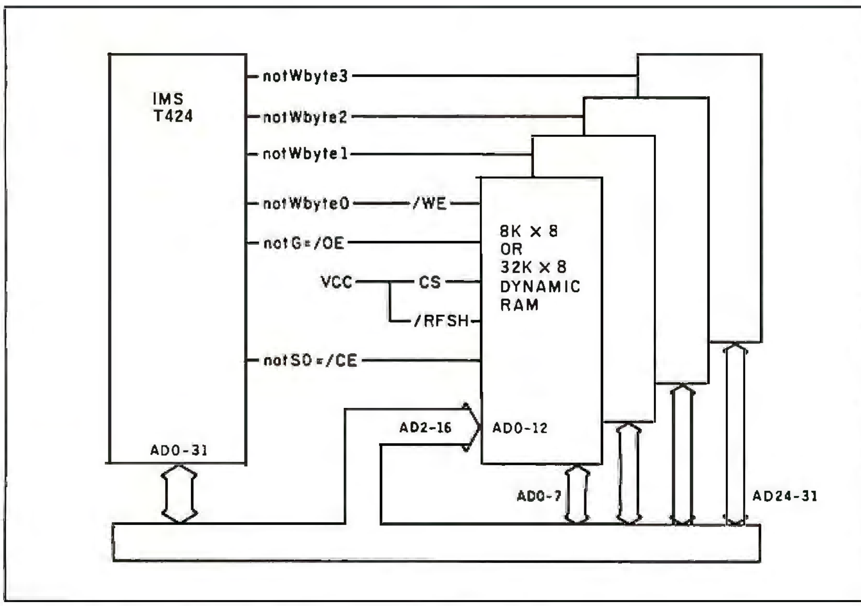

Figure 3: *Four byte-wide RAMs connected to a* T424.

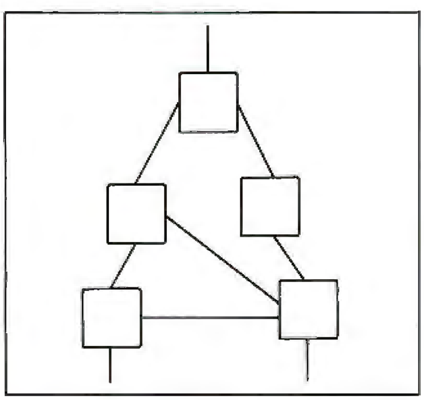

Figure 4: A *random, possibly functionally distributed, network.*

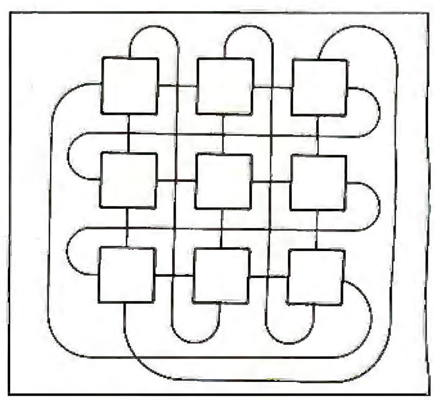

Figure 5: A *toroidally connected array.*

The right network isn't a matter of choice. It's a matter of fact.

Fact: You can't buy smarter than an OMNINET™ Network.

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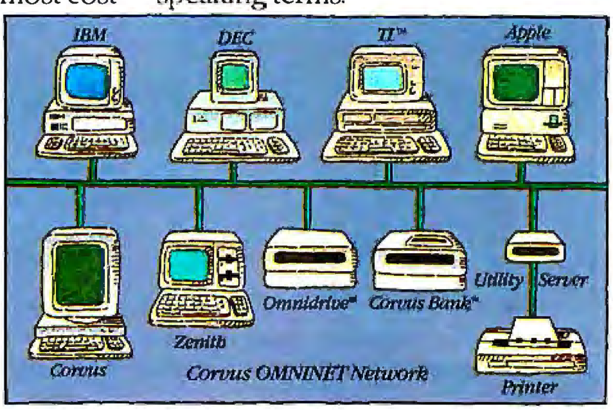

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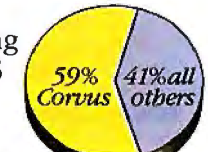

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not force this constraint, as the toroidal network in figure 5 shows.

Using Transputers

For the small computer, a simple base product might contain one to four Transputers, probably in a functionally distributed network with one Transputer handling file I/O (input/output) and another handling the screen. More performance could be achieved with add-on boards; it would be possible to add Transputers and memory in much the same way that memory add-on boards are used now.

If the add-on board has four Transputers, each with four 32K by 8-bit RAMs, as in figure 3, the board would have a processing power of 20 to 40 MIPS and a memory of ½ megabyte. Four boards would produce 80 to 160 MIPS and 2 megabytes. An alternative, densely packed add-on board might have two Transputers, each with thirty-two 256K by 1-bit dynamic RAMs. Four of these boards would produce 40 to 80 MIPS and 8 megabytes. Four of either add-on board produces a machine that could fairly be described as a "personal supercomputer."

Transputer-based add-on boards could alternatively be used with an

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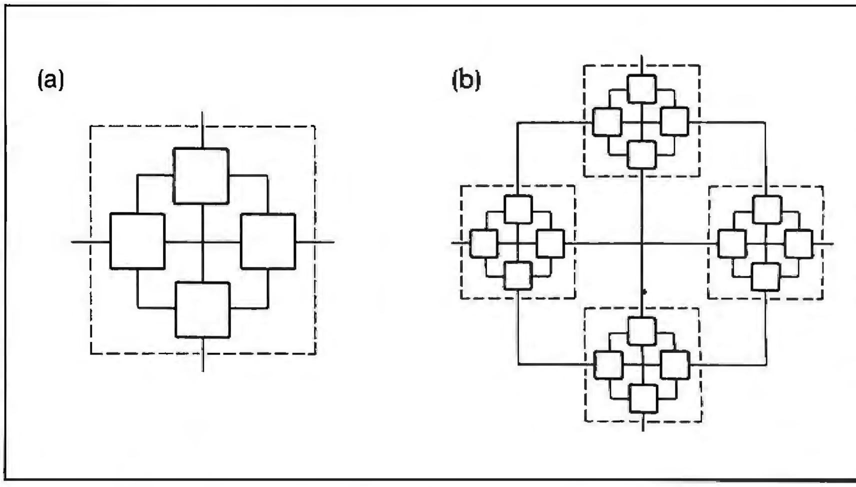

Figure 6: *(a) A big Transputer built from four Transputers. (b) A bigger Transputer built from four big Transputers.*

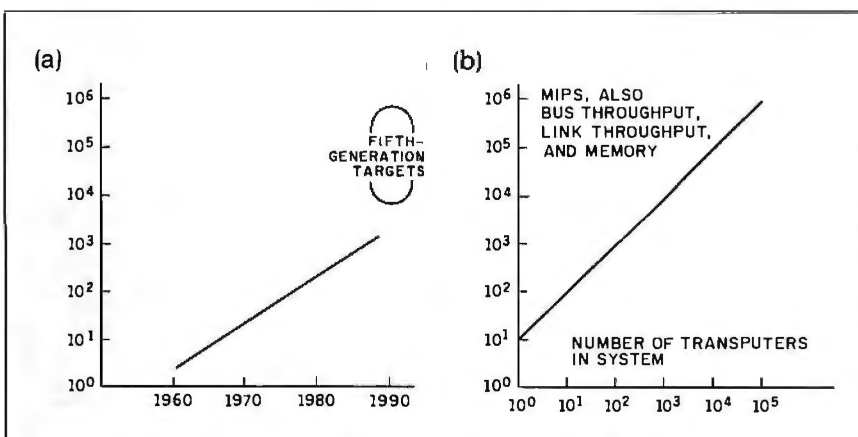

Figure 7: *(a) Conventional system throughput (in MIPS) by year (very approximate). (b) Transputer system throughput as a function of the number of Transputers in the system.*

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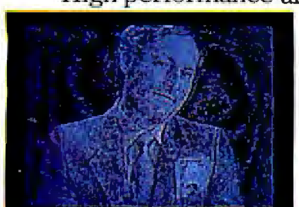
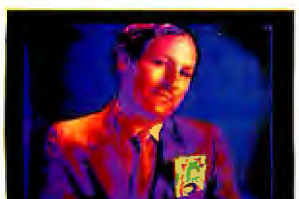


Laplacian Filter



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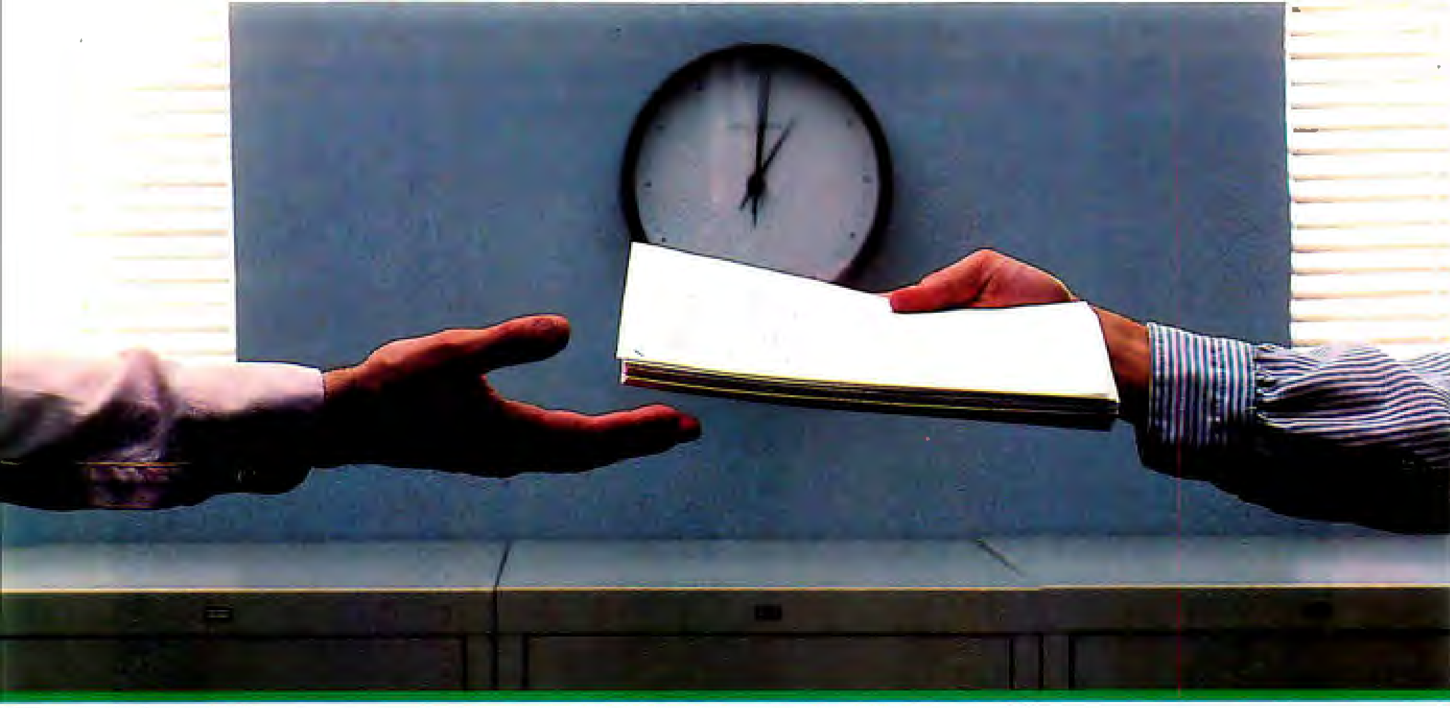

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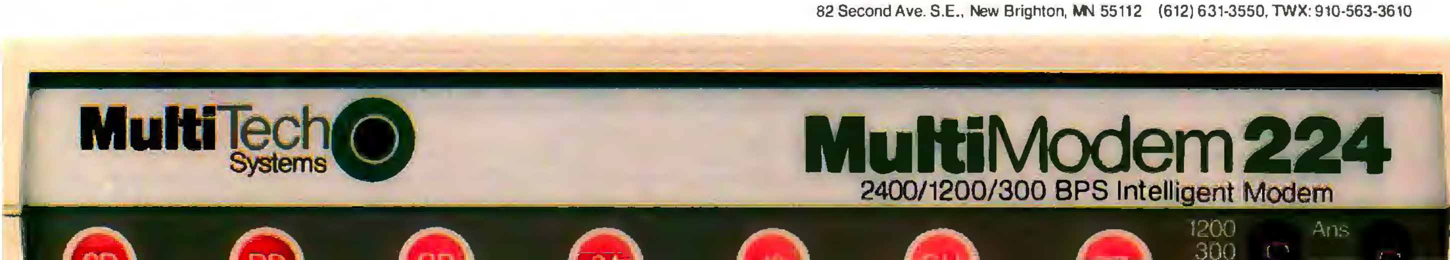

Performance is a function of the number of Transputers.

existing computer, similar to Steve Ciarcia's Trump Card (reference 9).

The linear increase in performance with the number of Transputers used makes the Japanese Fifth Generation targets achievable as a function of the number of Transputers rather than as a function of years (figure 7). ■

ACKNOWLEDGMENTS

I would like to acknowledge the help of colleagues in Bristol, England, and Colorado Springs, Colorado, in the preparation of this article. Particular thanks to Phil Atkin and Owen Ransen, who developed the ray-tracing program used in the panel.

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- IFDEF, IFNDEF
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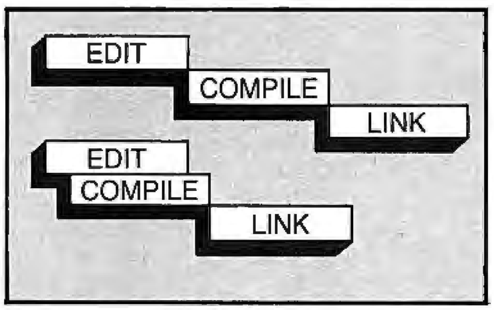

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DATA-MOVEMENT PRIMITIVES

BY J. ERIC ROSKOS AND CHING-DONG HSIEH

A low-cost implementation of an innovative technique for sharing memory

THE MOST COMMON digital-computer architectures use primary memory having two access primitives. These primitives are the lowest-level operations in the system. Typically, the *read* operation nondestructively copies a value stored in a memory location to a location in the central processing unit (CPU) known as a *register*. The *write* operation writes over an existing value in primary memory with a value from the processor's registers.

In single-process systems, and in multiprocess systems that do not use shared memory, these operations are generally sufficient for the manipulation of data. Although a time lapse occurs between the reading and rewriting of data, no problems will result since only one process is accessing the data.

In multiprocess systems accessing shared data, this is not the case. Two processes that execute a statement on a common variable in overlapping time will both read the same value, increment it, and rewrite it; the second process writes over the value produced by the first process without taking that value into account.

Other problems exist in multiprocess data sharing. In *producer/consumer* process pairs, for example, one process produces a data stream that the other process consumes. Problems include preventing the consumer from accessing memory locations that have not been filled by the producer and the producer from writing over data in the shared buffer before the consumer has acquired the previously written data.

To solve these problems, we have defined *data-movement primitives*, which are concerned with the movement of data between the central processor(s) and main memory. These primitives actually remove data from a location upon reading it. Thereafter, if a second process tries to read at that location, an interrupt is generated—the process has to wait until data is present to continue. Similarly, if a location already has data and a second process attempts to write over it, an interrupt is generated. We have defined the data-movement primitives as get and put.

To demonstrate the feasibility of constructing a multiprocessor system using data-movement primitives, our research team built a three-CPU multiprocessor based on the Motorola 6800 microprocessor. On September 27, 1984, this system successfully executed its first concurrent program, an implementation of Per Brinch Hansen's "incorrect" program (see reference 1). Such a system is not only feasible, it is inexpensive; the cost of the entire multiprocessor system was around $450. The project also demonstrated the effectiveness of the data-movement primitives by successfully executing a program that would not have functioned correctly on a conventional machine.

SELECTION OF HARDWARE

Planning for a multiprocessor system began in late summer of 1983. We examined several implementation methods. The first of these involved the use of 6502-based Apple II CPU boards. These had two significant advantages: a "set overflow" (SO) pin could be used to set a condition code indicat-

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ing the no-data-present condition, and no debugging of the CPU hardware itself would be necessary. The boards were also available at low cost. We discarded this option, however, because no test equipment for 6502s was available to us.

We next examined the use of an IBM CS9000 system, which is based on the Motorola 68000, with additional 68000s for the added CPUs. Unfortunately, time constraints and other difficulties made this implementation impossible.

We decided finally on the use of Motorola 6800s. Such a design had several disadvantages. The 6800 is an old-technology microprocessor. You cannot stop the instruction-execution sequence for more than a few milliseconds once an instruction has begun execution; thus we could not implement the primitive wait at the hardware level as we could have with the 68000 processor. Also, the 6800 does not have an SO pin as the 6502 does. Thus, interrupts would have to be used to signal the exception condition, with software simulating the wait primitive. The 6800 also has no support for multiprocessor operation; it has no test-and-set instruction. This meant that we would not be able to obtain empirical results comparing the traditional synchronization primitives with the data-movement primitives, without the use of indirect simulation methods.

On the other hand, we had considerable resources in the form of test equipment lent to us by Vanderbilt's electrical engineering department, which uses the 6800 in its microprocessor course. Furthermore, we could implement the machine easily and at low cost, thanks to the low price of 6800s and our prior experience with 6800 system design. The graduate school was also willing to provide funding for such a project.

We selected an IBM Personal Computer, based on the Intel 8088, to serve as the host processor for the system. Again, this choice was largely practical in nature; an IBM PC was available, and Eric Roskos had very extensive experience with the machine, having previously constructed peripheral control interfaces for it and written a 6800 cross-assembler for use with it.

SYSTEM DESIGN

We designed the system with three 6800 microprocessors, each with its own private memory, and a memory shared by all three CPUs, supporting the data-movement primitives. The IBM PC would serve as a host machine, on which we could quickly edit, assemble, and download programs to the multiprocessor.

Each CPU's private memory was shared with the IBM PC and would be

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accessible to the IBM PC only when its CPU was halted; we made this design decision to simplify design of the interface for the private memories.

We designed the multiprocessor with no read-only memory (ROM) whatsoever. While most people considered this a somewhat radical design decision, it was a carefully planned one. No real justification exists for putting ROM on a system of this sort. The ROM is needed to start execution of one CPU in the system, but this role was already filled by the ROM in the IBM PC. On the other hand, the use of ROM would have caused considerable time delays in loading test programs and debugging software (which requires erasing old ROMs and reprogramming new ones) and would have placed physical stresses on the CPU boards due to repeated removal and insertion of ROMs. Also, the use of ROM requires an unnecessary design trade-off: Code in ROM is immediately available at power-up, but you cannot modify it without physically replacing the ROM. We expected that we would need the ability to modify a test system such as this, and we were right.

Instead of ROM, we used the 2K-byte private memories to contain programs. We also incorporated a "halt register" and a "reset register," which are simple latches and with which we could individually halt or reset each of the three CPUs. When initially powered up, the halt register halted the multiprocessor's CPUs, the IBM PC loaded the program (including the RESET vector used at start-up) via the private memories, and the reset register then started the CPUs. To simplify implementation, we did not include a register to indicate whether a CPU had halted via the programmed halt instruction—although this would have been beneficial. This information is available on the processor's "bus available" (BA) pin.

IMPLEMENTATION DETAILS

The implementation for the multiprocessor system is shown in figure 1. The IBM PC is interfaced to the halt and reset registers via the PC's I/O (input/output) instructions, and the addresses of the registers are in the I/O address space of the PC at addresses 300 and 301 (hexadecimal). The IBM PC also interfaces to 3 three-state controllers. These controllers connect the private memories to the PC's bus—during reads or writes to their respective addresses—only if the corresponding CPU is halted via the halt register. The private memories start at the PC's memory addresses C0000, C0800, and C1000 for Processor 0, Processor 1, and Processor 2, respectively. Each memory is a 2K-byte Hitachi 6116 static RAM (random-access read/write memory), which is

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Each processor is interfaced directly to its respective private memory. Since the 6800's bus interface is in the high-impedance state whenever it is halted, and since the IBM PC interface's three-state controllers are only enabled when the corresponding CPU is halted, this guarantees mutually exclusive access to the private memory. The IBM PC can, in the worst case, attempt to access the private memory when the attached CPU is running; but since the three-state controller will be disabled, data written will not be passed through to the private memory, and reads will return meaningless data since nothing will be driving the bus during the read—no damage to the system will occur.

The interface between the CPUs and the shared memory is considerably more complex. Each CPU is interfaced through a three-state controller that switches both address and data lines onto the shared-memory bus. When a CPU outputs an address in the address space occupied by shared memory (which starts at address 3000 [hexadecimal] for all three processors), the address is immediately decoded by the address-decode logic (which appears to the right of each CPU in figure 1) and asserts request line R*n*, where *n* is the number of the CPU making the request. This line transmits the request to the arbitration logic, described in detail below, which asserts grant line G*n* if and only if Processor *n* is currently allowed to access shared memory. If a request line is asserted but the arbitrator does not assert the corresponding grant line, the processor's clock is immediately halted, suspending instruction execution until the grant line is asserted. (This is not shown on the diagram in figure 1, which does not include the processor clock logic. The clock-halting function is controlled by a Motorola 6875 clock generator, which has a Memory Ready control pin designed for this purpose. We specifically chose the 6875 clock generator for this feature.) The three-state controller assures that a CPU that has not been granted access to the shared memory will not output data onto the shared-memory bus.

ENTERING ARBITRATION

The arbitrator guarantees all CPUs equal access to the shared memory. We designed and implemented our memory arbitrator using a National Semiconductor PAL (Programmable Array Logic), a trademarked PLA (programmable logic array) having only one programmable-gate plane. The other plane normally found in PLAs is replaced by a fixed set of gates, with different PALs available for dif-

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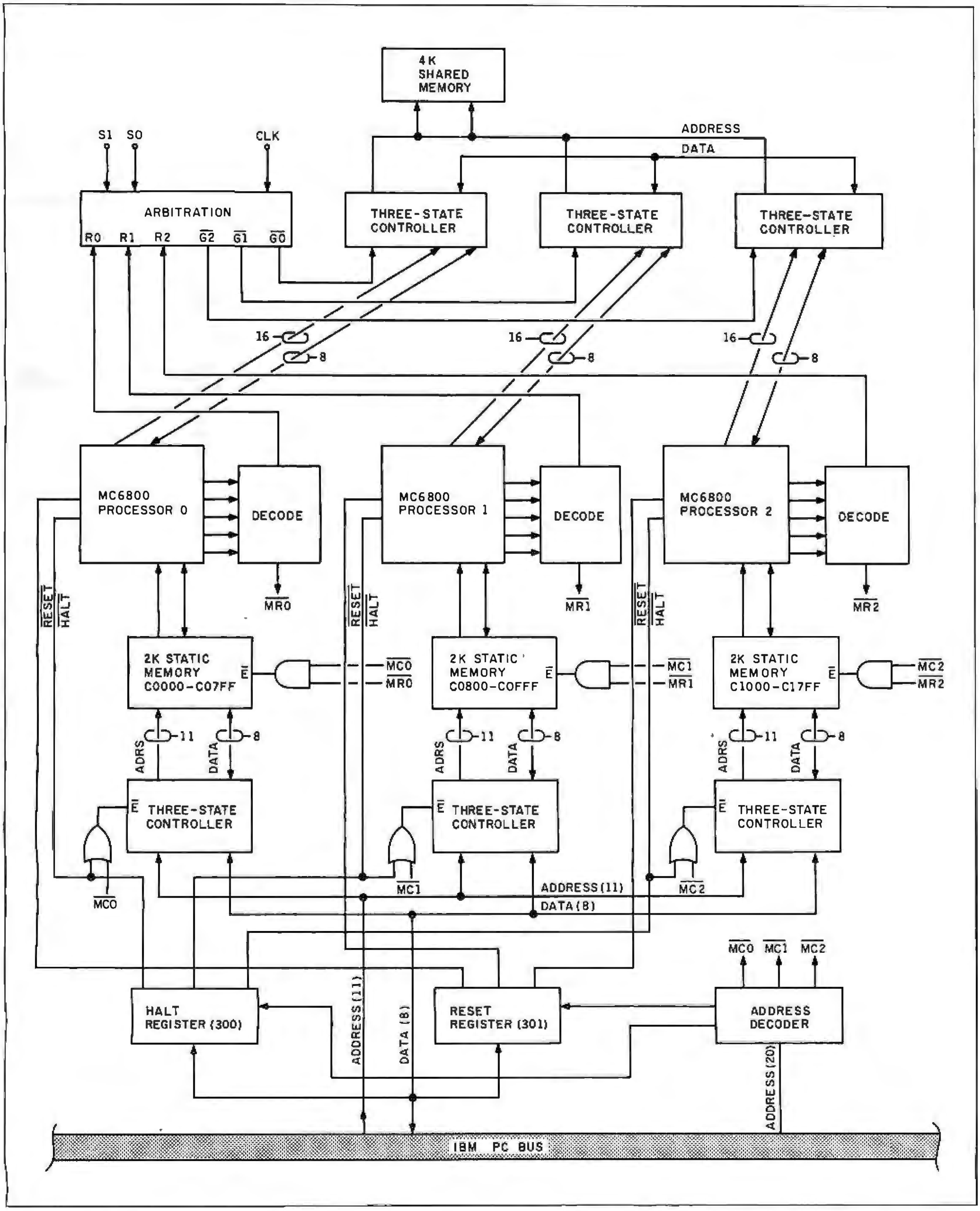

Figure 1: A *block diagram of the multiprocessor, built around three* MC6800 *microprocessors and controlled by an* IBM PC.

ferent gate configurations.

Our arbitrator implements the finite-state machine whose transition table is shown in table 1. Such finite-state machines are quite common in the control logic of CPUs, and this design, the Mealy Finite-State Transducer, was suggested by Mead and Conway's *Introduction to VLSI Systems* (reference 2), whose chapter "Data and Control Flow in Systematic Structures" provides a very thorough discussion of the principles used here.

The arbitrator's current state (denoted by S_1, S_0) reflects which CPU

(continued)

Table 1: *The memory-arbitration state table for the multiprocessor, based upon the Mealy Finite-State Transducer. Depending on the current state (which CPU was last granted access to the shared memory) and which CPUs are now requesting access to memory (R_0 to R_2), the arbitrator grants access to shared memory, via output lines G_0 to G_1.*

Input					Output				
Currrent State		Access Requests			Access Granted			Next State	
S_1	S_0	R_0	R_1	R_2	G_0	G_1	G_2	S_1	S_0
0	0	0	0	0	0	0	0	0	0
		0	0	1	0	0	1	0	0
		0	1	0	0	1	0	0	0
		0	1	1	0	1	0	1	0
		1	0	0	1	0	0	0	1
		1	0	1	1	0	0	1	0
		1	1	0	1	0	0	0	1
		1	1	1	1	0	0	0	1
0	1	0	0	0	0	0	0	0	1
		0	0	1	0	0	1	0	1
		0	1	0	0	1	0	1	0
		0	1	1	0	1	0	1	0
		1	0	0	1	0	0	0	1
		1	0	1	0	0	1	0	0
		1	1	0	0	1	0	0	0
		1	1	1	0	1	0	1	0
1	0	0	0	0	0	0	0	1	0
		0	0	1	0	0	1	0	0
		0	1	0	0	1	0	1	0
		0	1	1	0	0	1	0	1
		1	0	0	1	0	0	1	0
		1	0	1	0	0	1	0	0
		1	1	0	1	0	0	0	1
		1	1	1	0	0	1	0	0
1	1	* don't care condition							

Note:

1. S_1,S_0 ——— state
2. R_0 ——— request from Processor 0
   R_1 ——— request from Processor 1
   R_2 ——— request from Processor 2

Equation

$$G_0 = R_0 * S_1 * S_0 + R_0 * R_1 * R_2 + S_0 * R_0 * R_2$$
$$G_1 = R_2 * R_1 * R_0 + S_0 * R_1 + S_1 * R_1 * R_0$$
$$G_2 = S_1 * R_2 + S_0 * R_2 * R_1 + R_2 * R_1 * R_0$$

$$S_0 = S_0 * R_0 * R_1 + S_0 * R_1 * R_2 + S_1 * S_0 * R_0 * R_1 + S_1 * R_0 * R_1 * R_2 + S_1 * R_0 * R_1 * R_2 + S_1 * R_0 * R_1 * R_2$$
$$S_1 = S_0 * R_0 * R_1 + S_0 * R_1 * R_2 + S_1 * R_1 * R_2 + S_1 * R_0 * R_1 * R_2 + S_1 * S_0 * R_2 * R_1 * R_0 + S_1 * R_0 * R_2$$

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was last granted access to shared memory. The arbitrator's input indicates the shared-memory requests currently outstanding (R_0 to R_2), and its output on each transition (G_0 to G_2) indicates which CPU is allowed to proceed with the memory access.

An arbitrator of this complexity was made necessary for two reasons: first, simple fairness; second, and more seriously, the 6800 processor can only be halted for a few milliseconds via the 6875's Memory Ready pin, after which the contents of the processor's internal registers disappear. The processor's registers are implemented via simple MOS circulating-data registers, which require continuous clocking to keep the data circulating and refreshing the registers. When the clock is stopped, refreshing stops, and the charge representing the data in the registers leaks off over a period of several milliseconds, until the data values are no longer detectable when the clock is restarted. Thus, the arbitrator has to guarantee that a CPU will never be halted for more than the allowed period; the arbitrator does this by not allowing any CPU to have two consecutive accesses until all other CPUs simultaneously requesting access have been granted their turns.

The 4K-byte shared memory to which the arbitrator controls access includes 8 bits of data for each address and a "present" bit indicating whether a data object is present or absent at each address. The present bit is gated with the memory read/write line to produce an interrupt when a CPU attempts to read data at an address with no data object present or write data when a data object is already present. The present bit is also updated to indicate "no data present" following a successful read, or to indicate "data present" following a successful write. Because of the way the 6800 microprocessor operates, the interrupt occurs following completion of the read or write operation. In either case, no access to shared memory actually occurs when an interrupt is generated: With data

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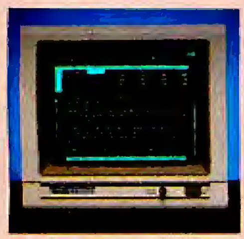

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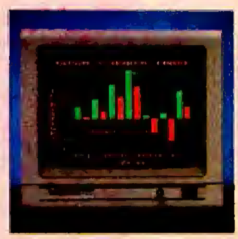

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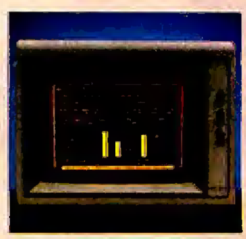

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IMPLEMENTATION RESULTS

Implementation of the multiprocessor was successful; we demonstrated this by executing a test program based on Hansen's "incorrect" program (listing 1). [*Editor's note: A complete listing of the test program is available for downloading via* BYTE*net Listings. The number is* (603) 924-9820.]

The test program consists of three concurrent parts, each running on a distinct CPU. The first, simulating the input device, simply produces a sequence of data objects in the form of consecutive integers, which it writes into location 3000 (hexadecimal) of the shared memory. Once the first object is written, the next write will not succeed until the first object has been removed. The removal is accomplished by the second concurrent part (running on the second CPU), which reads from location 3000 and writes the object it read into location 3001. Here, the read will not succeed until a data object has been written into location 3000, and the subsequent write will not succeed until the previous data object has been removed from location 3001. Finally, the third concurrent part, running on the third CPU and simulating the output device, reads the object from location 3001 and writes it into a circular buffer in its private memory. Once again, the read from location 3001 will not proceed until a data object is present there. To ensure that the other two CPUs will have to wait, the third CPU executes a delay loop between each access to shared memory to slow it down.

We verified successful operation of the multiprocessor by first checking that the circular buffer of the third CPU contained data other than consecutive integers, starting the program for a time, then stopping it and verifying that the circular buffer did then

(continued)

Listing 1: *A high-level outline of the test program described in the article.*

```
program pbh:
shared
      t,s: integer;
var
      eof: boolean;
      f,g: file of integer;
begin
      while not eof do
      cobegin
            t := s;
            output(g,t);
            input(f,s,eof);
      coend;
end.
```

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contain consecutive integers.

Each CPU's program part contains an identical interrupt procedure to simulate the primitive wait. This interrupt procedure simply decrements the interrupt return address on the stack to retry the unsuccessful read or write and then returns from the interrupt. This causes the CPU to repeatedly execute the memory access until it succeeds.

The multiprocessor successfully executed the test program on September 27, 1984, after several months of debugging. Almost all of this debugging time involved debugging the memory arbitrator and synchronization of shared memory access with the arbitration logic and not debugging the data-movement primitives. The implementation of the data-movement primitives is quite elegant; this elegance is reflected in the fact that, although many PALs were used to reduce the parts count of the multiprocessor (which otherwise would have been very large), no PALs were needed for the portion of the circuit implementing the data-movement primitives.

CONCLUSIONS

This project successfully demonstrated the feasibility of implementing a multiprocessor system with data-movement primitives using off-the-shelf hardware. We have demonstrated the success of the data-movement primitives by using them to correctly execute a concurrent program, without using the software-synchronization primitives that would be required otherwise. Furthermore, the cost of implementing this machine ($450) shows that such an implementation is affordable; the large portion of this cost was for the CPUs, interface hardware, and conventional memory components. ■

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2. Mead, C., and L. Conway. *Introduction to VLSI Systems*. Reading, MA: Addison-Wesley, 1980.

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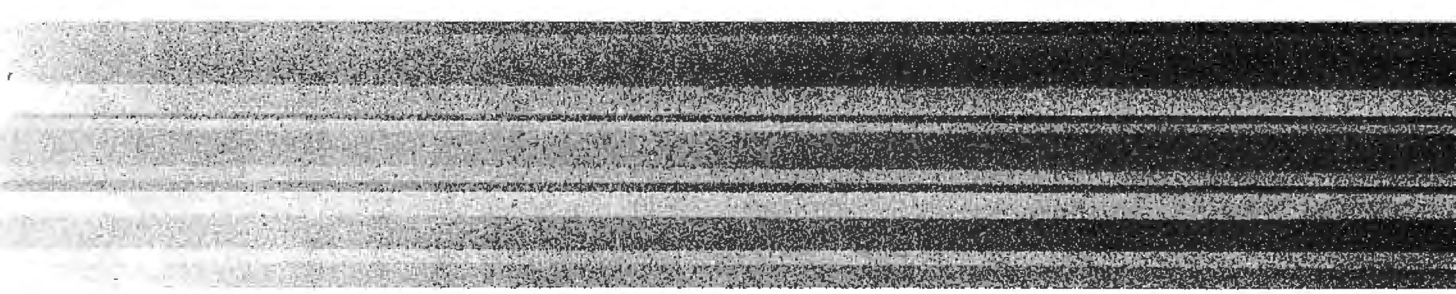

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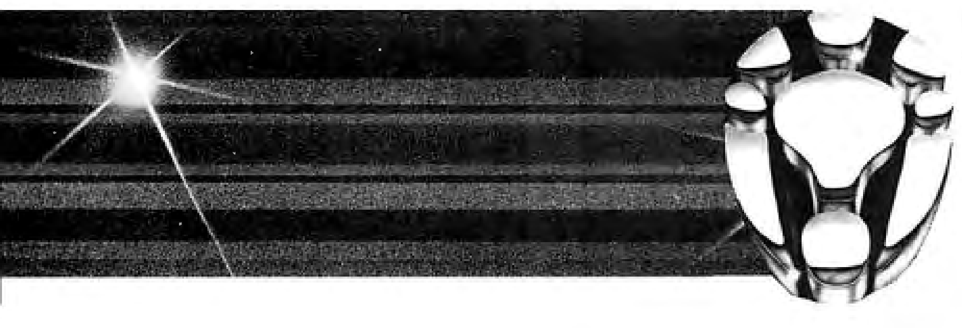

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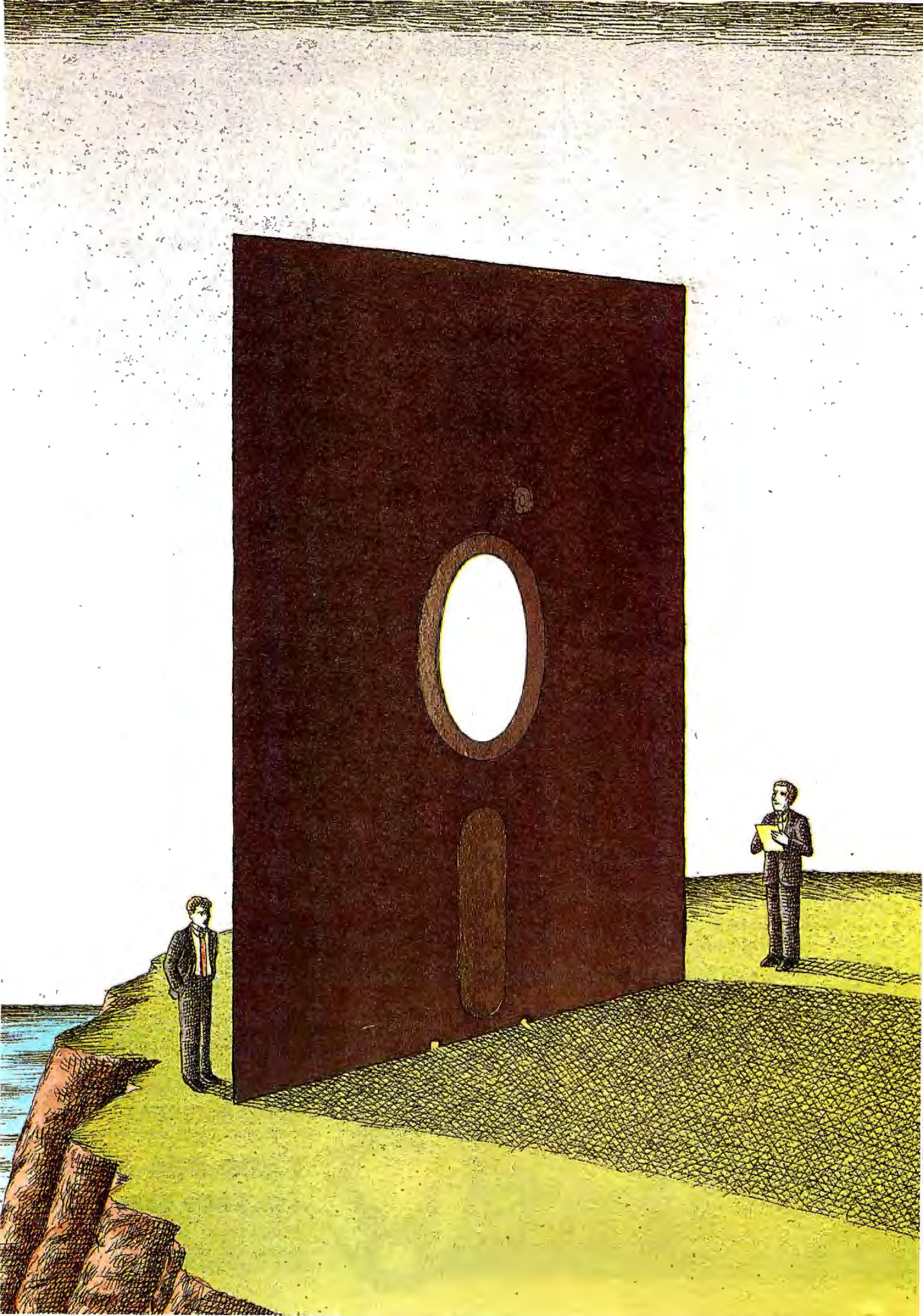


Reviews

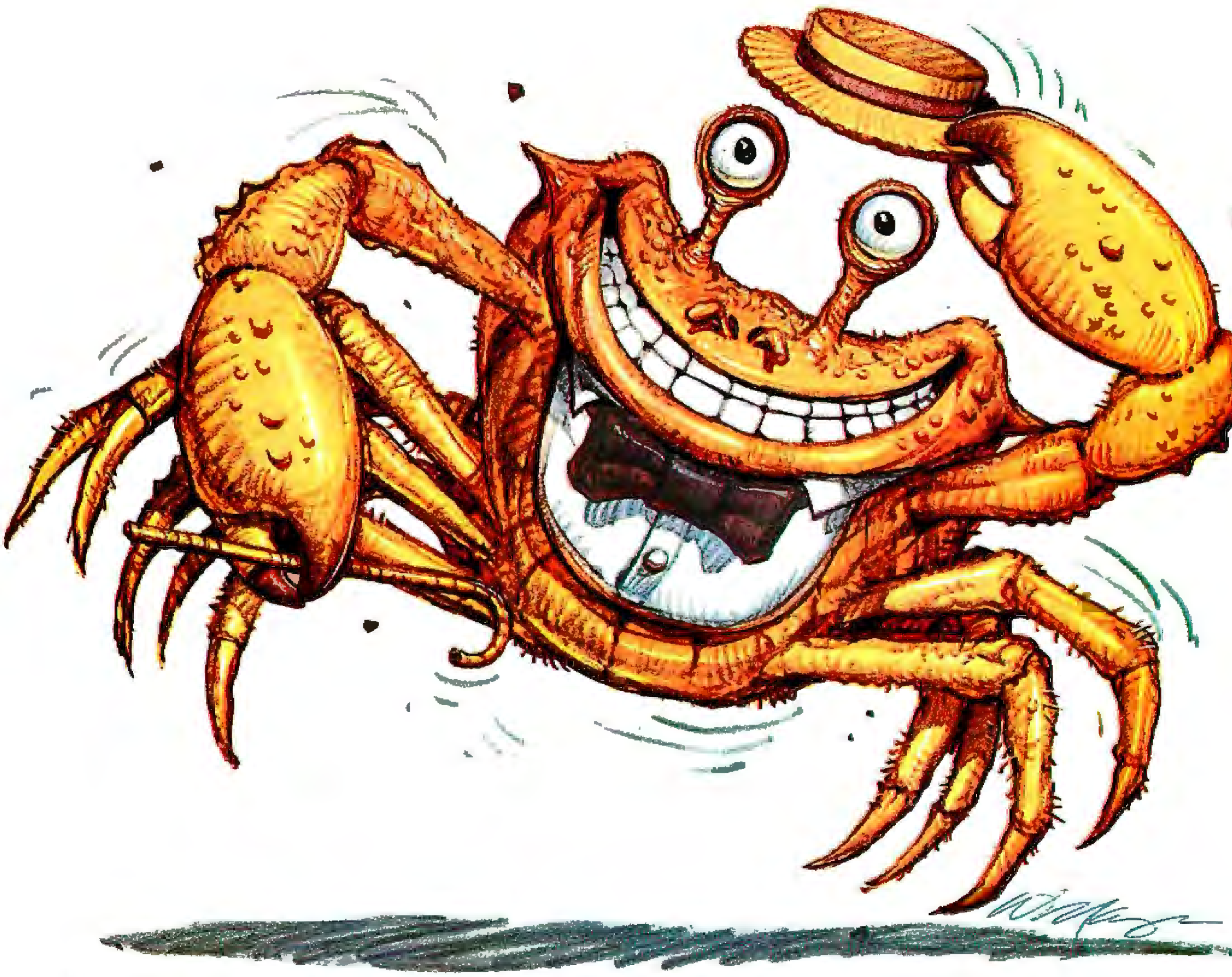
THE DESKPRO LINE of computers (there are four models) from Compaq Computer Corporation, Houston, Texas, all come with an extra boost in the form of a dual-speed processor. Starting from this common base, each successive model builds on its predecessor with more memory, bigger power supplies, additional drives, and a hard disk. The culminating unit, the Model 4, has everything that's built into the other three units plus a 10-megabyte tape-cartridge drive for hard-disk backup. It also carries a $7195 price tag. In our first review, Jerry Grady takes a close look at the Model 4 and presents his findings. There's much to like about the Model 4, in Mr. Grady's view, and the breadth of the product line helps a lot if you like the basic technology but can't spring for, or don't need, all the bells and whistles.

Next, Alan Finger takes us through the IBM PC AT. Here, the ability to expand is limited to a basic unit and an enhanced unit. The major benefits of the enhanced unit are a 20-megabyte hard-disk drive, 256K bytes of additional memory, and a serial/parallel interface adapter. While it doesn't give you the option of two clock speeds like the Compaq, its Intel 80286 is quite fast enough for most applications, all by itself. The too-often-politely-ignored point about the IBM PC AT, however, is the fact that it's IBM's top-of-the-line personal computer. Is it worth all the hoo-ha it has inspired? Is it really fair to use the initials AT to signify Advanced Technology? Mr. Finger's analysis is just what you need if you're trying to figure out what's going on.

The BASIC programming language has more idiosyncratic versions than just about any other. Each version attempts to be just a little better (and just a little different) than all of the others for either technical or commercial reasons. The result, of course, is a Babel-like situation. With so many "dialects" running around it's hard to know which features are applicable across product lines and, in the end, which are really BASIC and which are just using the name. BASIC's creators, John Kemeny and Thomas Kurtz, set out to rectify this confused situation. With associates, they set up their own company called True BASIC Inc. and brought out a version of BASIC for microcomputers that conforms to the standard proposed by the American National Standards Institute's subcommittee X3J2. Called True BASIC, this version is a major departure from previous microcomputer BASICs. Michael Vose, a BYTE senior technical editor, shows you exactly how, where, and why to look for a fresh approach from True BASIC.

Finally, Mark Haas reviews the GTX-100 from Lockheed-GETEX. It's an intelligent dual-speed modem that includes four levels of protection for your computer. Some of the interesting features of this modem have more to do with its intelligence than its security-providing aspects. For example, Mr. Haas points out that the modem's software lets you select the data rate, dial the phone automatically, dial the phone manually, re-dial the last number, and select the desired level of security. This modem has quite a large number of special features—with just one of these being the ways it lets you control access to your computer.

—Glenn Hartwig, Technical Editor, Reviews



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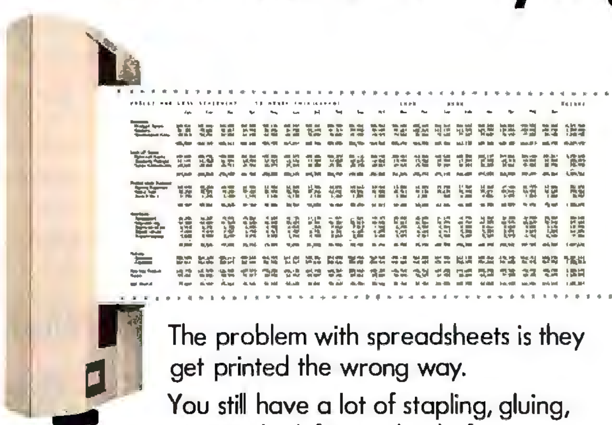

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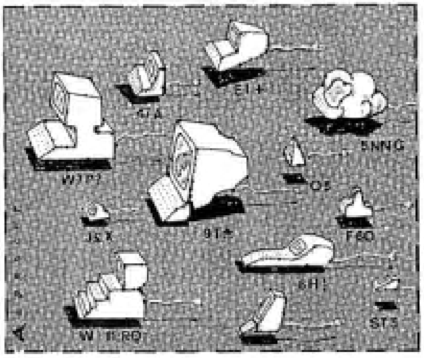
R·E·V·I·E·W·E·R'S N·O·T·E·B·O·O·K

Two portable computers, both previously described in BYTE, have now come back for full scrutiny in the Review department. In different ways each has aroused a good deal of speculation. First, the Hewlett-Packard Integral is just so different from a laptop computer that it deserves attention. A UNIX-based system with an electroluminescent screen, built-in printer, 3½-inch disks, a mouse, and a silhouette more like a sewing machine than a briefcase, it gives the definite impression that it is self-consciously incompatible with anything IBM would ever dream of producing.

All well and good. You really do get points for independence of spirit—but it still has to work.

So far, trying to use the Integral has resulted in a curious blend of appreciation and irritation. It doesn't come with much in the way of bundled software for things like word processing or communications. On the other hand, it hadn't been here a week before we got a copy of Multiplan designed especially for it. Hewlett-Packard apparently intends to support the Integral with its own considerable resources. Watching this one develop ought to be interesting. A full review is in the works and will probably be printed here in the near future.

Going almost entirely the other way from the Hewlett-Packard Integral is the Data General/One, first featured in BYTE as a product description last November (see page 102). In case you missed it, this one arrived amid great expectations. It's touted as having a high degree of compatibility with IBM's Personal Computer (PC), especially when used with the 5¼-inch external disk drives. And people I know have been very impressed with its capabilities.



The main source of discontent, both in the BYTE preview and elsewhere, has been the poor quality of the screen design. LCD (liquid-crystal display) screens suffer from lack of definition to begin with. When one is also saddled with a fixed viewing angle, the problem of seeing what you're writing goes beyond a reasonable level. Attempting to respond to criticism, Data General brought out what it hopes will be a better screen and is said to be retrofitting (for $350) all those sold. Our review unit is equipped with one of these newly designed screens; the upcoming review ought to show how well the company has succeeded in answering its critics.

Aside from that, the DG/One, as I said, generally has been met with warm words for its high degree of compatibility with most IBM PC-oriented software. Whether this is enough to endear it to a reviewer remains to be seen.

Perhaps more intriguing than what our reviewers think of these machines is the question of which one is more representative of what the user expects from a true portable computer. Is the portable's major function that of a drone for a desktop unit—and thus useful only if compatibility is very high? Or is the user of a small portable looking for something different enough from a desktop unit that questions of compatibility are irrelevant? These questions really go beyond the scope of reviews, but they do set the stage on which these machines will be more broadly judged.

Another subject for upcoming review is a very curious printer/plotter/typewriter combination from Panasonic. Instead of a dot-matrix or daisy-wheel-type print head, this unit comes equipped with four colored pens. By moving the print head/penholder back and forth while the platen moves the paper up and down, the unit draws each character—a typewriter that actually writes. Besides writing text, it draws an assortment of graphs and connects serially to a computer. It has direct, line-by-line, and block printing modes; a full-line preview window to show your text before you commit it to paper; a 4K-byte memory; word-search capability; two switch-selectable keyboards plus an extended character set; and the ability to print wide characters, tall characters, italics, underlining, and top-to-bottom or bottom-to-top vertical lines. At about five pounds and about $350, this one made a lot of friends right out of the box.

An editor's note about an IBM PC-compatible operating-system patch for the NEC APC III appeared with John Unger's review in March (see page 338) and has generated a lot of interest. Just to keep you updated, we're still running tests and have found that it works in some cases—and in some it doesn't.

We'll be running the code as part of a feature article in an upcoming issue. You'll undoubtedly run across programs that we either don't have or haven't yet had the time to test. Either way, when the time comes, let us know how you make out. This approach may also work with other close-but-no-cigar compatibles. We'd like to hear about any experiments you make with those as well.

—*Glenn Hartwig, Technical Editor, Reviews*

The Compaq Deskpro

A faster processor and an optional tape backup system

BY JERRY GRADY

How is Compaq Computer Corporation of Houston, Texas, establishing itself as more than just another IBM PC-clone company? By introducing a desktop that is yet another IBM PC work-alike, plus a little extra.

The new desktop is called the Deskpro (see photo 1), and it comes in four new versions that are labeled models 1, 2, 3, and 4. The little extra is an Intel 8086 processor with dual clock speeds on all models and a tape-cartridge backup system on the Model 4. A status light to the left of the disk drives indicates the operating speed: red if you are in PC-compatible common mode (4.77 MHz) and green if the processor is in "fast" mode (7.14 MHz). The switchable clock speed lets the Deskpro maintain what Compaq calls 99.9 percent IBM PC compatibility while providing the option of better performance. The availability of a 10-megabyte tape cartridge to back up the hard disk fills the need for a fast, economical, hard-disk backup system.

HARDWARE

All models in the Deskpro line are configured from the same basic unit, the Model 1. This is an important point for users who want to build their systems gradually.

Compaq considers the Deskpro Model 1 its smallest business system. The machine has 128K bytes of RAM (random-access read/write memory), one half-height 5¼-inch disk drive (360K-byte capacity), a parallel printer interface, the Compaq dual-mode monochrome-text/color-graphics display adapter board, and six IBM PC-compatible expansion slots. It has a current list price—without a monitor—of about $2240. The monitor sells for $255.

The Deskpro Model 2 is the system that Compaq expects to be most popular. This computer is similar to the Model 1 except that it has 256K bytes of memory and two floppy-disk drives. Weighing in at a little over 30 pounds, the Model 2 system unit is heavier than the IBM PC. This might be due to its steel casing and heftier power supply. With a monitor, it lists for $2995.

The Model 3 is the IBM PC XT work-alike with its 10-megabyte hard-disk drive. The Model 3 also has 256K bytes of RAM, one floppy-disk drive, an on-board parallel printer interface, a hard-disk controller capable of supporting the tape cartridge, a half-size card with a serial port and clock, and four IBM PC- or XT-compatible expansion slots. With a monitor, it costs $4995.

Finally, the top-of-the-line Model 4 includes everything the Model 3 has plus a 10-megabyte tape-cartridge drive for hard-disk backup and the maximum of 640K bytes of RAM on the motherboard. It sells for $7195 with a monitor. See "The Deskpro Model 4" text box on page 264.

As options, Compaq offers a 12-inch, high-resolution, amber- or green-phosphor monitor; a tilt/swivel mount for the monitor ($50); an option labeled the Desk-Saver, a small platform that raises the base unit off the work surface for enough clearance to store the keyboard; 128K-byte and 512K-byte memory upgrades; and a second disk drive for Models 1, 3, and 4.

MS-DOS 2.11 for the Compaq is not included with any model; it costs an additional $60. This customized version of MS-DOS recognizes the Deskpro's dual processor speed and battery-operated clock (if present) at boot time. BYTE's standard configuration of a monitor, two floppy-disk drives, 256K bytes, serial port, parallel port, MS-DOS, and BASIC costs $3205.

MONITOR

If you purchase the optional Compaq monitor, you can choose a green or amber display. The monitor is a 12-inch version of the Compaq Portable Computer's 9-inch display. The character display is sharp and the display contrast is good due to the monitor's etched screen. A single knob on the left adjusts brightness and contrast.

The monitor's case is angled at 10 degrees, so the display is at a comfortable

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viewing angle if it is resting on the system unit. The casing is plastic and about the same size as the IBM monochrome monitor.

Two cables connect the display to the system unit. The power cable uses an unusual three-pin DIN circular connector, not the usual three-prong AC-style connector. Perhaps this is to ensure that you will not plug a Compaq monitor into your IBM PC. The second cable is a nine-pin connector that plugs into the RGB (red-green-blue) connector of the system unit's display card. Like the Compaq Portable and unlike the IBM PC, the Deskpro display adapter can display shades of green or amber on a monochrome display as well as colors on an RGB display (see photo 2).

Another good feature taken from the Compaq Portable is the Deskpro's two display modes. The monochrome-text mode is very similar to the IBM monochrome monitor. It can display high-resolution text and graphics characters, but not colors or bit-mapped graphics. You can display this mode only on the Compaq monochrome monitor. You can display the color-graphics mode on any IBM PC-compatible RGB monitor, as well as on the Compaq monochrome monitor. This mode displays up to 16 colors or shades of green or amber and bit-mapped graphics.

Both modes use character sets almost the same as the IBM's equivalent character sets, including the graphics characters (see photo 3). The high-resolution monochrome character set occupies a 9- by 14-dot matrix. Most characters occupy an 8- by 12-dot area inside this matrix; the exceptions are special and graphics characters.

The color-graphics character set is much coarser but matches the IBM PC color-graphics set. Each character occupies a 7- by 7-dot area inside an 8- by 8-dot matrix.

It is easy to switch modes on the Deskpro. As with the Compaq Portable, you can toggle the display mode to color-graphics mode from the keyboard by pressing the Ctrl, Alt, and < keys simultaneously. To return to the monochrome mode, press Ctrl-Alt->. In color-graphics mode, you can use high-resolution graphics (640 by 200 pixels by two colors) or medium-resolution graphics (320 by 200 pixels by four colors), just as you can with the IBM PC.

In addition, the display-adapter card has an output for a composite monitor and an RF (radio frequency) modulator to attach to your color television. I connected a short stereo patch cord from the RCA jack on the display adapter to my television and was rewarded with color graphics, though the actual display left something to be desired.

KEYBOARD

The keyboard, which is enclosed in plastic, is extremely light: 2½ pounds. This is nice

(continued)

Photo 1: *The Compaq Deskpro Model 4 with 10-megabyte hard-disk drive, 10-megabyte tape-cartridge system, optional second floppy-disk drive, and optional 12-inch green monitor. Note the clock-speed indicator light and keyboard plug to the left of the disk drives.*

if you like to position the keyboard in your lap, especially since the keyboard's six-foot coiled cord plugs into the unit's front. But for those who prefer a more solid feel to the keyboard, this lightweight device can be disconcerting. Also, the Deskpro keyboard lacks crispness. I find it mushy and hard to use. It seems I must press harder to make the keys register.

Photo 2: A *display of the graphics capability of the color-graphics mode on the Compaq Deskpro. Shown is the display from* Microsoft's Flight Simulator.

Photo 3: A *display of the high-resolution, monochrome-text-mode character set on the Compaq Deskpro.*

The Deskpro system speaker emits a small click when you press a key. You control the volume of this click by pressing the Ctrl, Alt, and gray minus key to lower the volume and the Ctrl, Alt, and gray plus key to raise it.

The keyboard has a 16-character buffer that causes a beeping from the speaker when it is full. Unlike the other clear sounds that issue from the speaker, this beep sounds as though the speaker is cracked. This is caused by the keyboard click competing with the buffer overflow warning, each at different frequencies.

This keyboard, manufactured by Advanced Input Devices, complies with the IBM PC's nonstandard standard keyboard layout (see photo 4). The 10 function keys to the left, the numeric keypad to the right, and the undersize Enter and Shift keys all say clone. About the only noticeable visual difference is the LED (light-emitting diode) indicators on the Num Lock and Caps Lock keys. Unfortunately, these indicators do not always reflect the state of the computer. Occasionally I noticed that the Caps Lock LED was lit to indicate uppercase mode, but the input was in lowercase. After some investigation, I discovered that if you press the Shift and Caps Lock keys simultaneously, this reverses the current state of the indicator light.

PROCESSOR AND MEMORY

At the heart of the Deskpro is the Intel 8086 microprocessor. The processor has a top clock speed of 7.14 MHz, but to maintain compatibility with its portable systems and the IBM PC, Compaq built a switchable clock speed into this system. Pressing the Ctrl, Alt, and \ keys toggles the Deskpro between common mode (4.77 MHz) and fast mode (7.14 MHz).

To emulate the IBM PC 8088 microprocessor, the 8086 must be slowed down to the IBM's 4.77-MHz clock speed. Not only is the 8088 clock speed slower, but its internal instruction cache is smaller. This instruction cache is a series of internal registers on the 8088 and 8086 processor chips that hold a queue of instructions retrieved from memory. On the

8088, the length of this queue is four instructions; the 8086 can hold six instructions. To make the 8086 match the performance of the 8088, Compaq had to slow the clock rate and buffer the instructions so the 8086 did not exceed the four-instruction cache.

The 8086 is a true 16-bit processor with 16 address lines and 16 data lines (as compared to the 8088's 8 data lines). This means that data is retrieved from memory 2 bytes at a time and that memory upgrades must be performed in 16-bit-wide banks. With 64K-bit chips, this means you must add 128K bytes or 512K bytes (with 256K-bit chips) at a time on the motherboard.

The Deskpro Model 1 has a standard 128K bytes of RAM in two rows of nine chips soldered on the motherboard (in each row, eight of the chips hold the data and the ninth chip is for parity check). Models 2 and 3 add 18 more 64K-bit chips into sockets to give 256K bytes as standard. The Deskpro Model 4 comes standard with 640K bytes of memory on the motherboard. To accomplish this, Compaq fills the two rows of sockets (18 sockets) with 256K-bit chips. All the models can be upgraded to 640K bytes on the motherboard. On the Model 1, this means installing the 18 256K-bit chips in the open sockets. On Models 2 and 3, you must remove 128K bytes of 64K-bit chips, then install 512K bytes of the 256K-bit chips. This arrangement means you can have only 128K, 256K, or 640K bytes of RAM on the motherboard—nothing in between.

As an option, you can install a 7.14-MHz 8087 math coprocessor in the socket on the motherboard. This chip is more expensive than its 4.77-MHz counterpart. Since this chip was not available at the time of this review, I could not test whether the switchable clock rate also works with the 8087.

POWER SUPPLY AND EXPANSION SLOTS

The Deskpro offers a large 200-watt power supply. This is probably sufficient to handle about any expansion board (or combination thereof) added to the computer. The fan is quiet, more so than that on the IBM PC or Compaq Portable.

The Deskpro has eight expansion slots on the motherboard, although either two or four of them might already be occupied. Compaq has engineered the data bus to let you add third-party memory-expansion boards but warns that these might decrease the Deskpro's performance by slowing the memory accesses. Memory accesses on the motherboard are done 16 bits at a time, but to ensure that all optional expansion boards compatible with the IBM PC (and the Compaq Portable) will work, access to the expansion slots is done 8 bits at a time.

On all four models, a floppy-disk controller card occupies slot 7. This controller also provides the electronics for the parallel printer interface. Slot 5 is occupied by the monochrome-text/color-graphics video-display board.

On Models 3 and 4, the hard-disk controller board occupies slot 6. This controller also supports Compaq's tape cartridge. Slot 8 holds the short board that contains the serial port and clock. This board contains a battery to power the clock when main power is off; the battery recharges when the power is on. This is a nice convenience for anyone who has ever had to change the battery on a clock board.

The half-height floppy-disk drives in the base unit are manufactured by Mitsubishi. These are double-sided double-density drives capable of handling both single-sided and double-sided disks. Formatted capacities of disks are 160K, 320K, or 360K bytes. The operation of the drives is smooth and quiet. In fact, except for the rasping of the disk in its plastic jacket, there is no noise at all. Each floppy-disk drive occupies one of four identical half-height compartments in the chassis, so you can reposition the drives to fit your personal preference.

SOFTWARE

Compaq offers the MS-DOS 2.11 operating system, but it is not included in the unit's cost. Compaq has matched IBM's PC-DOS with all the Microsoft utilities or lack thereof. The major command processor (COMMAND.COM) has been modified to recognize some of the special Deskpro hardware. The dual-speed processor is recognized upon booting and the clock rate is set to fast mode. If the Compaq asynchronous communications/clock board (or any other clock using the National Semiconductor MM58167A chip) is present, the time and date are automatically read and the clock is set. Setting the time or date with the TIME and DATE MS-DOS commands resets the stored time or date value for use the next time you boot the Deskpro.

(continued)

Photo 4: *The Compaq Deskpro keyboard. Note the LED indicators on the Caps Lock and Num Lock keys.*

THE DESKPRO MODEL 4

BY RICH MALLOY

The Compaq Deskpro Model 2, with its two floppy-disk drives, fast processor, and dual-mode display, represents an impressive value in desktop systems. But the real power of the Deskpro series is embodied in the top-of-the-line Model 4, with its 10-megabyte hard-disk drive, 10-megabyte tape-cartridge backup system, and 640K bytes of memory. At BYTE I had a chance to use one of these systems. In fact, it even had an optional second floppy-disk drive, which gave me a large array of storage options.

The Model 4's most noteworthy feature is its tape-cartridge backup system. As of this writing, Compaq is still the only major microcomputer manufacturer that I know of to offer such a device. Admittedly, a tape backup system is not high on everyone's shopping list. But after a hard disk suddenly loses about nine months of data (an event that is not highly unlikely), the extra $1000 for a tape backup system seems less of an extravagance.

The Model 4 works quite well. Table A compares the Deskpro hard-disk drive with that of the IBM PC XT. The tape seems slow by disk standards, but usable. It took about 7 minutes to back up the 4.6 megabytes of data we had on our hard disk. A full 10 megabytes should take about 20 minutes.

Unfortunately, you cannot use the tape drive as an extra disk drive. Nor can you back up selected individual files. (These features are advertised by some third-party tape-drive manufacturers.)

Another nice feature of the Deskpro Model 4 is its ability to accommodate a second floppy-disk drive. This makes it easy to copy floppies and to run copy-protected programs.

Although somewhat expensive, the Model 4 is a good alternative to the IBM PC XT and AT. It might be even better with its recently announced 30-megabyte hard-disk drive ($2995).

Table A: *A comparison of the hard-disk drive perfomance of the Compaq Deskpro Model 4 with that of the* IBM PC XT. *The Deskpro's* 8086 *processor was tested in both fast* (7.14 MHz) *and common mode* (4.77 MHz). *The Deskpro used* MS-DOS 2.11; *the* IBM PC XT, PC-DOS 2.0.

Hard-Disk Benchmark Test	Times (seconds) Compaq Deskpro 7.14 MHz	Compaq Deskpro 4.77 MHz	IBM PC XT
BASIC			
Hard-Disk Write	19.0	33.8	43
Hard-Disk Read	16.4	29.4	28
System Utilities			
40K File Copy	2.4	2.6	2.8
Spreadsheet			
Load	2.1	3.5	3.8

With the purchase of Deskpro, Compaq supplies a hardware diagnostics test disk with a single program, TEST.EXE. This set of diagnostics is complete, testing everything from the keyboard through memory and mass-storage devices. The diagnostics will even test a light pen and other third-party options. Unfortunately, you cannot run the diagnostics without purchasing MS-DOS.

Other than the demonstration programs, the only difference in the MS-DOS software is the BASICA interpreter. Unlike IBM, Compaq puts all the BASICA code in RAM. This interpreter lacks no IBM BASICA features and actually gives you about 1000 bytes of extra memory space for your programs. I have seen Compaq's BASICA interpreter used on other manufacturers' PC-compatibles when their own interpreters didn't live up to the required PC compatibility.

DOCUMENTATION

The Deskpro comes with a thick, spiral-bound operations guide and a pocket-size quick-reference guide. The contents of the operations guide are organized and clear. The information covers installing and setting up, installing options, running diagnostics, and programming in BASIC.

The only typographical error I noticed in the operations guide is the diagram for the switch settings for memory size on the motherboard. Two of the three displayed settings for switches 3 and 4 do not correspond to the table on the previous page.

The operations guide indicates that a flat-bladed screwdriver or Phillips screwdriver will be the only tools required for installing internal options. This is not true because Compaq uses Torx head screws. These require a special screwdriver with a star-shaped end.

In addition to the operations guide, each piece of hardware has its own installation guide. The installation guides are a nice touch but are awkward because you cannot insert them into the operations guide's binder.

The MS-DOS and BASIC manuals are definitely for reference and not intended to teach you how to use MS-DOS or how to program in BASIC. Though fairly complete, the MS-DOS reference manual is missing the appendix on DOS function calls.

COMPATIBILITY

The name of the game for Compaq is IBM PC compatibility. With the Deskpro, Compaq has maintained the high level of compatibility demonstrated with its Portable Computer.

The Deskpro will read and write all

(continued)

AT A GLANCE

Name
Compaq Deskpro, Models 1, 2, 3, and 4

Manufacturer
Compaq Computer Corp.
12330 Perry Rd.
Houston, TX 77070
(713) 370-7040

Size
System unit: 5 by 19 by 16 inches; 40 pounds for a Model 4

Components
Processor: 8086, 4.77 MHz or 7.14 MHz (switchable)
Memory: 128K, 256K, or 640K bytes
Display: Dual-mode display adapter; monochrome-text/graphics (switchable); IBM PC-compatible in both modes
Keyboard: IBM PC-compatible 83-key layout, two LED indicators
Mass storage: Model 1: One or two 360K-byte, double-sided, half-height, 5¼-inch, floppy-disk drives
Interfaces: Parallel printer
Expansion: Four to six IBM PC-compatible expansion slots

Optional Hardware

128K bytes RAM	$170
512K bytes RAM	$1295
Monochrome display	$255
8087 coprocessor	$375
Floppy-disk drive	$430
10-megabyte hard-disk drive	$2280
10-megabyte tape-cartridge backup	$1075
30-megabyte hard-disk drive	$2995
Serial port/clock board	$150

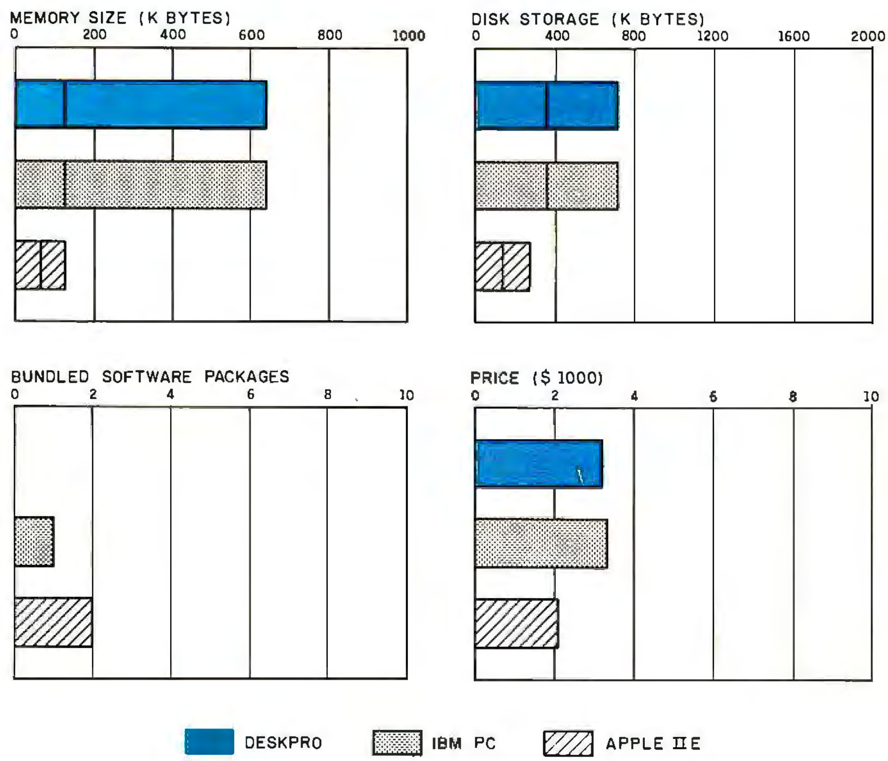
Optional Software

MS-DOS 2.11/BASIC 2	$60

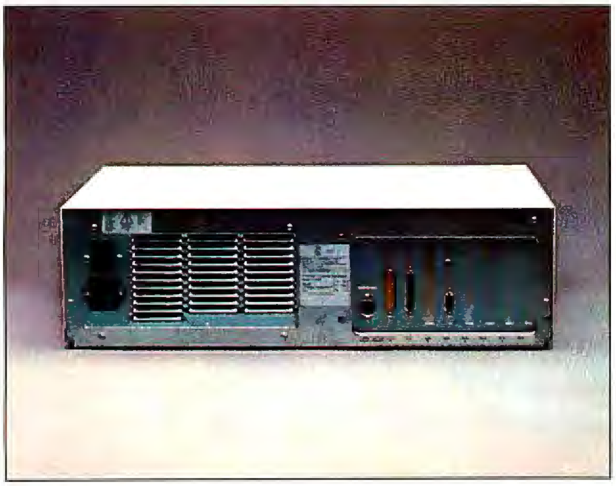
Documentation
Operations guide

Price (standard configuration with monitor)

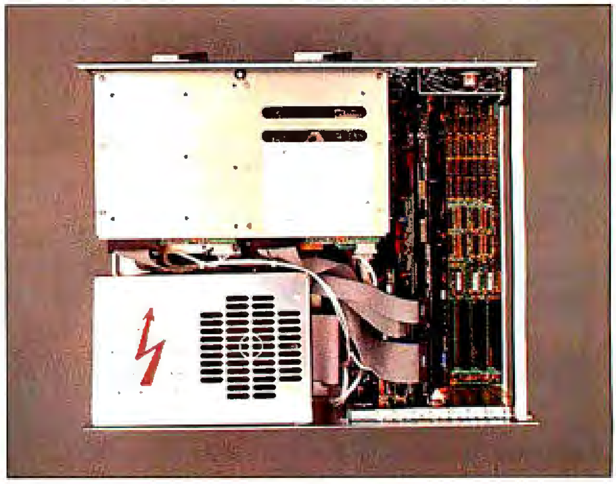
Model 1	$2495
Model 2	$2995
Model 3	$4995
Model 4	$7195



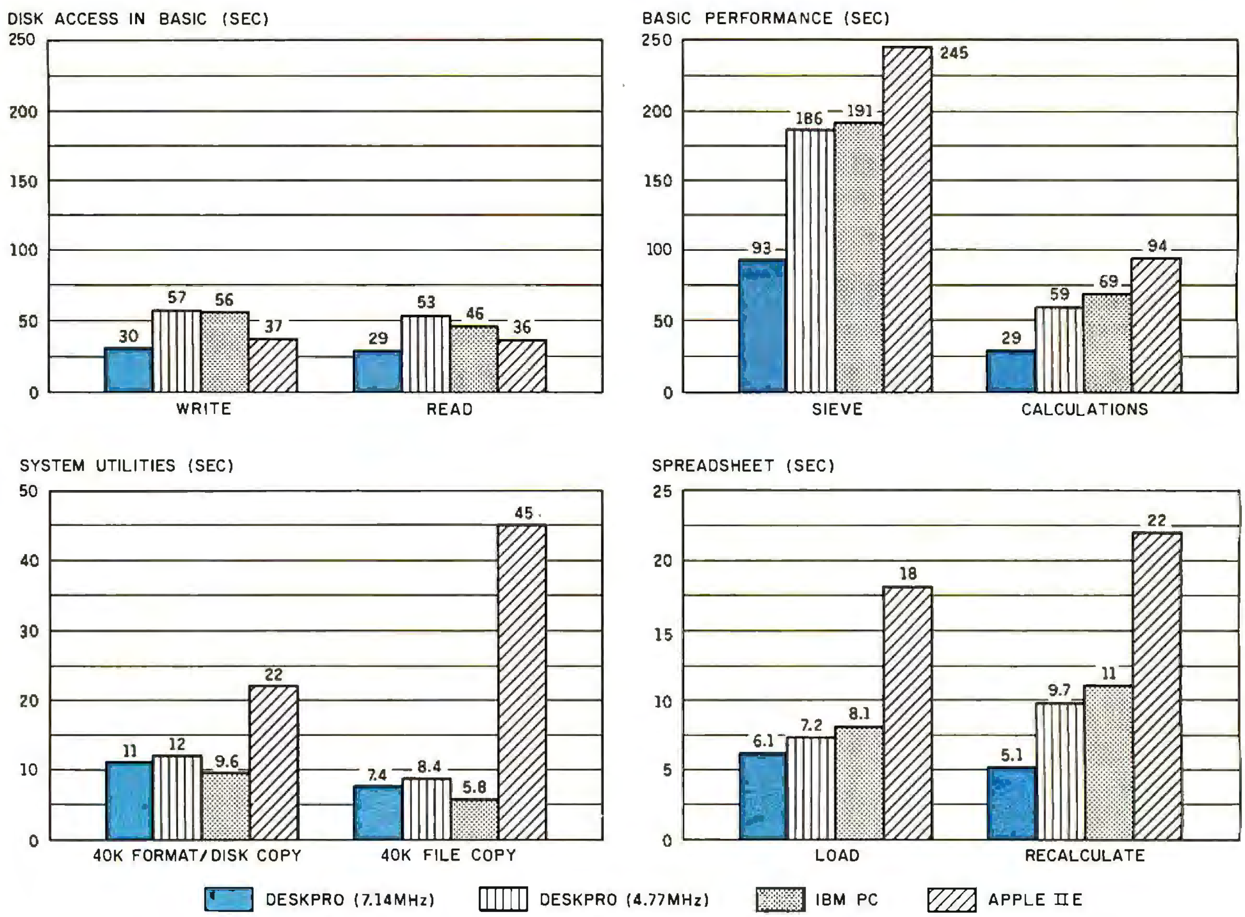
The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity of one and two floppy-disk drives for each system. The Deskpro can also support a 10- or 30-megabyte hard-disk drive. The Bundled Software Packages 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), the standard operating systems for the computers under comparison, and the standard BASIC interpreter for each system.



Compaq Deskpro with the serial/clock card in slot 1, the floppy-disk-controller/parallel-printer interface in slot 2, and the dual-mode display adapter in slot 4.



Inside the Compaq Deskpro Model 4 with 640K bytes of RAM installed.



The graphs for Disk Access in BASIC show 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 columns in the BASIC Performance graph show 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 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 Deskpro used MS-DOS 2.11 and BASIC 2.10. Tests for the Apple IIe were done with the ProDOS operating system except for the spreadsheet test, which was done with DOS 3.3. The IBM PC was tested running under PC-DOS 2.0.

levels of IBM PC disks, except the new AT 1200K-byte disks. The hardware options I tried, including memory-expansion and multifunction boards, all work properly in common mode. Almost all of them work in fast mode. The Iomega Bernoulli Box (10-megabyte disk-cartridge system) works well in common mode, but it will generate occasional read or write errors in fast mode. This is due to the use of software loops in the device handler. The problem has been corrected in the latest version of Iomega's device handler.

Software compatibility is equally high. None of the software packages I tested show any operational deficiencies. Turbo Pascal, WordStar, dBASE II and III, Microsoft's Flight Simulator, and Microsoft's compilers for C and Pascal all work without modification. WordStar and Turbo Pascal perform much better in the fast mode because of the faster screen refresh and memory access. dBASE II and III show marginal improvement due to the disk-intensive nature of their operation.

Comparing the Deskpro's benchmark results with the IBM PC shows a somewhat better performance by the Deskpro (see the "At a Glance" box). Hard-disk input and output for the Deskpro is appreciably faster, while the floppy disk is usually slightly slower. For pure calculation speed, the Deskpro is faster than the IBM PC in common mode as well as in high-speed mode due to the 16-bit memory accesses that the Deskpro performs. When combined with other processing (memory access, instruction fetching), the Deskpro is not quite twice as fast as the IBM PC.

In WordStar (see table 1) or Multiplan, the display screen repaints about twice as fast in the high-speed mode. Overall the Deskpro common mode is compatible with the IBM PC, while fast mode averages an improvement of about 90 percent.

Table 1: *A comparison of the Compaq Deskpro with the IBM PC and the Apple IIe using WordStar and dBASE II. The word-processing tests involved a 4000-word document (21K bytes). The Load and Save tests measure how long it takes to load and then save the document. The Search and Scroll tests measure, respectively, how long it takes to find the last word in the document and to scroll through the document line by line as fast as possible. The database tests measure how long it takes to sort a 2000-record data file (200K bytes) and to retrieve the last record using a nonindexed data field. These tests used an IBM PC with PC-DOS 2.0, 512K bytes of memory, a monochrome display, WordStar 3.3, dBASE II, and an Apple IIe with Microsoft's Softcard and WordStar 3.3. The Deskpro tests used a Deskpro Model 2 with MS-DOS 2.11 and WordStar 3.3.*

Test	Compaq Deskpro 7.14 MHz	Compaq Deskpro 4.77 MHz	IBM	Apple IIe
Word Processing				
Document Load	5.8	6.7	9.9	10.3
Document Save	17.9	18.7	24.2	32.3
Search	6.9	8.8	10.5	6.6
Scroll	7.7	10.6	41.2	46.4
Database				
Sort	702	798	765	N/A
Record Access	44.2	44.2	43	N/A

LIMITATIONS

The Deskpro's limitations are few and relatively minor in comparison to its features. Aside from those already mentioned, the only problem I found is with a chassis brace on the inside of the Deskpro chassis. This brace is directly above slot 1 and interferes with insertion or removal of any option board.

The Deskpro is also priced somewhat high in comparison to its competitors. The Deskpro Model 2 with two disk drives and 256K bytes of memory can cost several hundred dollars more than a comparably equipped IBM PC. Although the Deskpro is being sold by over 500 retail outlets, it is just becoming available through discount houses, so it is often costly in comparison to discounted compatibles.

Although the 8086's faster processing in high-speed mode is nice, it only slightly improves the performance of any system limited by floppy-disk accesses.

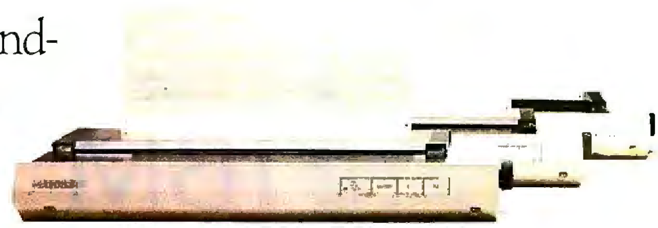
One reason for the IBM PC's success (and the birth of the Compaq Portable) was the availability of the IBM PC's technical reference manual. Compaq does not produce a comparable document for the general public. Because of the internal differences between the Deskpro and the IBM PC, Compaq should make its own technical reference manual available.

SUMMARY

Service for the Deskpro is provided by the retail outlets where you purchase the computer or by any authorized Compaq dealer. The Compaq service program is similar to the IBM program for training technicians of the authorized dealers. Compaq does not use a third-party maintenance organization for service.

Anyone who heavily uses spreadsheets, word processors, or monochrome graphics should buy the Deskpro. The improved performance of the 8086 in fast mode can increase your productivity if you use a spreadsheet for numerous calculations. It also improves the throughput of word processors and other applications that display a lot of text. Compaq's dual-mode display adapter lets you use applications requiring graphics without additional hardware or cost.

Would I buy the Compaq Deskpro? Yes, I would and did. And I recommend the Deskpro to others. It is a well-engineered and well-manufactured product. ■



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CITIZEN™

IBM PC AT

The PC gets down to business

BY ALAN FINGER

The IBM PC AT comes in two basic configurations. The basic model ($3995) comes with 256K bytes of RAM (random-access read/write memory), one of IBM's new high-capacity 1.2-megabyte disk drives, and a combination floppy-disk/hard-disk controller card. Available for an additional $1800, the enhanced model adds 256K bytes of memory, a 20-megabyte hard-disk drive, and a serial/parallel interface adapter (see photo 1). Both systems are based on Intel's 80286 processor and have eight I/O (input/output) expansion slots and a battery-backed clock/calendar.

The AT comes with IBM's usual voluminous documentation. It includes a setup guide, an operations guide, and a BASIC manual, all in IBM's standard boxed looseleaf format. An unwelcome addition is a variety of small pamphlets packed in each box. While these are intended to be helpful quick guides, they are easy to misplace and might confuse as much as inform.

By the way, the BASIC manual is now complete. You don't have to send in a coupon and replace pages to get up-to-date documentation.

POWER SUPPLY AND KEYBOARD

The power supply is 190 watts, as opposed to the 63 watts in the PC and 130 watts in the XT. This much power is needed. The PC is underpowered, causing many users to have hard-to-trace problems when adding to their systems. The XT's supply is much better but would be inadequate for the AT's two hard-disk drives. Since what goes in as electricity always comes out as heat, IBM has incorporated an innovative variable-speed fan that runs faster (and louder) as the internal temperature rises. Since my system was lightly loaded, the noise level never became obtrusive. A notable addition to the AT is a line-voltage select switch that lets it run on European 220-volt power.

The AT's keyboard and interface are more sophisticated than those on the PC and they are not compatible. You cannot use an AT keyboard on a PC. A single-chip microcomputer on the system board manages the keyboard and related functions. Any PC software that goes directly to the keyboard interface hardware, some key-translation programs, and many games will not work on the AT.

The keyboard layout is similar to that used on an IBM Selectric typewriter (see photo 2). The Shift, Control, Enter, and backspace keys have all been enlarged. Some of the less frequently used keys, such as backslash, grave accent, Print Screen, and Escape, have been moved to peripheral portions of the keyboard.

Three status lights have been added to the Caps Lock, Scroll Lock, and Num Lock keys—this is a welcome feature. The only new key, Sys Req, causes the keyboard-handling software that's in ROM (read-only memory) to generate a software interrupt whenever the key is pressed or released. This lets the user signal the operating system for attention. PC-DOS currently ignores Sys Req.

To go with its international power supply, IBM provides six different versions of the AT's keyboard for foreign languages. The layout and internal scan codes are all identical, but some of the key legends are different to permit use of symbols peculiar to specific languages. The standard display adapters can display these characters, and DOS 3.0 has a set of utilities to adapt itself to the specific keyboard type.

On the output side, the AT uses the standard PC display cards and so is completely compatible. Graphics generation is much faster than it is on the PC.

Much has been said about the inclusion of a key switch that disables the keyboard and locks the cover in place. It seems to me that this feature is of limited usefulness. You would have to secure the entire system and external wiring to prevent someone with malicious intent from interfering with a running program. A program can test the state

Alan Finger is a vice president of Comprehensive Computer Consultants (270 Littleton Rd., Building 14, Westford, MA 01886).

of the keylock and override its function to selectively get input from the keyboard.

THE SYSTEM BOARD

The system board itself is a completely new design. Instead of the 8088 processor found in the PC, Intel's high-performance 80286 provides the horsepower. An empty socket is provided for the companion 80287 numeric coprocessor. The board contains a number of familiar components and many new ones.

At start-up, the 80286 is operating in what is referred to as the "real address mode" and has an architecture identical to that of the 8088 used in the PC and XT. Like the 8088, it uses a segmented addressing scheme to access up to 1 megabyte of memory. It has the same instruction set with a few extensions and incompatibilities (see BYTE's product description "The IBM PC AT," October 1984, page 108).

The most important difference is that the 80286 runs faster; it uses a faster clock (6 MHz versus 4.77 MHz) and has a 16-bit data bus instead of an 8-bit data bus. The bulk of the speed increase, however, comes from internal improvements that let it execute most instructions in about half the number of clock cycles that the 8088 requires. The net effect is a two to three times increase in speed over a PC or XT when running computation-intensive programs.

Things get more interesting when the 80286 enters its "protected address mode." Although it still executes the same basic instruction set, its operation more closely resembles that of a large minicomputer or mainframe and is specifically geared toward multitasking and multiuser applications. (For an introduction to 80286 operation in the protected mode, see "The 80286 Microprocessor" by Paul Wells, November 1984 BYTE, page 231.)

While the 80286 packs quite a wallop in its 68-pin package, it is not the ultimate processor. It is very good at performing certain types of functions, such as cost-effective virtual memory and fast task switching for real-time applications, but it does have disadvantages. Like the 8088, the 80286's major problem centers around the use of segmentation. Since a segment has a size limit of 64K bytes, dealing with large arrays such as those found in graphics and signal processing becomes cumbersome. For these applications, a processor with a large linear address space, such as Motorola's 68000, is generally more efficient.

Software compatibility is another problem. Programs written for real mode will not usually run in protected mode and vice versa. For applications programs the changes required are small (generally just

(continued)

Photo 1: *The* IBM PC AT *with a 20-megabyte hard-disk drive, 1.2-megabyte floppy-disk drive, and 360K-byte floppy-disk drive.*

a recompilation), but you cannot plug your existing software into a protected mode 80286 and expect it to work. System software is more tightly tied to the processor architecture. PC-DOS works only in real mode. Even IBM's own ROM BIOS (basic input/output system) becomes unusable once you enter the protected mode. Microsoft's XENIX is the only announced operating system that claims to use the power of protected-mode operation, but it was not available for the AT at the time of this review.

The AT supports the 80287 numeric coprocessor as a $375 option. While the changes required are not especially great, the 80287 is not totally software-compatible with the 8087 used in the PC, so programs written to use the 8087 might not work in the AT. As with the 8087, the actual increase in performance you can expect depends on the application.

The system board has room for 512K bytes of parity-checked RAM. The basic AT has 256K bytes, while the enhanced model has 512K bytes. You can get 128K-byte modules that consist of two special 64K-byte RAM packages soldered together in piggyback fashion; they have Mostek part number MK4128N-15. IBM has never been the least expensive source for PC memory, and expanding the basic model to 512K bytes with IBM RAMs costs $495. I called the Mostek local sales office to find out if these parts were available from its distributors. The answer I got was "They used to be, but not anymore."

On the system board are eight full-length I/O slots; these give you more expansion capability than the XT's six full and two short slots. Also, the floppy- and hard-disk functions are combined on one card to free up an additional connector.

Each slot is equipped with the usual 62-pin connector. These connectors carry the same signals as those on a PC, although the timing is not identical. Six of these slots have an additional 36-pin connector intended for AT-specific cards and contain the extended address lines (A20–A23) to let you place up to 16 megabytes of memory in the system. The upper 8 bits of the data bus are here, too. To accommodate existing 8-bit I/O cards, hardware on the system board automatically converts each processor-initiated 16-bit data or I/O transfer to two 8-bit transfers. Any card that can support 16-bit transfers can send a signal back through this connector to disable the translation.

An interesting signal, Master, lets a processor on an I/O card temporarily take control of the system and access any memory or peripheral device. This capability opens up new possibilities for intelligent peripherals and coprocessor cards.

Photo 2: *Close-up of the* IBM PC AT *keyboard shows the repositioning of the grave accent, Print Screen, Escape, and backslash keys.*

Compatibility with PC I/O cards is good, but not 100 percent. The higher clock rate and timing differences render many cards inoperative in the AT. None of the PC memory-expansion and multifunction boards are likely to work. On the other hand, the AT's added memory and clock features make the boards somewhat superfluous, and new memory boards for expansion above 1 megabyte are available from IBM and other vendors. Table 1 lists which expansion options IBM supports.

A few cards, such as IBM's color-graphics adapter, won't fit in the double-connector slots because they extend below the connector top. These cards must be placed in one of the two available single-connector slots. Since the chassis is higher than the PC's, cards designed for the AT can be about an inch taller.

Mass Storage

The AT is the first major personal computer to use the new generation of high-capacity floppy-disk drives. These drives are capable of placing 1.2 megabytes on a special 5¼-inch disk. The data is stored on 160 tracks (80 per side) with fifteen 512K-byte sectors on each track. At 500K bps, the data-transfer rate is twice as great as for a standard disk. Rotation speed is greater too: 360 instead of 300 revolutions per minute.

To get this kind of density, you have to use special "high-coercivity" disks. Because the bits are crammed so closely together, as much as 10,000 per inch, the magnetic field used to write the data tends to spill over onto adjacent bits. The high-coercivity recording media requires a more intense magnetic field to set or "coerce" a bit. It ignores the less intense stray fields and is only affected by the strong field directly under the recording head.

To handle these drives, IBM developed a new disk-adapter card. They also threw in the standard floppy- and hard-disk controller. Unlike the old

(continued)

AT A GLANCE

Name
IBM Personal Computer AT

Manufacturer
IBM Corporation
Entry Systems Division
POB 1328
Boca Raton, FL 33432

Processor
Intel 80286

Memory
256K bytes (basic); 512K bytes (enhanced)
Up to 16 megabytes supported by hardware

Display
Uses standard IBM PC display adapters

Keyboard
84 keys, Selectric layout, 10 function keys

Disk Storage
Floppy: standard 360K bytes; high-capacity 1.2 megabytes
Hard disk: 20 megabytes (enhanced system)

Expansion
Eight I/O slots

Software
BASIC in ROM, diagnostic disk, tutorial

Price

Basic system	$3995
Enhanced system	$5795

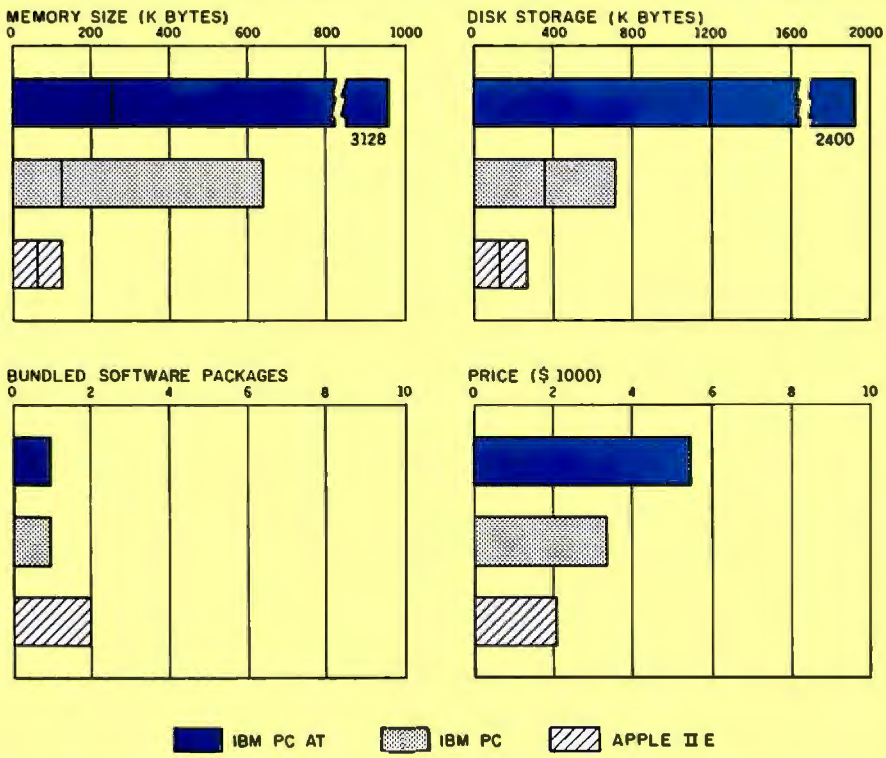
Software Options

PC-DOS 3.0 operating system	$65
XENIX operating system	$395
XENIX software-development system	$455
XENIX text-formatting system	$145

Documentation
Guide to operations included
Installation and setup included

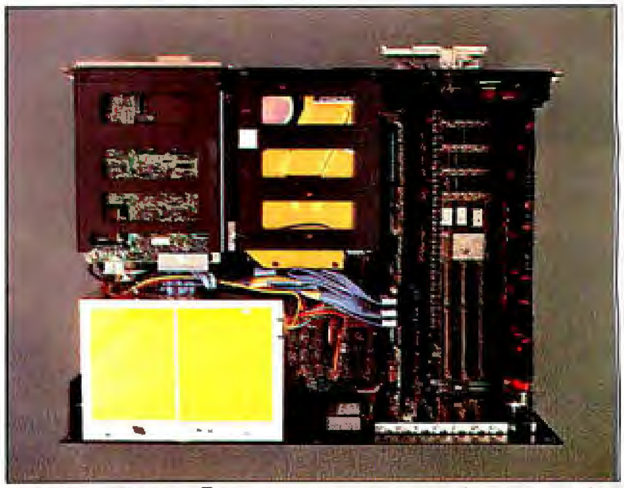
Technical reference manual	$30
PC-DOS technical reference	$40
Maintenance and service manual	$295

Audience
Business and scientific users

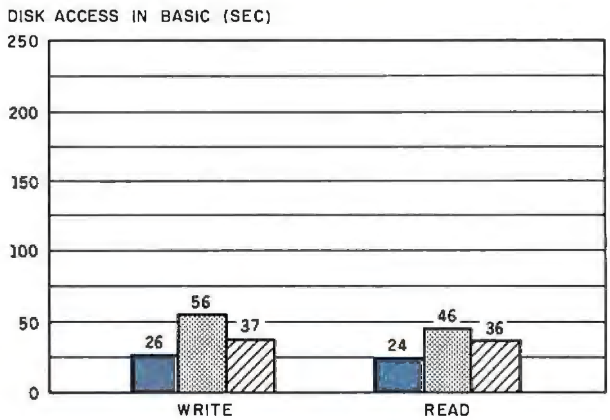


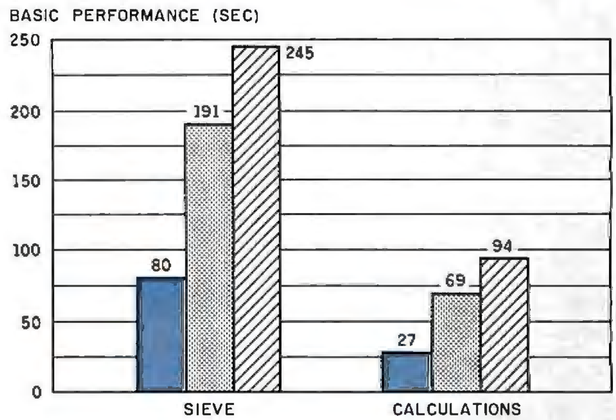
The Memory Size graph shows the standard and optional memory available for the computers under comparison. The Disk Storage graph shows the highest capacity for one and two floppy-disk drives. The Bundled Software Packages graph shows the number of software packages included with each system. The Price graph shows the list price of a system with two disk drives, a monochrome monitor, a color-display adapter, a printer port and a serial port, 256K bytes of memory (64K bytes for 8-bit systems), the standard operating system for the computers under comparison, and the standard BASIC interpreter.

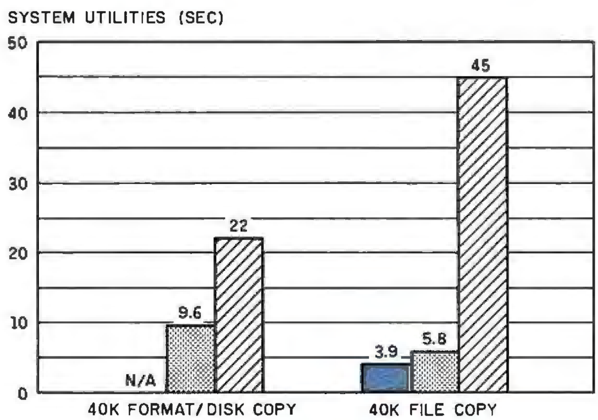
A rear view of the IBM PC AT.

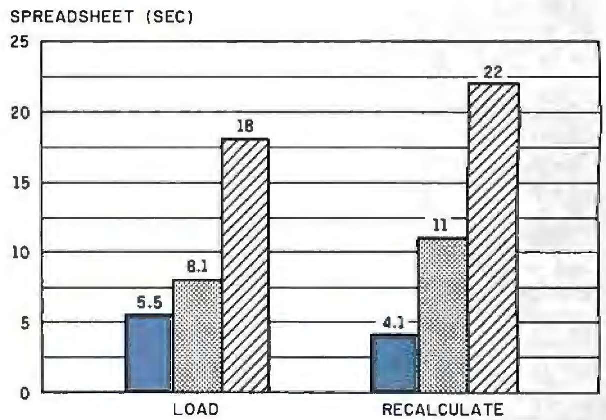


Inside the IBM PC AT. The expansion bus is at the right, hard-disk drive is top center, and power supply is bottom left.









IBM PC AT IBM PC APPLE IIE

The graph for Disk Access in BASIC shows how long it takes to write and 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 BYTE, 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' Format/Disk Copy graph shows how long it takes to format and copy a standard text file to disk (adjusted time for 40K bytes of disk data). The File Copy column shows how long it takes to copy a 40K-byte file using the system utility programs. The File Copy test on the AT copied from the hard-disk drive to the floppy-disk drive. The Systems Utilities graph does not include format/disk copy on the IBM PC AT because the review unit had one hard- and only one floppy-disk drive. The Spreadsheet graph shows how long it takes to load and recalculate a 25- by 25-cell Microsoft Multiplan spreadsheet where each cell equals 1.001 times the cell to its left. The IBM PC AT used PC-DOS 3.0 and BASICA. The Apple IIe used ProDOS, except for the spreadsheet test, which was done with DOS 3.3. The IBM PC used BASICA running under PC-DOS 2.0.

disk adapter, this new card can handle only two floppy-disk drives. However, you can use two controllers if you can find operating software and a place to put the drives.

Since no software is currently available in the high-capacity format, the high-capacity drive and controller can read standard disks. You can also write on them, but you probably won't be able to read that disk on a standard drive due to the much narrower track that is recorded. This means that the AT owner who needs to transfer data to PCs will be forced to either sacrifice a high-capacity drive for a standard drive or use a serial-communication hookup.

In my experience with the high-capacity drive, I never saw any data errors or even retries using the special IBM disks that came with the system.

The ROM BIOS automatically determines the drive/format combination after a drive reset; this makes the actual controller mechanics transparent to a program. It also makes many copy-protection schemes incompatible. One exasperating attribute of the disk system is the one-eighth-second minimum motor-start delay that the BIOS imposes. It makes each initial disk access take longer than it would on a PC. I realize that the half-height drives take longer to start, but I still wish this parameter had remained variable.

If you need hard disks, the enhanced AT comes with a 20-megabyte, full-height, hard-disk drive tucked inside the cabinet (for benchmark times comparing three hard-disk systems, see table 2). You can add a second drive in the spot where a second floppy would go.

THE ROM BIOS

The ROM contains a cassette-BASIC interpreter (the AT does not have a cassette interface), a power-up self-test (POST) program, and the BIOS functions in four 16K by 8-bit devices. If you moved a jumper, a pair of 32K by 8-bit ROMs could do the same job and leave two sockets open for expansion. As with the PC, expansion ROMs can be recognized by the ROM BIOS and incorporated into its functions.

The AT has a new version of the BIOS that provides a number of new features. The most notable is the addition of support for multitasking operating systems. Quite a few PC operating systems currently available can run more than one program at a time. Digital Research's Concurrent DOS and the multitude of UNIX-based packages are the best known. In all cases, these operating systems must supply their own BIOS because the one in the PC is single-threaded. Once you call it to initiate an operation (accessing the disk, for example), you cannot do anything else until the BIOS is finished—even if the processor is going to spend most of its time waiting. This is why your keyboard input seems to come to a grinding halt periodically while the PC-DOS print spooler is in operation and a disk access is necessary.

However, the AT BIOS functions can return to the caller with a flag that says "This will take a while." The operating system then runs another program while the hardware does the work. When the operation is done, the BIOS sets another flag saying "I'm ready to finish up" and the software can go back to the original program.

While this feature is helpful, it (and the ROM BIOS in general) is only available in real-memory mode. With the possible exception of the multitasking facility built into IBM's TopView, new multitasking or multiuser systems are likely to operate in virtual mode and include their own BIOS.

Other new features are designed to isolate programs from the hardware for back and future compatibility. These include joystick support and a short-interval (microseconds) timer.

One potentially useful new function has some hidden problems. Since PC-DOS supports only the first 640K bytes of memory, IBM built a function into the BIOS to allow block transfers between standard and extended memory including a device driver to use this memory as a virtual disk.

The way the BIOS Move Block function operates is simple: You put the processor into protected mode, make the transfer, and go back to real mode again. The one problem is that the

(continued)

Table 1: IBM PC *hardware compatibility with the* AT.

Supported	Not Supported
IBM monochrome display adapter	IBM asynchronous communications adapter
IBM color display adapter	IBM printer adapter
IBM SDLC communications adapter	IBM expansion unit
IBM binary synchronous communications adapter	IBM compact printer
IBM cluster network adapter	Other memory-expansion options
IBM PC network adapter	Other keyboards
IBM graphics printer	Other disk and fixed-disk drives
IBM color printer	

Table 2: *Some benchmark times in seconds for the* AT *with a hard-disk drive.*

Test	IBM PC AT	IBM PC XT	Apple IIe (Profile)
BASIC			
Hard-disk Write	17	43	22
Hard-disk Read	12	28	13
System Utilities			
40K File Copy	12	2.8	20
Spreadsheet			
Load	1.7	3.8	N/A

only way to get back to real mode from protected is to literally reset the processor. But first a flag is set in the battery-backed configuration RAM signaling that the reset is for this particular reason. Near the beginning of the initialization routine, the flag is detected and the program returns to Move Block again for cleanup.

There are two key failings to this method. First, the entire operation, taking as much as 4 or 5 milliseconds, must be done with all interrupts shut off. This can delay interrupt-intensive operations to the point where critical events might be missed. You could lose characters coming in on a 9600-bps serial port, for example. The second problem is even more serious. If the power or the system fails in the small time-window during which the flag is set, each time the system is powered up or reset it will think it is coming back from a Move Block and lose control. The only way to get the system working again is to open it up and disconnect the battery for a moment to kill the flag. You will also have to reset the clock and rerun the configuration program. You are better off to stick to the hard disk for fast storage. It's less expensive and more reliable.

A New PC-DOS?

A new version of PC-DOS accompanies the AT. The release of DOS 3.0 serves two purposes. First, it provides the internal changes necessary to run on the AT. It also serves as an interim release to let programmers begin to interface their software with the file-sharing facilities required to operate in the local-area-network environment that IBM announced with the AT.

File sharing is required in multiuser or networked systems to ensure that only one user can change a file or record at a time. Otherwise, a change or update might not be recorded properly. Although local-area networks for the PC have been around for some time, they each had different sharing mechanisms. Software developers tended to ignore the issue rather than build separate versions for each brand of network. Although the actual network software will not be available until DOS 3.1 appears, DOS 3.0 standardizes the software interface for developers.

DOS 3.0 fixes a few minor bugs in DOS 2.1 and also adds some new commands. The ones I am particularly pleased to see fixed are the ability to use a pathname before a command and correction of the FOR batch command that previously could not deal with sets longer than 64 characters. Functions of the new commands include supporting foreign-language keyboards, making files read-only, and changing the volume label on a disk.

A major internal change lets PC-DOS handle up to 65,526 allocation blocks on disk, up from 4086. This allows much more efficient use of disk space on larger hard-disk drives.

BASICA has also been enhanced, but the changes are really to the documentation. A number of keywords that were reserved but undefined, such as SHELL, ENVIRON$, and IOCTL, have finally been included in the manual as commands and functions. Most of these existed in previous versions, albeit with some bugs. This release simply acknowledges them.

Minor changes to some of the system calls can cause problems for programs that don't play by the rules. One such change is the use of all 8 bits in filename characters to support the foreign character sets. This made my version of Digital Research's GSX graphics extension unusable on the AT and the PC. I understand that DR's latest release fixes the problem.

Table 3: IBM PC/PC AT *software compatibility.*

Compatible	Not Compatible
PMATE Editor	Flight Simulator
Ci-C86 C compiler	J-Bird
Lotus 1-2-3	Frogger
WordStar	Burgertime
MultiMate	PC-Man
XyWrite	CP/M-86
Multiplan	Concurrent CP/M
SuperCalc2	DR's GSX
PeachText	
ASCOM	
dBASE II	

SUMMARY

All the programs I tried, except the games, stand-alone programs, and GSX, ran perfectly. Table 3 lists what worked and what didn't. IBM supplies a pamphlet with the AT telling you which programs the company knows won't run and mentioning any special considerations for supported software. Mostly this consists of instructions on how to copy a program to a high-density disk.

IBM states that a number of programs won't run on these disks because of copy-protection techniques or assumptions the program makes about disk layout. You have to run these on a standard drive.

To sum this all up, the IBM PC AT is a powerful machine that you can use in place of a PC or XT system for a two or three times increase in performance and storage. As a small, cost-effective, multiuser business system? I'll just have to wait and see what XENIX looks like. ■

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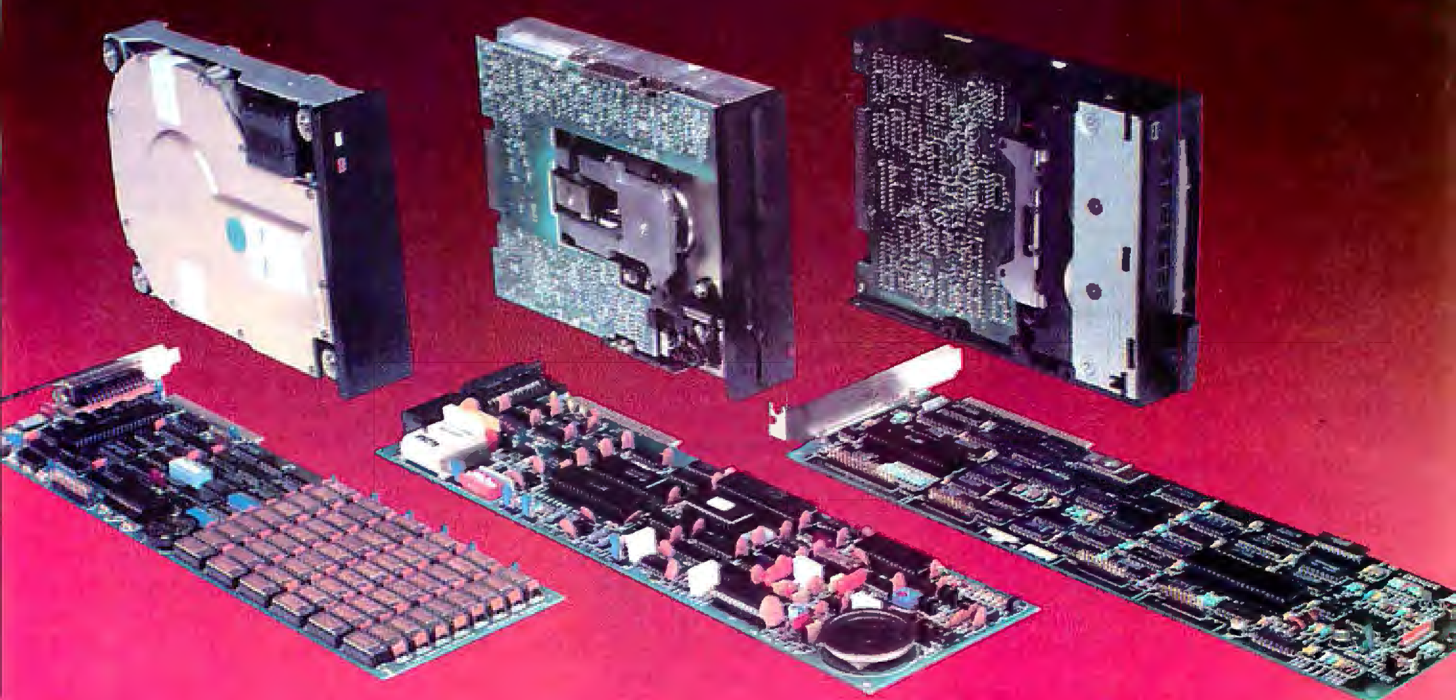

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S·O·F·T·W·A·R·E R·E·V·I·E·W

True BASIC

Bringing structure to the realm of "spaghetti code"

BY G. MICHAEL VOSE

Eighteen months ago, BASIC's originators, John Kemeny and Thomas Kurtz, informed the world they planned to port their creation to microcomputers. The intention of Kemeny, Kurtz, and associates Chris Walker, Brig Elliot, and Dave Pearson at True BASIC Inc. focused on cleaning up "Street BASIC," their name for the widespread but limited versions of BASIC that dominated the microcomputer world. These men view Street BASIC as a weak sister to the substantially evolved Dartmouth BASIC. Calling Street BASIC "a horrible dialect of a beautiful language," they bemoan its hardware specificity and lack of modern structure.

Secondarily, they were keen to create a BASIC that conformed to a standard. They wanted it to be widely disseminated and, therefore, wanted it to be uniform for textbooks and other educational materials that need program listings. The standard to emulate, in their estimation, was the embattled American National Standards Institute (ANSI) X3J2 subcommittee's proposed standard (see the text box "ANSI Standard BASIC" on page 288). Kurtz had served as chairman of the subcommittee for 10 years.

The result is True BASIC, a compiled ANSI standard BASIC distributed by textbook publisher Addison-Wesley of Reading, Massachusetts. In this review, I look at the first implementation of True BASIC, the IBM Personal Computer (PC) version. It requires MS-DOS 1.1, 2.0, 2.1, or 3.0 and 128K bytes of memory, plus a disk drive. The PC version's price is $149.90.

A version for the Apple Macintosh is slated for late spring, and a PCjr version reportedly will be ready by the time you read this. All versions of True BASIC are intended to be identical at the source-code level, but the Macintosh version proposes to exploit the machine's icon-/mouse-oriented user interface at the command level.

The unique features of True BASIC, and those that will be closely examined here, include its user interface, use of external subroutines and libraries, floating-point math package, graphics and sound capability, debugging tools, and availability of access to the machine. (Table 1 offers a comparison of True BASIC, PC-BASIC, BetterBASIC, and Turbo Pascal.)

A major departure from previous microcomputer BASICs, True BASIC is compiled instead of interpreted. The compiler produces an intermediate code. A pseudo-microprocessor interprets this code at run time and uses the resulting interpretation to generate machine code for the IBM PC's 8088 CPU (central processing unit). This compilation technique enhances program-execution speed and permits execution of programs from within the True BASIC editor, using the familiar BASIC command RUN. All activity in True BASIC happens within the numerous windows of the system's editor.

Users view the True BASIC world through the editor's three windows—the source window, the command (or history) window, and the graphics window. The True BASIC editor functions as a screen editor within a window; movement is controlled by the cursor keys. The first two windows dominate the screen display during a programming session.

The source and command windows share the screen and can be adjusted by the user. On the IBM PC, you move between windows using function keys F1 and F2. You use the Home, End, PgUp, and PgDn keys to move through a file within a window.

The source window is for entering and modifying source code. The PC's Insert and Delete keys function within this window to aid the editing process.

The command window lets you issue commands (like RUN and SAVE), and it displays all nongraphic program output. In addition, the command window preserves all the command-line activity during a programming session. With the cursor keys, you

(continued)

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can move back through all command-window activity to look at any sequence of actions. Within this window, the PC function key F9 enters the RUN command, and the F7 key recalls the last line entered. The F10 key is the help key.

Since you both enter and execute

Table 1: *A comparison of features and capabilities.*

	True BASIC	PC-BASIC	BetterBASIC	Turbo Pascal
Hexadecimal numbers	no	yes	yes	yes
8087 support	yes	no	yes	yes
Maximum string length (bytes)	32K	255	32K	256
Binary-coded-decimal math	no	no	yes	no
Byte	no	no	yes	yes
Windows	yes	no	yes	yes
DOS call	no	no	yes	yes
DOS 2.0 files	yes	no	yes	no
Chaining	yes	yes	yes	yes
Overlays	yes	yes	no	yes
Libraries (modules)	yes	no	yes	yes
Procedures	yes	no	yes	yes
Functions	yes	yes	yes	yes
DO loops	yes	no	yes	yes
ELSEIF/ENDIF	yes	no	no	no
CASE	yes	no	no	yes
Scoped variables	yes	no	yes	yes
Recursion	yes	no	yes	yes
PEEK/POKE	yes	yes	yes	no
Number of open files	10	2	5	15
Array dimensions	10	255	unlimited	255
Option base	declarable (default = 1)	0 or 1 (default = 0)	0 or 1 (default = 0)	declarable

Table 2: *The largest number for which the respective languages can calculate the factorial, followed by the factorial.*

Factorial Calculations

	Largest Number	Factorial Computed
True BASIC	170	7.25742E + 306
BetterBASIC	145	8.0479272E + 251
PC-BASIC	33	8.68331761 87E + 36
Turbo Pascal	33	8.683317E + 36

Listing 1: *The factorial program coded in True BASIC.*

```
10  ! Program to Calculate and Print Factorials
20  ! Requires the Input of a Base Number
30  PRINT "Type a Number :";
35  INPUT number
40  LET dummy = number
50  IF number < 2 then LET fact = 1
60  LET dummy = dummy - 1
70  LET number = number*dummy
80  IF dummy< >1 then GOTO 60
90  PRINT "The Factorial is ";number
95  GOTO 30
100  END
```

programs from within the editor, True BASIC spots and reports errors as it encounters them during the compilation of the source program. The RUN command initiates the compiler, and there is a noticeable delay from when you enter the RUN command until True BASIC successfully completes the compile cycle. Errors make the compiler stop, display an error message in the command window, and move the cursor to the beginning of the line containing the error in the source window. Often, the cursor moves to an improperly placed keyword or punctuation character.

Another interesting component of the True BASIC user interface is that it lets you execute DO files. A DO file is a filter program or utility. For example, the True BASIC program disk contains a DO file called FORMAT that produces a formatted ("prettyprint") listing of the program file in the source window. Renumbering True BASIC's optional line numbers is accomplished with another DO file called RENUM.

DO files written in True BASIC are coded as external subroutines and compiled to object files using the command COMPILE. The resulting object file can then be saved on disk, where it resides until called by the DO *filename* command.

The final component of the user interface is the on-screen help facility. Engaged by pressing F10 or typing HELP, the on-screen assistance is not context-sensitive. To get help on a specific topic, like saving source files, you must enter HELP SAVE.

EXTERNAL SUBROUTINES AND LIBRARIES

Most BASIC programmers use subroutines, sections of code within a program that perform often-repeated functions. True BASIC similarly provides for subroutines, although you call them by name and they permit parameter passing. But the language also includes a mechanism for calling routines that reside outside a program—external subroutines and libraries.

A library is merely a collection of external subroutines grouped within a file. External subroutines allow parameter passing and look identical to internal subroutines, except that they stand alone or occur after a program END statement. The keyword EXTERNAL identifies a subroutine or group of subroutines and functions as a LIBRARY. External subroutines can reside independently on disk. To call a library, use a LIBRARY *filename* header at the beginning of the source program that calls the external subroutines.

Variables within True BASIC's external subroutines are local to that program unit; they are unknown to other external subroutines or to programs. But within any subroutine or program, all variables are global in scope. Subroutines, internal or external, may have any number of arguments, but the arguments passed must match the data type (string or numeric) of the arguments as originally declared.

Functions in True BASIC can also be external, in which case they use local variables.

True BASIC has several libraries on its program disk. A graphics library provides routines to draw an *n*-sided polygon, a filled-in circle, or six other shapes. The four mathematical libraries offer hyperbolic functions, trigonometric functions in either radians or degrees, and such functions as *n* factorial or binomial coefficients. A menu library contains five subroutines that let you use menus within programs. By invoking them you can open a window for a menu, display the menu, get a reply, clear the menu, and return to the working program window.

FLOATING-POINT MATH

To test the dynamic range of True BASIC, I ran the short factorial program shown in listing 1. Table 2 shows the largest number for which this algorithm can calculate the factorial for a variety of languages on an IBM PC. The dynamic range claimed for the PC version of True BASIC is 1.11254E−308 to 3.59539E+308, a claim verified by this test. True BASIC Inc. says that the minimum dynamic range

(continued)

for True BASIC, regardless of the computer, is 1.0E−99 to 1.0E+99.

The numeric precision of True BASIC is 14 digits of accuracy on the PC, except for the built-in transcendentals, where the accuracy is 10 digits. The external format for True BASIC numbers conforms to the IEEE 754 floating-point standard. The language's implementors sacrificed some of the standard's precision to obtain greater speed and produced a math package with better speed *and* precision than most languages offer (see the "Benchmarks" section). In accordance with the ANSI standard, only 6 digits of a number are displayed unless you invoke special format commands, like PRINT USING. (Other True BASIC limits include a maximum string length of 32,767 and a maximum of 255 array dimensions.)

The traditional BYTE calculations benchmark, rewritten in True BASIC and shown in listing 2 (the standard BYTE calculations benchmark is shown in listing 3 for comparison), reveals that True BASIC's round-off error is substantially lower than that of the PC-BASIC interpreter (see table 3 and the graphs on the "At a Glance" page). True BASIC also automatically senses, and uses, the Intel 8087 coprocessor when installed. The 8087 further enhances the speed and accuracy of floating-point math, fully conforming to the IEEE 754 standard.

Listing 2: *The* BYTE *calculations benchmark coded in* True BASIC. *Note that line numbers are optional.*

```
LET startime = time
LET nr = 5000
LET a = 2.71828
LET b = 3.14159
LET c = 1
FOR i = 1 to nr
     LET c = c*a
     LET c = c*b
     LET c = c/a
     LET c = c/b
NEXT i
PRINT "Done"
LET finishtime = time
PRINT "Error = ";c - 1
PRINT finishtime-startime;" seconds"
END
```

Listing 3: *The standard* BYTE *calculations benchmark.*

```
5  REM: THE CALCULATIONS BENCHMARK
10  NR = 5000
20  DEFSNG A-Z
30  A = 2.71828
40  B = 3.14159
50  C = 1
60  FOR I = 1 TO NR
70  C = C*A
80  C = C*B
90  C = C/A
100  C = C/B
110  NEXT I
120  PRINT "done"
130  PRINT "error = ";C - 1
```

GRAPHICS AND SOUND

True BASIC places a substantial emphasis on graphics. Most of the sample programs on the distribution disk generate graphics output. The design goals of the graphics command set were portability and elimination of pixel calculations.

To eliminate pixel math, True BASIC performs *x, y* coordinate graphics using statements like PLOT, BOX, and DRAW. You can plot lines, points, or areas to create simple shapes. The only concern is the character of the graphic, such as the length of the sides of a triangle, and not pixel positioning on the screen. The graphics statements make all the pixel calculations. BOX statements let you draw and redraw graphics fast enough to create animated displays.

The PICTURE construct allows more sophisticated graphics. PICTUREs are special graphics subroutines called with the DRAW state-

(continued)

Table 3: *The* BYTE *benchmarks for several languages. Times are in seconds.*

	True BASIC	PC-BASIC	BetterBASIC	Turbo Pascal
Sieve	21.2	190.7	31.4	15.4
Calculations	19.7	69.2	91.3	82.6
(Error)	−4.5830006457E-13	−1.788139E-07	0 (uses binary-coded-decimal notation)	−1.3384124031E-08

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AT A GLANCE

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True BASIC

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Hanover, NH 03755

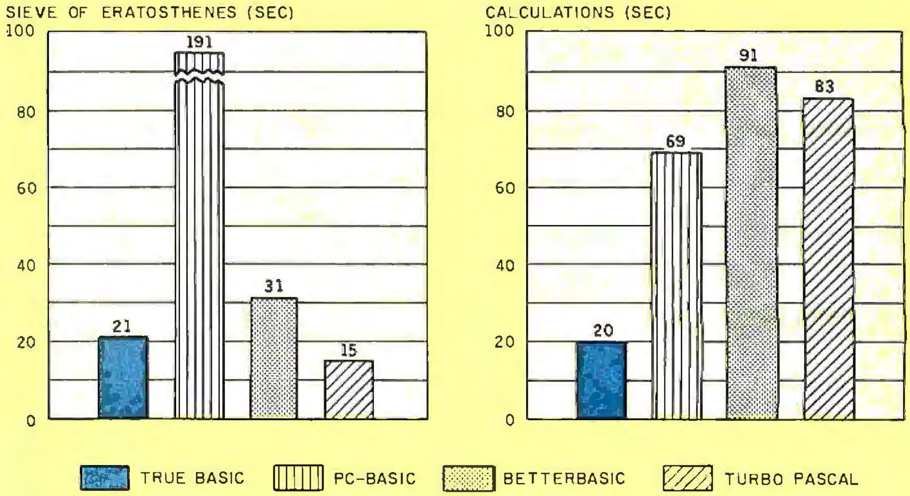
Distributor
Addison-Wesley
Publishing Co.
Reading, MA 01867
(617) 944-3700

Price
$149.90

Computer
IBM PC with 128K RAM and a disk drive

Features
An ANSI standard BASIC language compiler with a window-oriented user interface, characterized primarily by its outstanding math package

Documentation
A reference manual and a user's guide plus on-screen help



The benchmark for the Sieve of Eratosthenes measures (in seconds) how long it takes for each of the tested languages to run one iteration of a program that determines all of the prime numbers up to 7000. The Calculations graph shows how long it takes to do 10,000 multiplication and 10,000 division operations using single-precision numbers. Listings 2, 3, 4, and 5 show the standard BYTE benchmarks for calculations and the Sieve—as well as how they were modified to accommodate True BASIC's slightly different syntax.

ment. Since a PICTURE emulates a regular True BASIC subroutine, it can be called with parameters. For example, a PICTURE that draws a square can be called with an argument that determines the length of the square's side.

Sophistication in picture graphics is made possible by what True BASIC calls transformations. These transformations include the ability to rotate a picture, shift a picture right or left on the screen, change the size of a picture, or even shear the picture (tilt all its vertical lines forward by a specific number of radians or degrees).

Like regular True BASIC subroutines and functions, PICTUREs can be either internal to the program or external. They may even reside with other PICTUREs in a library.

The graphics functions of True BASIC also include the ability to combine text and graphics (using the PLOT TEXT statement) and the use of adjustable windows. To enhance output within the system graphics window, you can open separate windows of any size and divide the output among them any way you like. The windows in True BASIC do not overlap.

To create music or sound in the language, you use common keywords like PLAY, SOUND, and PAUSE. On the IBM PC, you can play music in either foreground or background mode so your programs can provide music along with other activity. Background music is limited to a string of 32 notes or pauses, played repeatedly until the program's end.

CHAINING AND DEBUGGING

The CHAIN statement in True BASIC functions like a subroutine call. Program flow can pass to another program and then return to the original program when the second program completes execution. CHAINed programs can even accept arguments.

You can write and call assembly-language subroutines from within True BASIC programs, and you can perform traditional BASIC memory examination and assignment operations using PEEK and POKE. On the IBM PC, True BASIC's memory addresses do not use the Intel 8086 conventions of segment and offset. Instead, they use a simple decimal address. Programmers will have to calculate this address, using the formula *segment**16 + *offset* = *address*, before performing PEEKs and POKEs.

This version of BASIC treats assembly-language routines the same way it treats libraries. Therefore, assembly-language subroutines need preface bytes identical to those in a library file. Assembly-language routines can accept arguments. Once created, assembled, linked, and

(continued)

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- Creates a cross-reference listing of the definitions and locations of all symbols used in an assembly language program.

filtered by EXE2BIN, an assembly-language subroutine is treated just like any True BASIC library routine.

Bit manipulation is not provided in True BASIC, other than that allowable by PEEK and POKE routines and the bit-packing routines, PACKB and UNPACKB. The logical operators AND, OR, and NOT are relational, not Boolean. You can use them on expressions but not on variables, meaning that you can't use them to mask all but certain bits of a byte. PACKB and UNPACKB place integers into strings and retrieve integers from strings, respectively. This allows storing numbers between 0 and 255 more economically.

True BASIC provides no special debugging aids. The manual suggests using BREAK to set breakpoints and CONTINUE to resume program execution after a breakpoint-defined halt. The editor provides a global search-and-replace command called CHANGE.

Listing 4: BYTE's *Sieve benchmark in True* BASIC.

```
10  let startime = time
20  let size = 7001
30  dim flags(7002)
40  print "Start One Iteration"
50  let count = 0
60  for i = 1 to size
70  let flags(i) = 1
80  next i
90  for i = 1 to size
100  if flags(i) = 0 then goto 180
110  let prime = i + i + 3
120  let k = i + prime
130  if k>size then goto 170
140  let flags(k) = 0
150  let k = k + prime
160  goto 130
170  let count = count + 1
180  next i
190  print "Done: ";count;" Primes Found"
200  let finishtime = time
210  print finishtime - startime; " seconds"
220  end
```

Listing 5: *The standard* BYTE *Sieve benchmark.*

```
5  REM: THE SIEVE BENCHMARK
10  SIZE = 7000
20  DIM FLAGS(7001)
30  PRINT "start one iteration"
40  COUNT = 0
50  FOR I = 0 TO SIZE
60  FLAGS(I) = 1
70  NEXT I
80  FOR I = 0 TO SIZE
90  IF FLAGS(I) = 0 THEN 170
100  PRIME = I + I + 3
110  K = I + PRIME
120  IF K > SIZE THEN 160
130  FLAGS(K) = 0
140  K = K + PRIME
150  GOTO 120
160  COUNT = COUNT + 1
170  NEXT I
180  PRINT "done: ";COUNT;" primes found"
```

BENCHMARKS

Table 3 and the graphs on the "At a Glance" page show benchmark results for several languages on the IBM PC. The benchmarks indicate that True BASIC is an average of 6.4 times faster than interpreted PC-BASIC, 3 times faster than BetterBASIC, and twice as fast as Turbo Pascal. True BASIC performs particularly well on the calculations benchmark. Listing 4 shows the Sieve benchmark program coded in True BASIC. Compare this with the standard BYTE benchmark for the Sieve in listing 5.

CONCLUSIONS

The True BASIC compiler conforms closely to the ANSI standard for BASIC but is not identical to the standard. It is likely, due to hardware anomalies, that there will never be a compiler that is 100 percent compatible. Even compilers for C, held up to the world as the most portable of languages, show variation from compiler to compiler; even C compilers from the same vendor can differ on different machines.

The principal advantage of ANSI compatibility is portability. In educational institutions, where there are as many different hardware brands as there are pencils, portability is crucial to BASIC's continued usage. Secondarily, ANSI BASIC conforms more closely to the structured programming precepts that computer scientists see as essential to learning effective programming.

The disadvantage of ANSI compatibility is its nonconformity to the massive existing BASIC software base. Laborious recoding will be necessary to port existing programs to new BASICs like True BASIC.

Another, more subtle, disadvantage is aesthetics. I do not like the use of LET statements, for example, to assign values to variables. Though aesthetic considerations may seem arbitrary, they are important to a product's acceptance. People resist learn-

(continued)

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ing new syntax that they find inelegant. Since the ANSI standard requires only that a conforming language *correctly process* LET statements, True BASIC should make them optional.

Minor syntax variations can also cause headaches. For example, True BASIC uses semicolons to separate multiple statements on a line, in a manner similar to Pascal. Microsoft BASIC and C use semicolons for completely different functions (for screen formatting and ending lines, respectively); these subtle differences will probably frustrate first-time users of True BASIC.

In keeping with the goal of aiming True BASIC at education, the reference manual and user's guide are written for the learner. But they do not condescend or oversimplify, presumably because they will be used in conjunction with a textbook or a class in programming. The documentation will be suitable for use outside of schools as well. The manuals are above average in content, style, and presentation. They avoid cute graphics and convey a sense of academic authority without being dull.

Surprisingly, True BASIC stacks up well as a software-development tool. Its structure allows the writing of easily maintainable programs, and its modularity—with external subroutines, libraries, and chaining capability—makes it suitable in team-programming situations. The programs execute a speeds that are comparable to those of other compiled BASICs. The company reportedly has a run-time package under development that will eventually permit the distribution of executable True BASIC programs.

The company reportedly has a run-time package under development that will eventually permit the distribution of executable programs.

The lack of a screen display during the compile process is a substantial error. Many people will get nervous during long program compilations, which could be several minutes, when the machine appears to be hung, doing nothing. A simple PROGRAM NOW COMPILING message might alleviate this tension.

The ultimate conclusion I draw about True BASIC is that it is superior to Microsoft BASIC as a programming language. Its strengths are its modularity, portability, graphics, and high-quality math package. Its weakness is its lack of compatibility with existing BASICs. ■

ANSI STANDARD BASIC

Expected to be formally adopted this year, the ANSI standard for BASIC calls for a broad and powerful set of control and command structures (see references 1, 2, and 3). In addition to a language core, the standards document specifies extensions for graphics, sophisticated file structures, real-time control, fixed decimal arithmetic, and editing. Unfortunately, conformity to the ANSI standard produces headaches for people using an existing BASIC, since its syntax almost certainly won't conform to the standard. Transporting existing programs to the new ANSI environment necessitates substantial rewriting of code. For example, all assignment statements, such as a = 1, must process the word LET (for example, LET a = 1) in ANSI BASIC.

The thrust of the proposed standard is to add structure to microcomputer BASIC, which has long been criticized as the language of "spaghetti code" with multiple conditional and unconditional branches, plus no satisfactory method of naming and labeling functioning blocks of code. The de facto industry standard, Microsoft BASIC, also suffers from limited variable names and a bewildering variety of keywords from machine to machine.

ANSI BASIC provides a full complement of advanced control structures, named subroutines, long variable names, and array-manipulation statements. Array manipulation statements use the keyword suffix MAT, an abbreviation for matrix. With the MAT suffix, you can read data into arrays, put data into arrays, add or subtract or multiply arrays, and print arrays. In most microcomputer BASICs, these operations require looping, using the loop index as the array subscript.

Because ANSI BASIC attempts to make the GOTO and GOSUB statements unnecessary (although it does include them), it replaces the ON. . .GOTO/GOSUB construct with the SELECT/CASE structure. Similar to Pascal's CASE statement, ANSI BASIC's SELECT/CASE allows multiple path branches according to evaluated expressions. True BASIC even allows ranges within the CASE evaluation, as in CASE 0 TO 9.

Control structures in ANSI BASIC include DO loops, using both WHILE and UNTIL modifiers at either the beginning or the end of the loop block, as well as the common FOR/NEXT loop. In addition to older IF/THEN decision structures, ANSI BASIC adds multiway decision coding using the ELSEIF/ENDIF construct.

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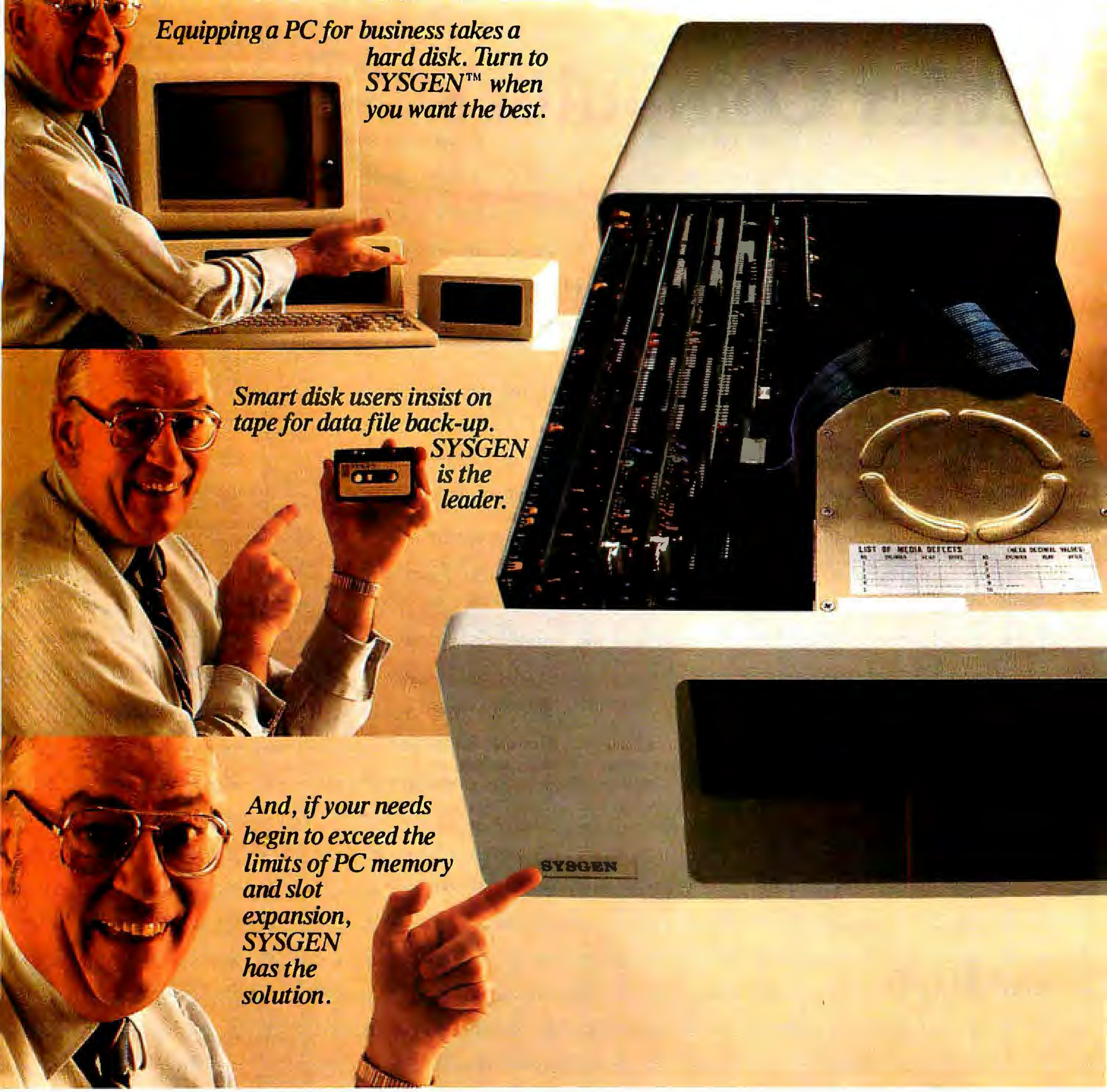

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The GTX-100 Modem

An intelligent device with built-in security functions

BY MARK HAAS

The GTX-100 is an intelligent 300/1200-bps (bits per second) modem that claims to provide four levels of security for the computer to which it is attached. Until recently, Lockheed-GETEX, makers of the GTX-100, called it the Data Sentry and advertised it as "so secure even Mata Hari couldn't hack it."

The GTX-100 contains a Z80 microprocessor that controls all of the modem's functions. CMOS (complementary metal-oxide semiconductor) memory with battery backup stores the data the security functions are based on. The unit measures 8½ inches wide, 10 inches deep, and 2 inches high; it's constructed of good-quality plastic.

The GTX-100's front panel contains eight LEDs (light-emitting diodes) that indicate the modem's status (off hook, carrier detect, etc.). Also on the front panel are three rocker switches. The first is an Answer/Originate switch that you use to set these protocols when connecting without dialing, as when using a leased line. The center position of this switch permits voice operation with a telephone connected to one of the jacks on the rear panel. The Test switch puts the modem into an analog loop so that what the connected terminal sends is echoed back. After a while this function automatically times out and puts the modem back into normal operation. The Remote/Local switch controls an optional power-on device and does not control the modem's remote and local modes.

The rear panel contains two RJ11C jacks for connection to the phone line and the telephone; a DB-25 connector; a four-position miniature switch that sets the data format, parity, carrier-detect/data-terminal-ready signal activation, and mode of operation (English responses or single-character codes); and a voltage regulator mounted on a heatsink.

Connecting the modem to my office computer was fairly straightforward, and the manual provided good directions. An RS-232C cable (not supplied) connects the rear-panel jack to the computer's RS-232C port. Tapping a few keys on the keyboard while my communications software was in Terminal mode confirmed proper operation.

MODEM SMARTS

When you first turn the GTX-100 on, it runs a diagnostic on itself and then awaits a carriage return from the terminal (or computer) connected to it. This allows the modem to determine the proper data rate (300 or 1200 bps) automatically.

You are then ready to enter commands. The GTX-100 contains what could be called its own minicommunications package. From its Help menu, the modem's software lets you select the data rate, dial the phone automatically (speed dialing), dial the phone manually by entering a number, dial again the number last dialed, and go to the Security menu.

Speed dialing lets you store up to ten 62-character telephone numbers, including special dialing characters that direct the GTX-100 to pause 5 seconds, wait for a dial tone, or use tone or pulse dialing. Another character lets you link multiple numbers as one entry, causing the modem to dial each number in turn until it detects a carrier. An F in front of a number (or linked list of numbers) tells the modem to dial the number "forever," and the pause between repeated dialings can be set for 20 to 180 seconds. You can also enter remarks to help identify phone numbers or use the special characters just mentioned while dialing manually. Entering, changing, and erasing numbers is easy.

The GTX-100 can detect several line conditions—dial tone, busy signal, ringing, dead line, and excessive noise—and report these conditions to the operator in English or single-letter codes, as determined by a switch on the rear panel. The modem contains no speaker, but indicators make up for this.

(continued)

Mark Haas is technical director for Osborne/McGraw-Hill (2600 Tenth St., Berkeley, CA 94710).

AT A GLANCE

Name
GTX-100

Manufacturer
Lockheed-GETEX
1100 Circle 75 Parkway
Atlanta, GA 30339
(404) 951-0878

Type
Intelligent modem with security features

Size
8½ by 10 by 2 inches

Equipment Needed
Terminal, or computer with simple communications software and an RS-232C port

Features
300/1200-bps operation, automatic detection of data-transmission rate, automatic dialing and answering, battery backup of memory (protects all menus and tables), force answer/originate mode for leased-line operation, analog loop test with automatic time-out, pulse or tone dialing

Options
Remote-ON power regulation to turn computer on or off remotely

Documentation
48-page manual

Price
$795

Warranty
1 year, limited

The Modem menu lets you set a variety of modem functions. You can set the modem's hang-up command code, dialing speed (slow or fast only), and local echo, and you can set the modem to answer on a specific ring. You can suppress the status reports from the modem to avoid interference with some communications packages, and you can suppress hang-up upon loss of carrier, thus allowing a mix of voice and data during the same call. The commands the GTX-100 accepts are not compatible with the Hayes Smartmodem.

Note that you can enter commands only from the host terminal. This means no one can "bump" the modem into command mode from a remote terminal and access your files.

SECURITY

What sets this modem apart from other intelligent modems (such as the Hayes Smartmodem) is its built-in security measures. The GTX-100 has four levels of security: call back from list, call back any number, password without call back, and modem only.

In modem-only mode there is no added security and the GTX-100 acts like any other modem. The three remaining levels of security all involve the use of passwords. You can store up to sixteen 20-character passwords in the modem. Entering any one of the passwords is sufficient to gain access to the system. The modem also keeps a log of the last 16 numbers called back and the last 16 passwords entered (whether valid or not). These logs are useful in tracking potential breaches of security.

The highest level of security is the call-back-from-list mode. In this mode, the remote caller dials the modem's number. Upon connection, the modem requests from the caller a phone number it can call back. The modem checks the number entered against a table of authorized call-back numbers. Assuming the number checks out okay, the modem hangs up and then proceeds to dial the call-back number. Once connection is reestablished, the modem asks for a

(continued)

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password. If the caller enters a correct password (one of the 16 possible), access is permitted.

The call-back-from-list mode provides several security measures. Even if someone steals a password, the modem will call back only numbers contained in the list of authorized numbers. Any intrusion would have to originate from one of these numbers. Assuming the perpetrator is calling from one of the authorized numbers, he will gain access only after entering a correct password. You can control the number of incorrect attempts at entering the password, and if an intruder exceeds that number, his phone number is placed in a "not allowed" list. Any numbers appearing on the list will not be called back, even if they are also on the list of authorized numbers.

The main drawback to this level of security is the limited number of call-back numbers. Since the system can contain only 16 numbers on the authorized list, users can access the system from, at most, 16 locations. If any user needs to have access from more than one location, then each possible call-back number would have to be listed, cutting down the space remaining for other users (unless your phone has automatic call-forwarding and you remember to set it).

Breaking this level of security would not be an easy task, probably impossible for the average person. Any break-in would probably have to be an "inside job." The next level of security, call-back-any-number mode, is another story.

In call-back-any-number mode, users can call from anywhere: the modem calls back any number not on the not-allowed list. Again, if the number of attempts to enter a correct password exceeds the limit, the modem enters that phone number into the not-allowed list. Unfortunately, there is a simple way around this security measure, but I will not describe it here. Suffice to say that you don't have to be Mata Hari to figure it out.

This mode enables you to provide a unique service, however, by paying the phone bill for most of the time the caller is on the line. The caller pays only for the first call to the modem, usually no more than one minute.

In the password-without-call-back mode the modem merely asks for a password. The list of authorized passwords may contain 16 passwords, and you can limit the number of tries that a user gets with each call.

All the features of the secure modes are controlled from the Security menu, which is password-protected itself. From this menu you can choose the mode of security, enter allowable call-back numbers and passwords, and set the limit on the number of password attempts. You can change the password for entry into the Security menu. This menu also gives you access to the call-back-number and password logs.

Research has shown that the best way to secure a computer system is through the use of passwords and by changing the passwords regularly. The GTX-100 allows up to 20-character passwords, which should keep any potential intruder busy for a while. The question is, Do you need to spend $795 for a modem just to get password protection?

CONCLUSIONS

The GTX-100 is a high-quality 300/1200-bps intelligent modem offering varying levels of security. Overall I found its performance to be excellent. Security in the call-back-from-list mode is very good but has its limitations. Security at the next level, call-back-any-number mode, is no better than password-without-call-back mode. It may be useful, however, as a service to the caller, who usually has to pay only for the first minute of the original call to the modem.

I doubt most personal computer users will need the highest level of security or the call-back feature. You could build these features into your application software and use a less-expensive intelligent modem. However, commercial users requiring these security features could probably benefit from purchasing the GTX-100 modem. ■

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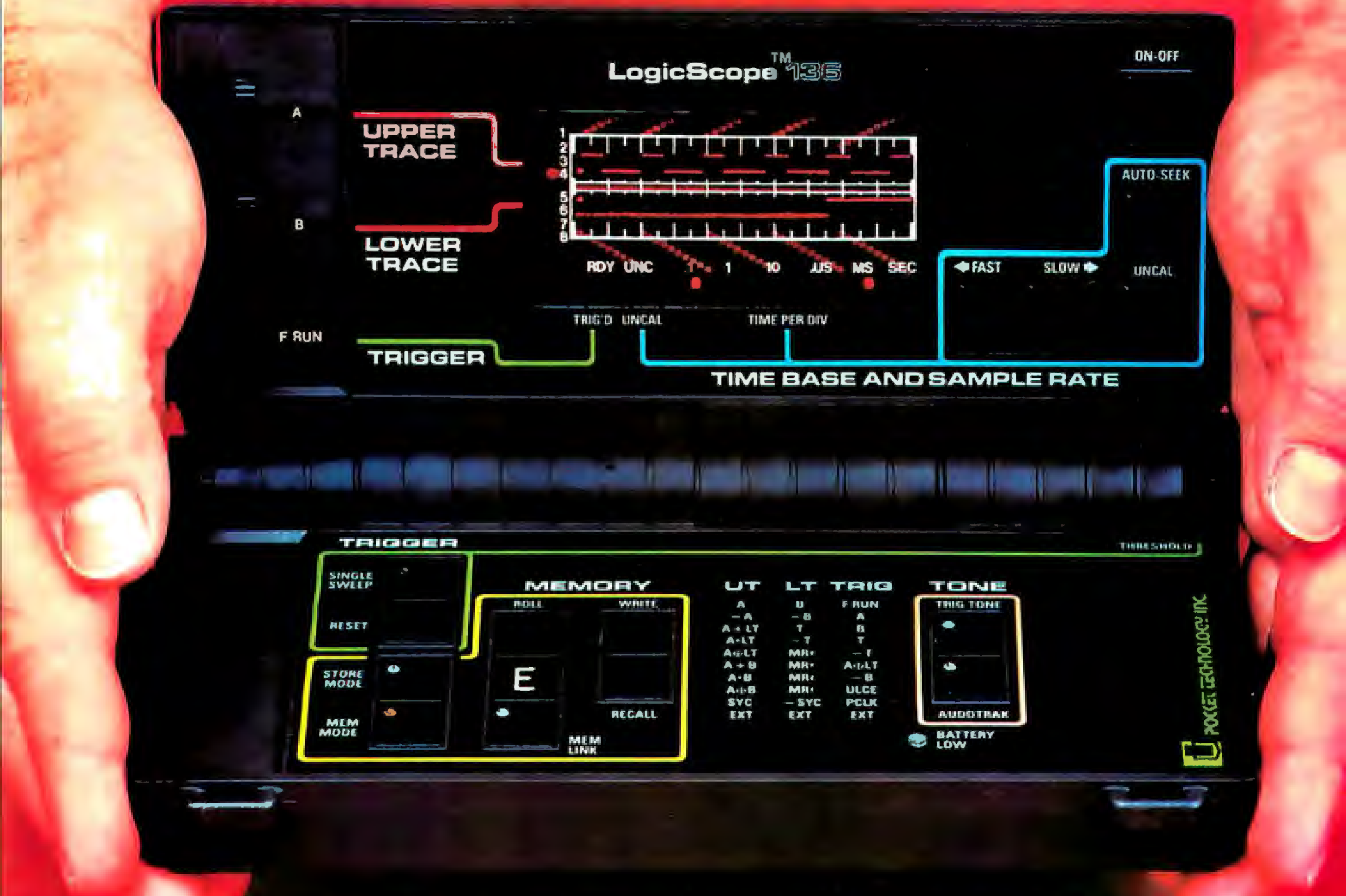

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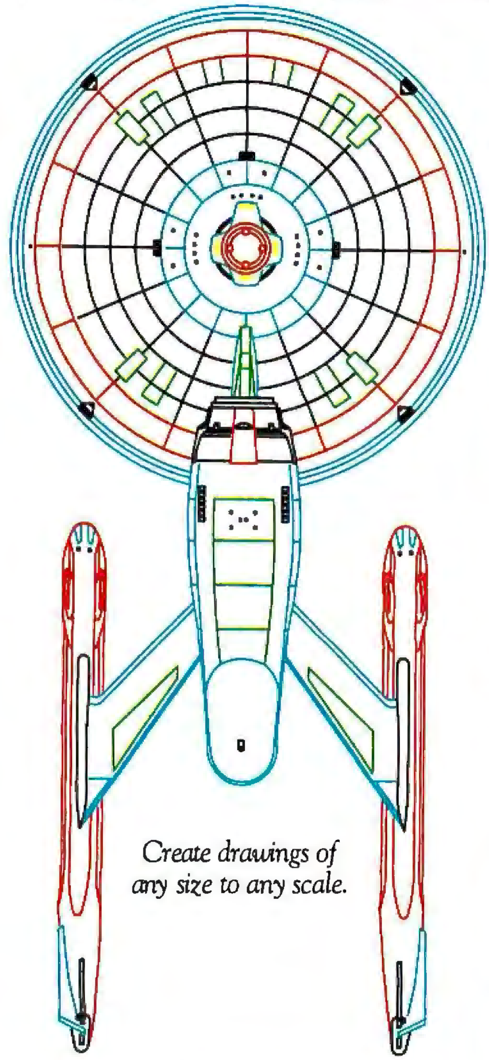

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Q. Do you often modify existing drawings?

A. We make it fast and simple, with a revised, plotted drawing that looks as good as the original. So, your productivity will be greatly improved.

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Q. Do you use standard symbols or parts?

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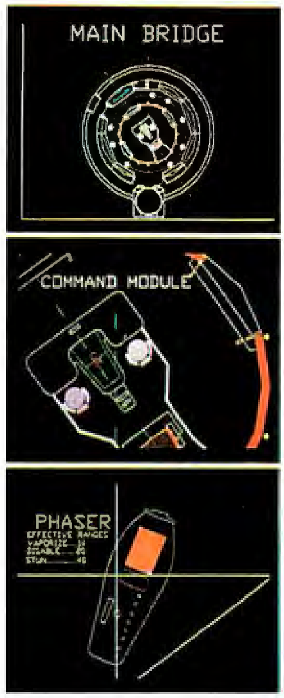

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Q. Do you have other PC needs?

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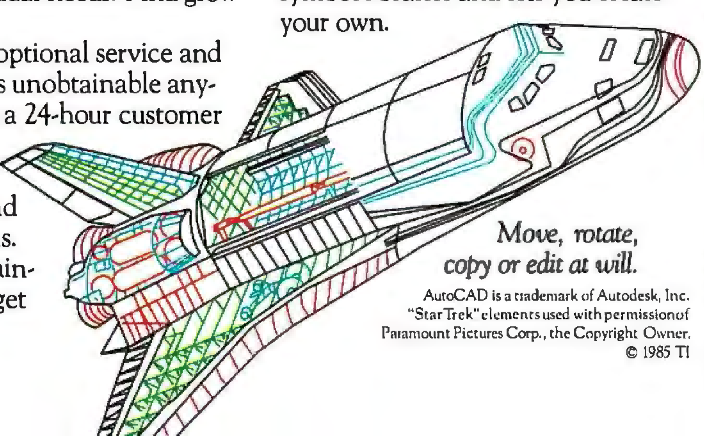

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TANDY 2000 UPGRADE

The review "The Tandy Model 2000" by Mark S. Jennings (December 1984 BYTE, page 239) states, as does literature from Radio Shack, that maximum RAM (random-access read/write memory) capacity is 768K bytes. The service manual for the 2000 (page 252) states that RAM capacity of 896K bytes is attainable by using all three available slots for upgrade RAM boards and kits.

A string in the last line of a 338K-byte file was located by the Find command in 18 seconds. When I added a RAM-disk utility, the same string was picked up in 3 seconds.

As your review indicates, RAM upgrade cost is high indeed. The cost for adding 512K bytes of RAM to the 256K bytes of RAM that came with my hard-disk model is $1596. I am not aware of any other computer that costs as much for a RAM upgrade.

Apart from this one complaint, I am delighted with my 2000 and with the cooperation I have received from the Tandy/Radio Shack home office.

GREGORY GROVER
Los Angeles, CA

THE H-150 KIT

In the text box "Building the H-150 Computer Kit" (December 1984, page 258), Henry B. Cohen might have done a disservice to kit builders, especially novices, with some of his advice. I have constructed many kits, printed-circuit (PC) boards, and other electronics projects, so I speak from experience.

Mr. Cohen recommends working around parts that you can't locate immediately and then putting them on when they turn up. This is a poor practice, especially for novices. Often the order in which parts go on PC boards is important for ease of installation and because a certain sequence might be required if you are to install the part at all. Always install parts in the order specified in the instructions.

Mr. Cohen's suggestion that you should solder for integrity first and then go back and solder for appearance is also not a good practice. Each connection should be soldered only once. Reheating a solder connection on a PC board to improve appearance is unnecessary and could damage the part, increase the probability of solder bridges, and degrade the integrity of the traces on the board (particularly on multilevel boards). Soldering integrity is the only consideration.

Mr. Cohen is incorrect when he states that a VOM or multitester is necessary to build the Heath H-150. I constructed the H-160 (the transportable model) and did not need test instruments. With these computers, Heath supplies a tester that you must also solder together. All the testing described in the Heath construction manuals refers to this tester, which uses a generated tone for test measurements. In fact, you would have to refer to other technical data to use another type of tester (to get voltage levels and to understand what the tests accomplish).

Other advice offered by Mr. Cohen was very good, and I would like to confirm that the PC-compatible H-150/160 is a fine computer. You get additional technical documentation with Heathkit products that can prove extremely valuable when you run into problems in the future.

LOREN D. MARTINDALE
Yuma, AZ

WORDPERFECT

I was happy to read Ricardo Birmele's enthusiastic review of WordPerfect (December 1984, page 277). This program is by far the best of the dozen word processors I have sampled. I believe that several of the problems Mr. Birmele acknowledges are easily solved or are not WordPerfect's fault.

Mr. Birmele states, "Any characters underlined on a monochrome monitor will appear in blue on a color monitor; if fed by a color video drive board, they will appear in reverse video on the monochrome monitor." My experience with WordPerfect on the IBM PC suggests that it is the computer's fault that underlining is not available on a color monitor. When you run WordPerfect with the /S option (by typing WP/S from MS-DOS) and exercise the "Set Colors for Color Monitor" option, the program prompts for the color it should use to represent underlined words. You can select whatever color you like from the IBM repertoire; underlined words will be displayed in that color, or in reverse if you select this option. I believe that Mr. Birmele will find that a document's underlined words will appear as such on a monochrome monitor driven by the IBM monochrome card, while on another machine with a color-display card the same words will be in color or reversed. Finally, it is not technically possible to successfully drive the IBM monochrome display with the color card.

Mr. Birmele is correct in mentioning that setting tabs is not convenient. But WordPerfect already provides tabs at even intervals; setting a tab at the current cursor position entails remembering the column number before pressing the Set Format key and selecting Tabs, then typing the number of the column where you want a tab. The WordPerfect manual explains this procedure.

It is also an injustice to imply that WordPerfect runs only on the IBM PC, Victor 9000, DEC Rainbow, Tandy 2000, and Zenith Z-100; indeed, there are customized versions of WordPerfect for nearly any MS-DOS computer in existence, and it is compatible with a wide variety of computers including the Victor, the TI Professional, the Data General/One, and others.

JOE CLARK
Halifax, Nova Scotia, Canada

TOSHIBA P1340

In Ken Sheldon's review "The Epson LQ-1500" (December 1984, page 293), I believe that the author makes a misleading comparison. He compares a properly operating LQ-1500 with an improperly operating Toshiba P1340. As a happy owner of a Toshiba P1340, I know that it is capable of producing much higher quality output than is shown in the sample.

From the sample, it looks like at least three of the pins in the unit are failing to drive. My guess is pins 8, 12, and 18. It might be that this P1340 is simply in need of its regular print-head cleaning, as specified in Section 5 of the owner's manual. A toothpick will remove the paper and rib-

(continued)

Table A: *Benchmark results for the Aztec, Eco-C, and OS-9 compilers. The code sizes are reported in bytes.*

Compiler	Comp.	Assem.	Link	Size	Execution
Aztec	0:25	0:20	0:45	9096	2:06
Eco-C	1:08	0:24	0:52	7280	1:41
OS-9	2:13	1:18	0:59	5805	1:19

bon debris that can cause the pins to stick.

MAXIM G. SMITH
Natick, MA

C BENCHMARKS

Review Feedback (December 1984, page 301) contains another benchmark program for C compilers (listing 1, page 302). According to author David C. Clark, the program is designed "to examine the quality of the implementation of long integers among various versions of C." Mr. Clark gives results for two fully implemented C compilers running on a 4-MHz Z80 system (table 1).

Curious to see what would happen, I ran the same test on a Tandy/Radio Shack Color Computer with the OS-9 C compiler (no flags set). I won't guarantee the clock times closer than a second either way, but as you can see (table A), a few seconds make no difference at all.

My question is: What would a full-featured Gimix system with a 2-MHz clock make of this?

R. W. ODLIN
Sedro-Woolley, WA

ALF 8088 COPROCESSOR

David Morganstein's review "ALF's 8088 Coprocessor for Your Apple" (in the *Guide to the Apple Personal Computers*, December 1984 BYTE, page A38) gives an objective and fair assessment of this coprocessor for the Apple II. However, when speaking of reading IBM PC-compatible disks, Mr. Morganstein mentions the Rana 8086 coprocessor system, which includes IBM PC-compatible disk drives. I cannot understand why he does not mention ALF's own IBM PC-compatible Apple II disk-drive system, which has been available for the better part of a year to support ALF's coprocessor.

Mr. Morganstein was unable to get his Videx 80-column board working on the ALF board. This is, in fact, the only bug I have found in the product, and I believe it is an outcome of ALF developing the product-support software on Franklins rather than Apples. I finally got my 80-column board running under CP/M-86 by using two different drivers.

I originally bought my ALF 8088 coprocessor because of its support of the 8087 math coprocessor. Mr. Morganstein reports only a modest improvement in processing speeds using the FTL program. However, anyone doing large numbers of trigonometric and log functions in Applesoft using ALF's FTL87 8087 Applesoft support will have a pleasant surprise—a hundred-or-more-fold speed increase.

Mr. Morganstein points out that you need to take care, when running the ALF coprocessor under MS-DOS or CP/M-86, to ensure that software written for an IBM-type personal computer will run in the Apple environment. However, it is not necessary to purchase software that is not copy-protected in Apple-compatible format, since commercial services are readily available to perform this conversion.

The ALF 8088 coprocessor is not for everyone. But for those who can integrate it into their Apple system, it can be a useful addition. I have found the ALF technical-support people helpful, supportive, and knowledgable. The hardware and software are reliable and perform as ALF says they do. I have had my ALF board two years and have had no problems with it.

DWIGHT WILLIAM JOHNSON
San Diego, CA

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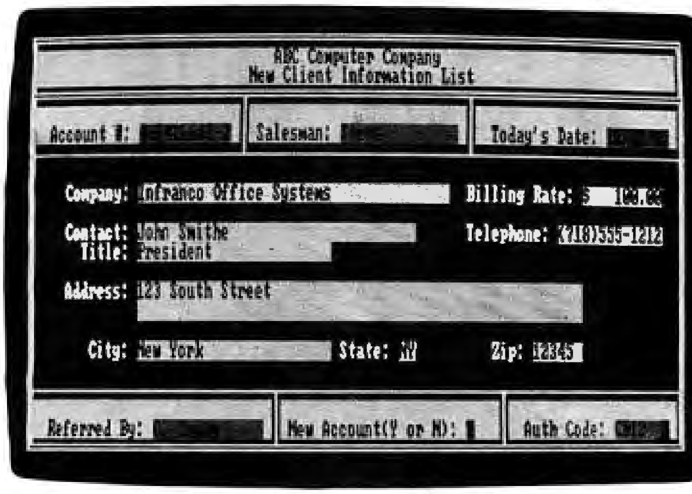

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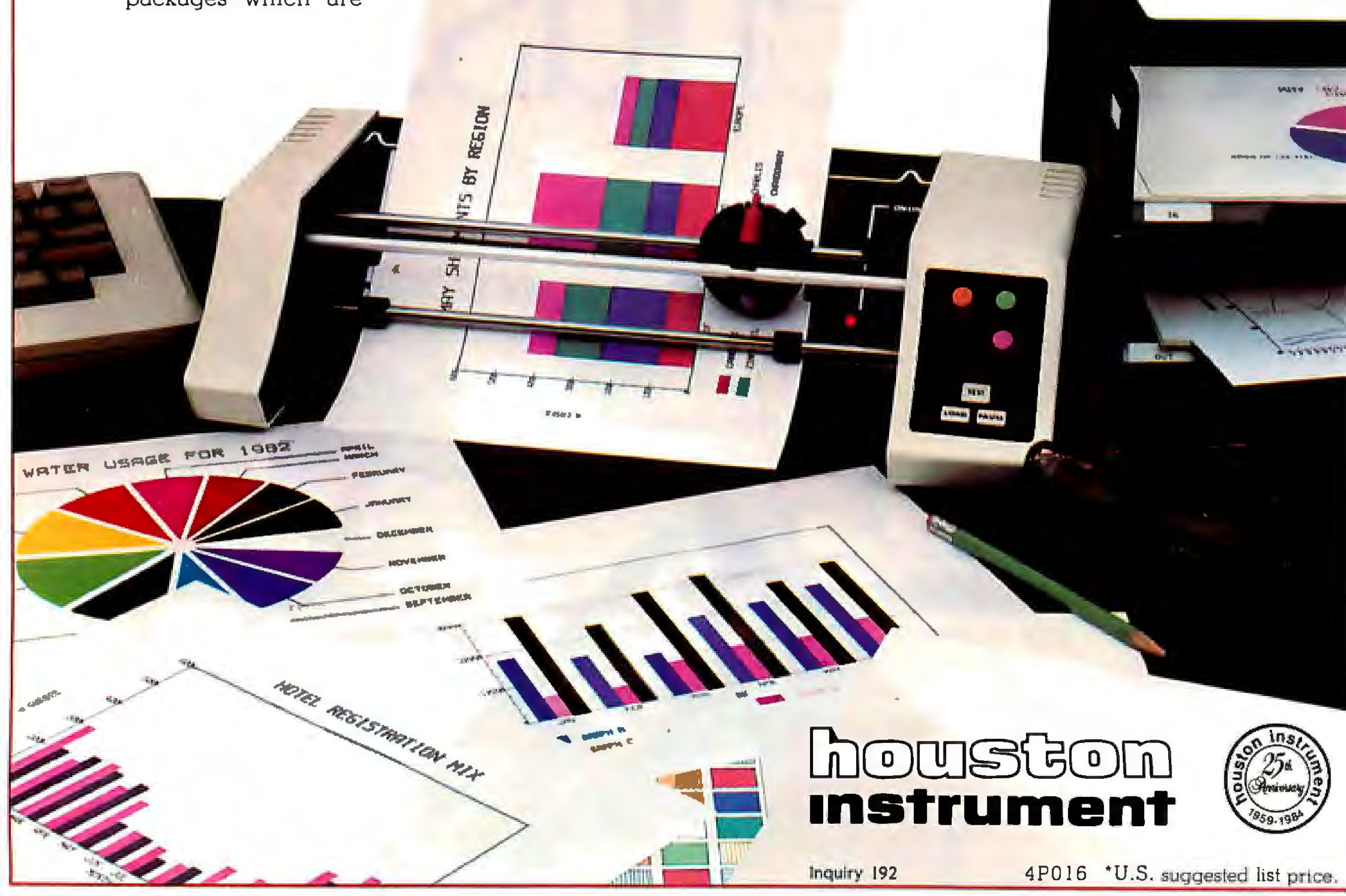

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Inquiry 192

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Kernel

IN SPITE OF A FLU BUG, Jerry Pournelle was up to picking his favorite products of the year for 1984. As he says, "Purely subjective."

Bill Raike reports on IBM Japan Ltd.'s test production of 1-megabit RAM chips and takes a look at some new microcomputers.

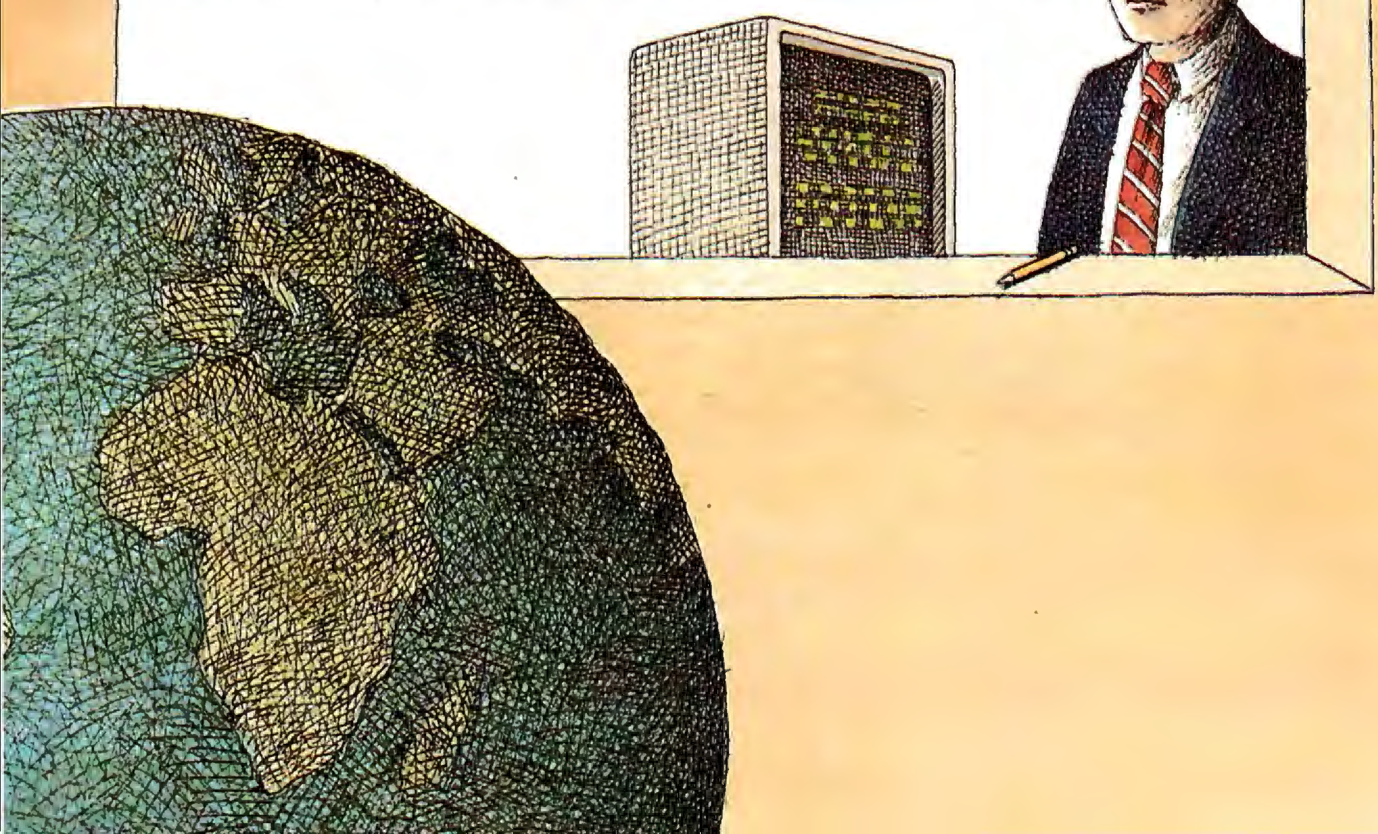
The BYTE West Coast editors describe an economical approach to custom chip manufacturing and give us their impressions of some new software.

Dick Pountain deals with this month's theme as he acquaints us with ALICE and Hope, two components of a parallel-processing approach in the U.K.

In Computers and Law, Robert Sterne and Perry Saidman shed some legal light on buying and selling computer products.

Bob Kurosaka uses the game of Nim in an exercise in BASIC bitwise logic operation in this month's Mathematical Recreations.

And Steve Ciarcia replies to readers who have built his Circuit Cellar projects.



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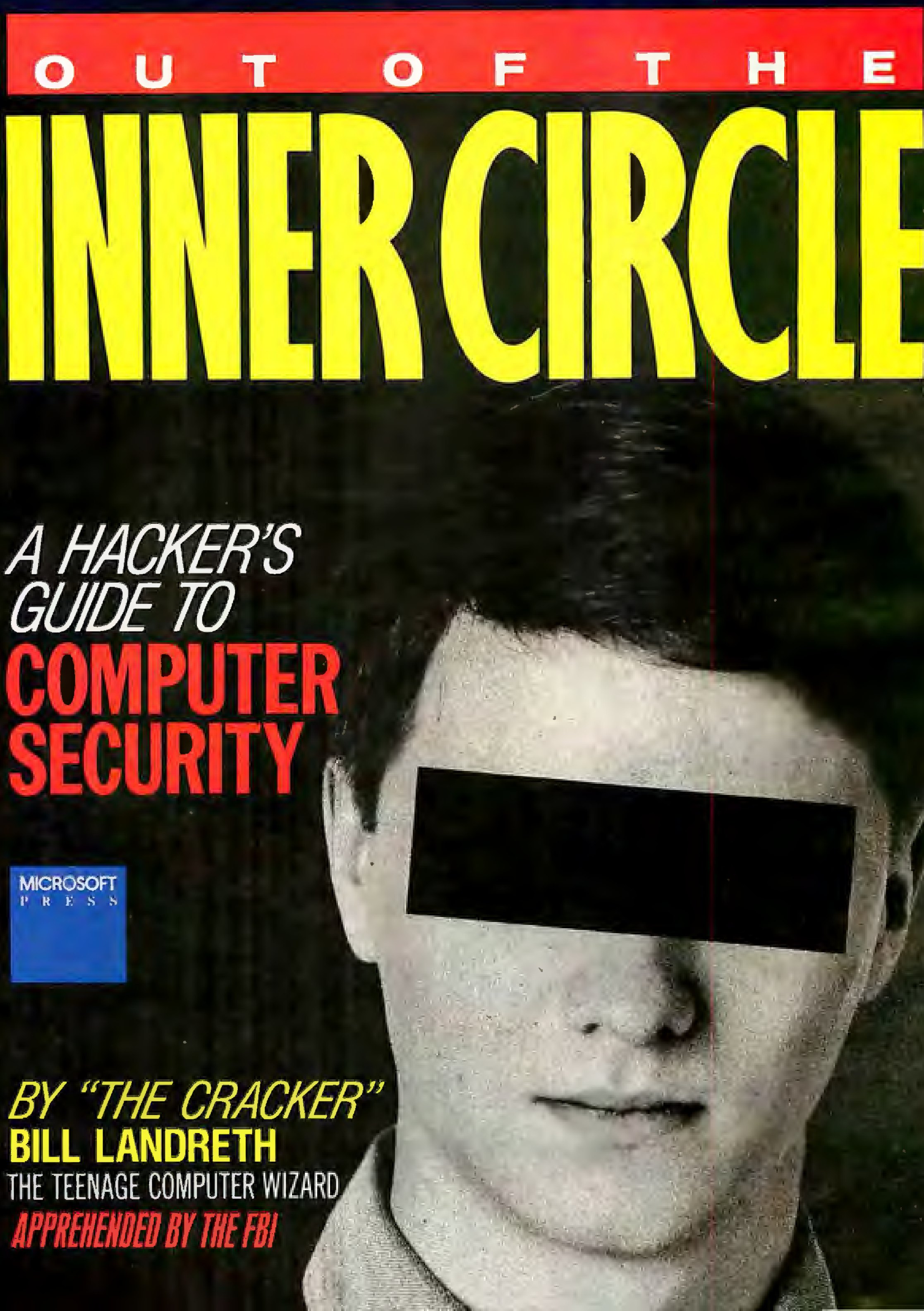

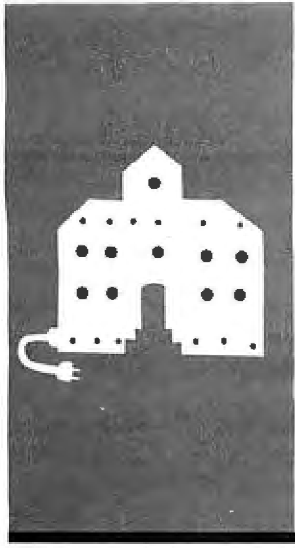

C·O·M·P·U·T·I·N·G A·T C·H·A·O·S M·A·N·O·R

In Search of the Perfect Product

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.

The good news is that this is the last of the one-every-three-weeks columns. The bad news is that it's just past the New Year and I've spent the past three weeks nursing a flu bug that won't go away and leave me alone. Between that and the holidays, I have done less with computers than I intended. I *have* seen more television than I've watched for the past three years, and I'm now in a position to state for the record that even with the 20 channels we get in Los Angeles, there's little worth watching. You need mush for brains to watch the tube for long—or you'll *get* mush for brains if you do.

Even with flu, holidays, and TV, there's a fair amount to cover.

CHAOS MANOR'S PRODUCTS OF THE YEAR

Many magazines have special product-of-the-year features this month. I'm a mite late with mine. Of course, my rules are a bit different from other people's. I pick the products I like best. Purely subjective. And "year" doesn't necessarily mean it came out in 1984, only that I acquired it then. With those ground rules, here goes.

LASERJET

First choice, hands down, is the Hewlett-Packard HP 2686A LaserJet printer. That sucker has changed my life. It replaces the big and noisy Diablo 1620. The Diablo has served me well in the past eight years, and it's still in good shape, but I'll probably donate it to a prospace organization because I'll never go back to it.

The LaserJet runs off Zeke II, the Viasyn CompuPro Z80 I'm writing this on. It's *quiet*. The main printer used to be the NEC 7710 Spinwriter, which runs off the CompuPro 8/16 workhorse we use for everything except writing. For the past week, the 7710 has been loaded with fanfold checks because nobody bothered to feed it normal paper; it's so much easier to use the LaserJet for everything except checks.

It's easy to feed single sheets of letterhead to the LaserJet. It's not much harder to put a stack of letterhead in; or a mix of letterhead and second sheets. The LaserJet will feed sheets from its magazine or accept single sheets as you insert them.

The LaserJet is quiet. Whisper quiet. So quiet that it's uncanny; the noisiest thing about it is the *schlap* when it feeds a sheet of paper. And it's *fast*. Eight pages a minute, just like clockwork. It eats characters at 9600 bits per second (bps), and while it can't keep up with WRITE (my word-processing software), it almost does. Because the LaserJet is so fast, there's no pressing need for a printer buffer. In contrast, we feed data to the NEC Spinwriter through a dandy little Applied Creative Technology Printer Optimizer. The Optimizer is a box full of memory that the computer thinks is a really fast printer, and I'd name it as a product of the year except that I've had it more than a year. I suppose one day I'll get around to hooking the LaserJet to the Optimizer, but there's no hurry.

The LaserJet is smart, too. We've never had a paper jam, although my friend Tony managed one with his. The LaserJet will print both sides of a sheet, but it's a heat and dry powder process, meaning that you want to be careful about loading and stacking paper already printed on one side. Tony was recycling paper and put some in carelessly. A sheet jammed. He cleared it. The LaserJet automatically repeated the page—from the top, complete with header and proper page number.

LaserJet, I love you.

TWEEK IT

The second product of the year goes by the unlikely name of Tweek, which advertises itself as a "contact enhancer." It's a clear liquid you dab onto places where you suspect you're getting bad contact: IC sockets, edge connectors, RS-232C plugs, that sort of thing. It comes in a kind of

(continued)

CHAOS MANOR

hypodermic syringe with a thin flexible tube instead of a needle, making it easy to get it into hard-to-reach places.

My first use was on a sticky Reset button. I didn't bother to turn off the machine, just pulled the top off the button and squirted in the merest drop. Voilà!

Last week my telephone started to make horrible static noises, which could be cured by violently shaking the instrument, only they'd come back. I took it apart, took off the plastic cover over the little relay contacts activated by hanging up the phone, and squirted. The noise went away. Faulty TV remote controller: squirt. Noise in an audio system: squirt. So far, Tweek has cured about a dozen annoying problems. A little bit of the stuff goes a long way. Get some. You'll love it.

FIXING UP A PC

Four products of the year for the IBM PC. First, the outstanding Wico Smartline Smartboard keyboard, which is very nearly everything I ever wanted a keyboard to be.

My other three choices of outstanding PC products are: Orchid Technology's PCturbo 186 board, which makes the PC at least as fast as a PC AT and gives you RAM (random-access read/write memory) disk capability in the bargain; Borland International's SideKick, which lets you take notes, send messages, fix your calendar, and look up phone numbers anytime you have your PC turned on and no matter what you're doing with it; and Living Videotext's ThinkTank. Writers who use a PC and don't use ThinkTank are working too hard. Believe me.

TUTSIM

It's not exactly a product of the year, but one of the most improved programs I've seen lately is Tutsim. If you have any interest at all in mathematical modeling, the short form of Tutsim for $29.95 is a pretty good deal if you want to know something about analog block-structure models.

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C SHARP Realtime Toolkit - well supported, thorough, portable, objects, state sys. Source MANY $600

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Inquiry 101

Tutsim is a rather odd program that turns your digital computer into a whole mess of op-amp (operational-amplifier) analog amplifiers. If you don't know what that means, you'll have a bit of work puzzling out how to use the program. If you haven't had elementary calculus, it's unlikely you'd want Tutsim, but you might. One of my boys is in precalculus in high school, and it's interesting to watch him play with dynamic models.

The last time I mentioned Tutsim, I said, "It ain't easy to use, and the manual's lousy." Since then the people at Applied i have added examples, rewritten the manual, and provided help files. Even if you've never done block-structure simulation, if you read the whole manual about five times you'll begin to get the idea. A couple of hours of mucking around with Tutsim taught me more about simulation than I'd have thought I could learn in a week.

It's simple enough to use Tutsim once you cotton on to how to do simulations with blocks. There are clock-function blocks, Booleans, integrators, delays, random-noise-generator blocks, etc.; certainly a rich enough variety to build some pretty complex models of things changing over time. Those with experience in this sort of modeling will find Tutsim a delight. Those who haven't done op-amp modeling can learn about it and have fun at the same time.

There are versions of Tutsim for CP/M-80, the Apple II, and the IBM PC. There is an IBM PC version making use of the 8087 and another to support the Hercules high-resolution graphics board; there's no install program, but the IBM PC review copy I received had both the regular and the 8087 versions on it.

The demonstration or short form of the program is limited to 15-block models, which is big enough to allow you to learn the principles of simulation. The professional version lets you build models up to 999 blocks, but Applied i wants $495 for it. That seems a bit steep to me. I suppose if you need this kind of thing it might be worth the price, but I'd be surprised if they sold many of them.

Tutsim is not copy-protected, and it works like a bomb with the Orchid PCturbo 186 board; it also runs fine on the Z-150 and Z-160 PClones. The CP/M-80 version works with a Z-100. I recommend Tutsim for anyone teaching calculus or engineering, and if you have any interest in math, you ought to be able to get as much fun out of the $29.95 short form as you would get from a game at the same price.

UNIVERSE

Speaking of games, an outfit called Omnitrend Software has come up with the most complicated game I ever did see. It's called Universe, and it runs on an IBM PC (color only) or the Z-100; the version I have can figure out which machine it's running on, which is pretty clever. It will also run on the Z-160 without a color screen. There are versions for Apple and Atari, but I've never seen them.

Universe has some of the features of the Imperial Trader game I've been writing off and on for a year now. In fact, it has some of the features of nearly every game I ever heard of. It takes *time*; it took me nearly five hours to take out a mortgage loan, buy and equip a ship, and get started loading cargo and passengers; that, however, was before I got the manual updates.

Once I get financing and choose a ship and equipment, I can make some trading runs. There are a lot of options. I may try my hand at piracy, but not just yet, since I couldn't afford to buy any weapons for my ship, and the bank will want its payments in a few short years. First task is to pick up some profits carrying passengers.

Universe comes on two disks with an enormous manual. The first version I got didn't have enough examples, so that it was pretty hard to figure out what to do. I complained, and Omnitrend added a scenario getting you through the early purchase and jump-off.

There are about a zillion decisions to make. I confess that the silly game has got me interested; even with the

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flu, I found myself working on ship-design trade-offs and the like. There are a *lot* of choices. It's all logically structured and pretty realistic.

Universe is copy-protected, which is acceptable for a game. If you have a two-drive system, you can put the player data on your own disk. The player files are copyable, so you can start from any saved point if you don't like the way things turned out.

There's one "feature" I don't much care for. The game manual is enormous and fairly well organized (although the index leaves a lot to be desired). The manual includes a partial list of the products that you, the trader, can deal in—and an offer to sell you the complete list for about 15 bucks. Omnitrend claims you don't *need* the complete list, and you could make a good case that it's more realistic not to have it; but in my first play of the game I found it useful, and it seems a bit unreasonable to charge that much money for five sheets of paper.

Another feature that's going to drive me nuts is the control system. Universe is largely menu-driven, and to select items on the menu you can't just put in the item number. You have to move a cursor arrow up and down a menu (with as many as 35 items)—but the arrow keys won't always do that. Generally, you must use the Select, Start, and Option keys. Of course, the IBM PC doesn't have those keys—the manual was evidently written for the Atari version—so you must use F1, F2, and F3. Alas, while Select and Start may have intuitive meanings, F1 and F2 don't, and they don't always do what you expect them to do. I found myself wasting a lot of time giving inappropriate commands. Just how much trouble would it be to implement the arrow keys?

Quibbles aside, there's a lot of good planning in this game, and I'm impressed. Ordinarily I wouldn't review a game until I'd played it all the way through—but with Universe that's likely to take quite a long time. If you like complicated games, you might like this one.

Later: Aaarrrgghhh!!! I have managed to make an *enormous* profit, but I seem to be stranded in space. I quit in disgust, but after all, I did save the game at many stages, so I won't have to backtrack too far. The worst of it is, I expect I will have another shot at it. I did, too. And more after that . . .

PROFESSIONAL BASIC AND TRACE86

Another greatly improved program is Morgan Computing's Professional BASIC for the IBM PC. Alas, it won't work with SideKick. It doesn't work with Magic Keyboard either, but that doesn't bother me now that I have the Wico Smartline Smartboard. Professional BASIC is a complete interactive debugging system that makes it considerably easier to write large and complex BASIC programs. Morgan has recently dropped the price to $99.

Morgan also markets a program called Trace86. This was written by Dr. Neil Bennet, author of Professional BASIC. It's somewhat similar to the MS-DOS Debug utility, but it gives more information and is a bit easier to use. I haven't had extensive experience with it, but I did use it to see if it would be useful in writing demons to defeat copy protection. It is, but some copy-protected programs are also "Trace-protected," meaning that extra code has been put in to make the programs unrunnable under Trace utilities. This also makes the programs fragile and hard to debug, but many publishers seem to think they need protection more than customers. Trace86 is not copy-protected and has a reasonable license policy.

The Trace86 manual is as good as Digital Research's DDT and SID manuals were; if you're familiar with debugging tools, you'll have no problem with this one. If you're not, you'll have to learn the theory elsewhere; this will teach you how to use Trace86, but not why you need it.

COMPUTER COMPANION

Back in the seventies when I first got Ezekial, my friend who happened to be a Z80 computer, the big problem was systems integration. When you bought a computer, you got several boxes of parts, and even if you bought everything "assembled and tested," you had problems getting the computer to talk to the outside world.

> *Professional* BASIC *makes it considerably easier to write large and complex* BASIC *programs.*

Zeke used a memory-mapped video board and separate keyboard, mostly because in those days the best text editor I'd ever seen was Electric Pencil, and Pencil didn't know how to work with a terminal. Also, in those days it wasn't so easy to hook up to a terminal.

Then came Adam Osborne with the first low-cost all-up computer; you

(continued)

took it home, plugged it in, and it ran. It set the style for what a computer should look like: two built-in disk drives, a screen, and a keyboard. Pretty soon most of us decided those were the minimum requirements for a real computer, as opposed to toys.

It made sense. Real computers do important work. Important work needs backup copies. Making backup copies requires two disk drives, because if you don't have two disk drives, you won't make the copies. Nobody wants to sit there swapping disks back and forth. As for keyboard and screen, it was true that some systems didn't have them built in, but that was advanced equipment, suitable for experts who knew about smart and dumb terminals, and data-transmission rates, and complicated stuff like that. Computers for the rest of us came with everything.

It was easy enough to fall into the habit of thinking that way. Comes now the Companion to challenge that notion.

The Companion is about as simple as a computer system can get. It consists of a smooth gray metal box 13½ inches long by 6¾ inches high by 3½ inches wide. It weighs maybe eight pounds. There's one 5¼-inch disk drive; an on/off switch; a Reset button; two RS-232C jacks; one parallel output jack; an edge connector; a handle; and a power cord. Packed in with it is one floppy disk and a 50-page manual.

That's it. No keyboard, no screen, no mice. The manual tells me the Companion is a 4-MHz Z80A. The disk drive formats floppies in the Morrow single-sided double-density format. According to the manual, the disk drive knows how to read and write to IBM, Kaypro, and Osborne disks, although it won't format them. The manual doesn't say it, but the disk drive won't read double-density Osborne disks or Osborne Executive disks. There is apparently a model of the Companion that accepts double-sided disks, but mine doesn't.

In other words, the Companion is strictly a no-frills job—but within those limits it's quite a lot of machine.

The Companion actually has *three* disk drives. Drive C: is the regular floppy. Drive B: is a small ROM (read-only memory) drive that boots the Companion with CP/M 2.2. The ROM also contains a general utility program with Copy and Format commands and a terminal-emulation program.

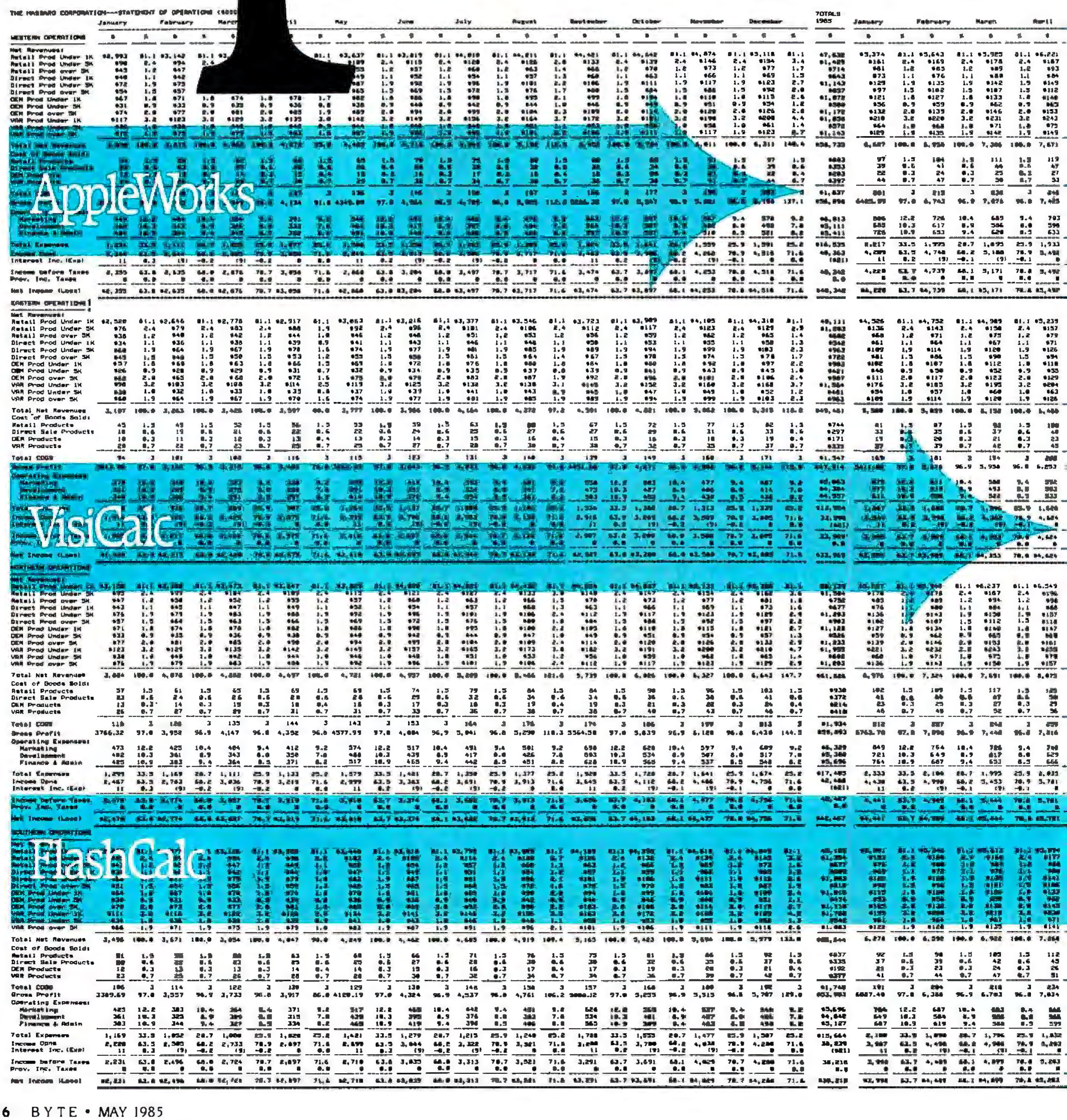
Drive A: is a 190K-byte RAM disk. That makes a *lot* of sense. Except for power failures, a RAM disk is more reliable than a floppy and certainly faster. The Copy routine lets you copy from the RAM disk to the floppy and vice versa. The theory is that you do most of your work on the super-speedy drive A: and from time to time save the results onto the floppy. That works, too, since copying is pretty fast. My first thought was that 190K bytes (186K on the floppy) isn't really enough disk space, but then I recalled that my first machine's 8-inch drives didn't hold but 240K bytes and were noisy to boot, and I thought Zeke was *wonderful*. Zeke and I did a lot of writing, kept my accounts, did my taxes, and managed my files. Zeke's old iCOM drives were slower than the Companion's floppy, and Zeke never ran faster than 2 MHz.

That got me to thinking. I'd have been thrilled to have the Companion back when I first started. With a good terminal and the WRITE text editor I use, the Companion would be one heck of a writer's engine; and depending on which terminal and printer were selected, the cost could be kept low. Up to now I've tended to recommend the Kaypro to colleagues asking for low-cost entry-level equipment; but some of them don't like the keyboard and/or the small screen. The Companion might just be the ideal first computer for a writer.

One problem, though: how hard

(continued)

Space



would it be to set up? One reason we used memory-mapped video instead of terminals in the old days was the difficulty of hooking up a terminal. RS-232C connections are anything but standard, and how do you explain data-transmission rates and the like to a beginning writer?

Setting Up

I got the Companion running while I was talking on the telephone about something else. The only hard part was finding an RS-232C cable with which to hook up to the terminal. Then I remembered one I'd bought and never used: Priority One's "Shielded RS232 Serial Cable Pin 1 THRU 8 and Pin 20 Male to Male." There was a lot more than I needed—the cable was 25 feet long—but that would be a good test, too, since some systems can't handle long cables due to excessive noise pickup (the cable acts as an antenna). I took the Companion out of its box and plugged it in; plugged the RS-232C cable into the plainly marked Terminal Port on the Companion; and plugged the other end of the cable into the TeleVideo 950 that my CompuPro 8/16 normally talks through at 19,200 bps. Then I turned on the Companion and hit Return on the terminal. According to the manual, the Companion was smart enough to figure out the data-transmission rate for itself.

It did, too. I'd left the Companion's drive door open, so it booted off the ROM just as it's supposed to. It comes up in a little utility shell program that offers you the alternative of typing 0 through 5; 0 puts you into CP/M, 1 will copy a disk, and so forth. Since I could read the messages, it was obvious that the terminal was properly set up—data-transmission rate, data and stop bits, and so forth; and sure enough, pressing the 0 put me into standard CP/M.

Next the acid test. I let the Companion format a disk for me, put that into the CompuPro 8/16 (I had to switch the terminal from the Companion to the CompuPro, of course, but that was no problem), used the CompuPro's Newmedia program to tell it we were going to work with the single-sided double-density Morrow format, and used PIP to transfer WRITE.COM from the 8/16 to the Companion's disk. Brought the floppy back to the Companion, fired up WRITE—

Bingo. Worked fine.

By gollies, I thought, this just very well may be the entry machine for writers. But I'd better make sure. . .

Glitches

Alas, there are glitches. One is serious. I'll get to it in a minute. The others are irritants that common sense will cure. Of course, I don't know how much common sense a new user will have.

For example: the floppy-disk drive is mounted vertically. There's no indication of which side is "up." I happen to know that drive doors generally close from the top, but does everyone? If you put the disk in upside down and try to access the disk, the drive motor goes on and the disk's little LED (light-emitting diode) lights up—and that's the way things will stay until doomsday. Reset will cure the problem. Turning the machine off will do it, too, but that's not a wise idea, since it's possible for a disk drive to write garbage during power-down.

CP/M 2.2 requires you to do a Control-C every time you change disks. WRITE is set up to do the equivalent of Control-C each time you do disk accesses; this is so that you can change disks without exiting WRITE. When we designed WRITE I insisted on this feature, because it lets me make intermediate backup copies of my work and physically remove them from the machine. Also, if I overfill a disk, I can still save the work simply by putting in a disk with more room on it. Once in a great while WRITE will still get confused when we not only change disks but change disk formats by switching from single to double density, but even then WRITE will recover from the error; at worst you have to log onto the new disk.

It doesn't quite work that way with the Companion. Somehow the Companion's interrupt-driven BIOS (basic input/output system) defeats all of

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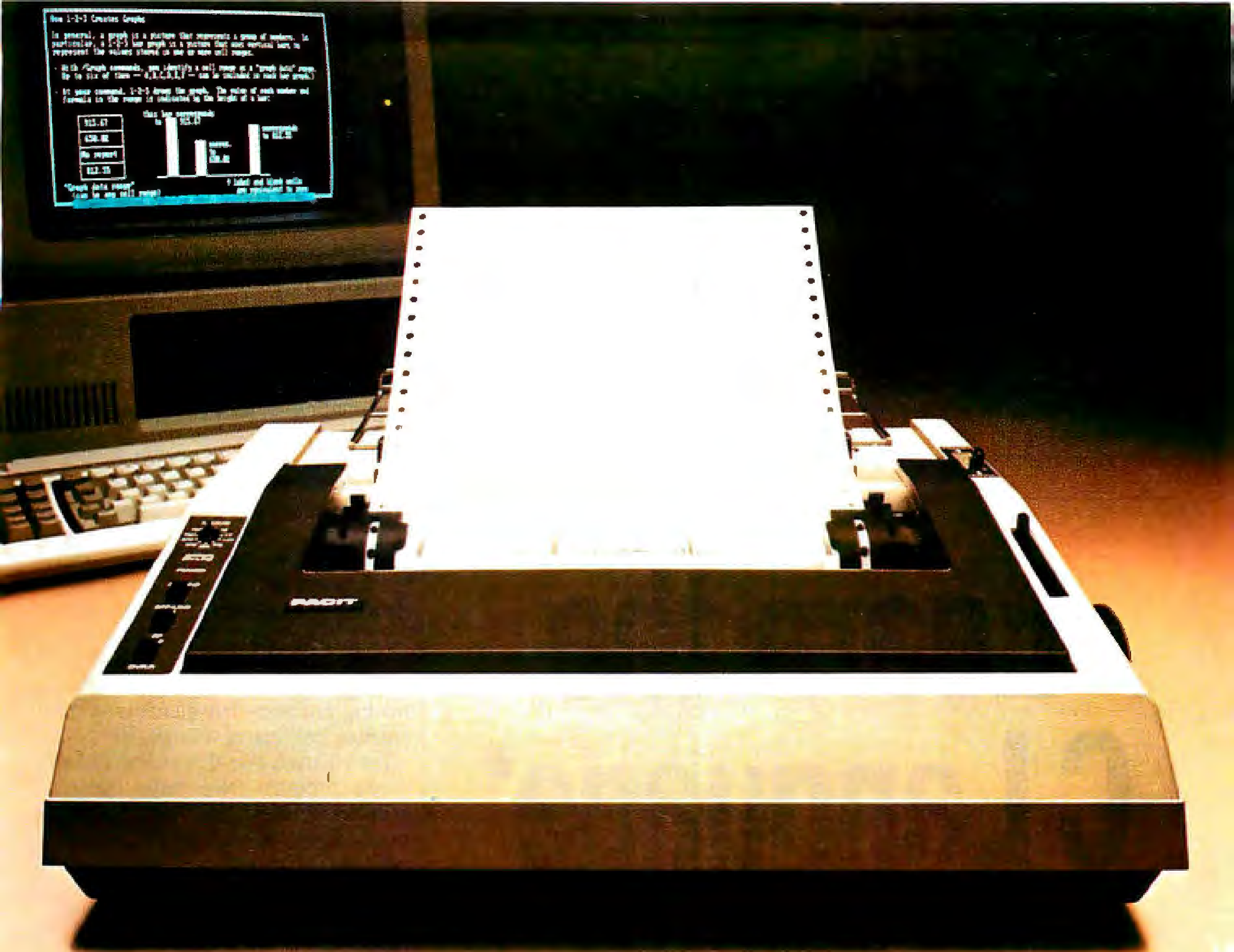

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WRITE's safeguards. The result is that I can, within WRITE, save a file onto the C: disk; change disks; log onto the A: disk; log back onto the C: disk; but when I get the C: directory, I get the directory of the *previous* disk! I can force it to log onto the current disk by attempting to load a file that existed on the previous disk but not on this one; the computer goes through a read operation and loads garbage into the text buffer, but after that has the proper bit map. I haven't managed to really mess up a disk by save or load operations, but that doesn't mean it won't happen. If this is a bit disquieting for me, I can just imagine how a beginner would feel.

There are other small problems. For example: if you accidentally (forgetting that the Companion uses single-sided disks) try to format a disk as double-sided, the disk spins, the Select LED lights up—and you can sit there until you reset or starve. Okay, that's not too bad. You reset, invoke the Format program again, and tell it to format that disk as single-sided. The same thing happens! Reset again. When you reset, you come up in the little utility program that offers you the opportunity to format a disk; just for the hell of it, I exited to CP/M, then instantly went back into the utility program and told it to format the disk as single-sided. This time it worked fine. No big problem, but guaranteed to confuse hell out of a beginner.

Then I used the CompuPro Newmedia program (Newmedia comes with the updated TMX BIOS for the CompuPro Disk 1-A Controller, and it can read, write, and format about 40 different 5¼-inch disk formats) to format a disk as double-sided Morrow and put some files on it. Remove from CompuPro and put into Companion. Do Control-C. Try to read the disk.

What I get is garbage. It pretends there's a directory on there, but with weird filenames like blank.blank and @.blank. Just for the hell of it, I used the Copy utility; worked fine, copying the garbage onto the A: RAM disk. None of it was readable, of course. No harm done. Now to invoke the Format program and reformat that disk so I can use it—

Drives spin. LED comes on. Wait a while. Reset. Fool around, exit Format, do Control-C, go back to Format. Same result. It will not format that disk. Finally, I took a small magnet to the disk. That took care of the problem. It formatted fine. Okay, I knew to do that. Would a beginner? Incidentally, as part of the Format process the Companion writes CP/M onto the floppy's system tracks, although the manual nowhere tells you that.

DOCUMENTS

The Companion comes with a 50-page manual. It's an interesting at-

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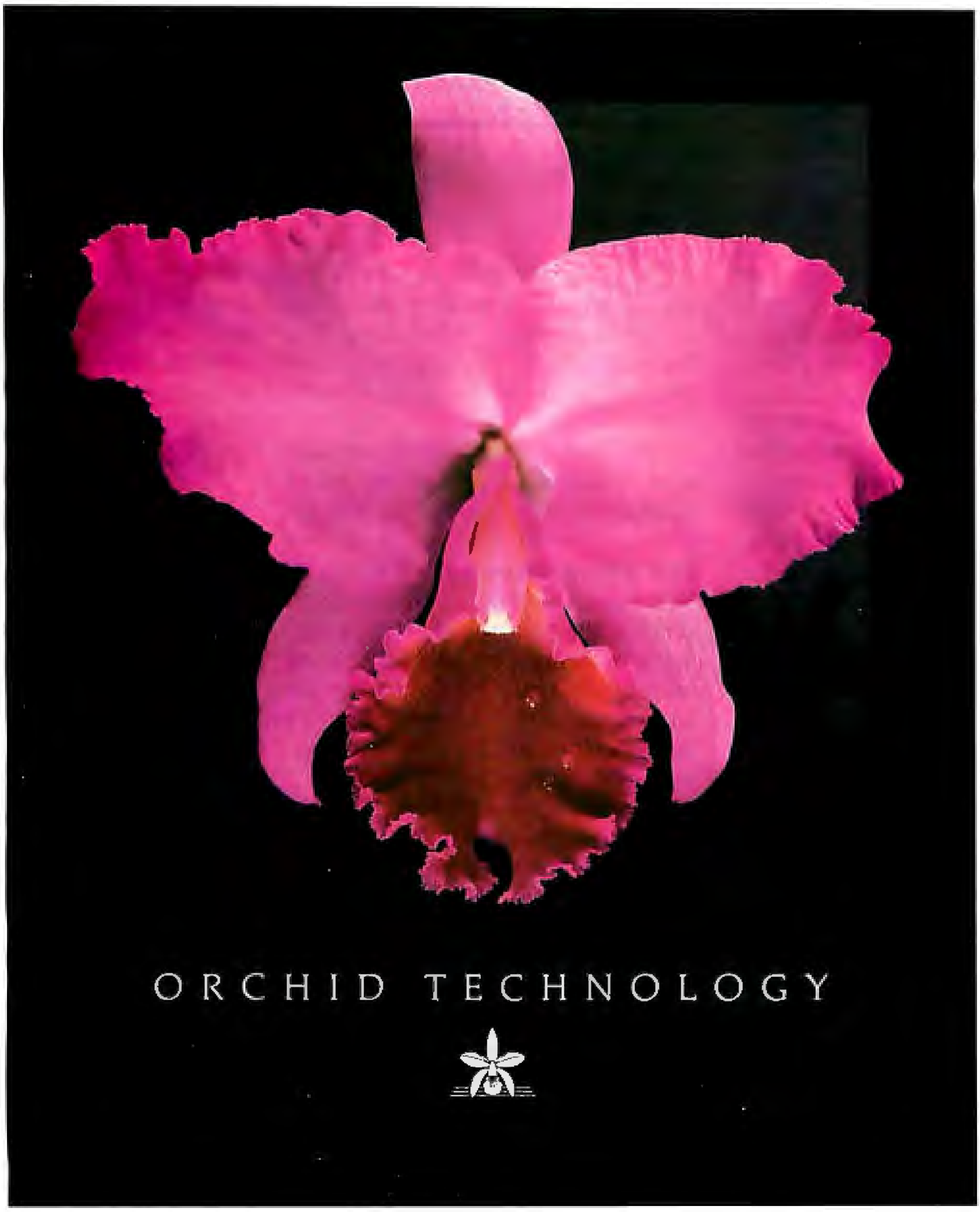

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tempt to pack in a short course on CP/M, some beginner's instructions, and all the necessary technical data about the Companion. In trying to do them all, it doesn't do any of them.

Even so, in some respects it's the best short computer manual I have ever seen—but it's written for someone with at least my level of understanding. They recommend that the new computer owner get a decent CP/M book. Since the usual CP/M 2.2 documents (which aren't very useful anyway) aren't furnished, the beginner will certainly need one of the myriad introductions to using CP/M; the Companion's manual explains just enough to get a completely naive user confused and into trouble. There's a one-page "Command Reference" for DDT, and another for ED.COM, and sandwiched in between those two pages is a very cryptic one-page "explanation" of DIR, LOAD.COM, and a program called XDIR.COM that was not, in fact, on the disk furnished with the Companion.

On the other hand, there's a very complete listing of the pin-outs for the three communications ports, an I/O Port Address Table, an Interrupt Vector Table, and lots of other information that should be available to buyers. There are a whole bunch of references to the BIOS, given in a way that makes it look as if they intended to furnish the BIOS source code; but there wasn't any source code on the disk that came with the Companion I received.

It also explains how to reconfigure your keyboard and how to do a number of other interesting things.

THE INSURMOUNTABLE PROBLEM

General Curtis LeMay, commander in chief of the Strategic Air Command many years ago, used to insist that all his subordinates think positively. One day a colonel ran into General LeMay's office and shouted, "General, we have an insurmountable problem!"

LeMay banged his fist on the desk. "Colonel, in this command we don't have problems! We have opportunities!"

The colonel saluted. "Yes, sir. General, we have an insurmountable opportunity."

At the moment the Companion has an insurmountable problem. If I had the BIOS code, I might have treated it as an opportunity to get my hands dirty; I haven't hacked a BIOS in a couple of years. I didn't have the BIOS, though, and so I never did get a printer hooked up.

The Companion normally sends output to be printed to the parallel port. This is documented, after which the manual explains how to connect a serial printer to the second RS-232C output port. It tells you that you have to do

```
d:STAT LST: = TTY:[RTN]
```

which is not really a very clear instruction for a beginner; if you treat that like a cookbook and type the d:, it not only isn't going to work (since there is no d: disk drive), but you will get an endless series of messages saying, "Not ready error."

Note that you do not get a BDOS (basic disk operating system) error. The Companion's BIOS has been jiggered around to defeat CP/M's BDOS errors. The Companion's manual doesn't tell me that, of course; in fact, it never mentions error messages at all. Note that the new user has been instructed to get a book on CP/M. That's going to tell him to expect the infamous BDOS errors. It isn't going to tell him what to do about a "Not ready error" on a nonexistent disk.

Incidentally, if you try to access a nonexistent drive other than D: or E:, you *do* get the message: "BDOS Err on K: Select," and neither Return, nor Escape, nor Control-C will get you out

(continued)

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of it. Like the "Not ready error," the only remedy is to reset. That BIOS needs work.

It's when you get past the d: error that the trouble really starts. The manual tells you to set your printer to no parity, 8 data bits, 1 stop bit, and full duplex. So far, so good. Now the instructions on data-transmission rate: "Set the same as your terminal."

That's ridiculous. Damned few printers run faster than 1200 bps—but a writer trying to use a computer talking to a terminal at 1200 bps might as well go back to a quill pen. Just for the hell of it, I tried to connect the Companion up to my NEC Spinwriter, using the Printer Optimizer as an interface since that runs at 9600 bps. I left the terminal set for 19,200; after all, the Companion figured out how to talk to the TeleVideo terminal, and maybe, just maybe, the manual meant to say that the data-transmission rate is set in the same way as with the terminal.

Nope. Actually, the result was weird: the Companion never did manage to talk to either the printer or the Optimizer, but attempting to make it do it would *lock up the terminal*. Locked it up good, too: not even Reset would get me out of that pickle. I had to disconnect the RS-232C line from the printer port, then turn both the Companion and the TeleVideo completely off, count to 20, and turn them back on again. No permanent harm was done, but I'd sure hate for that to have happened when I was first starting.

I suppose that if I were to muck about with the Companion and my printer I would, eventually, get them to talk to each other. There's nothing simple about setting up serial communications under the best of conditions. Even with a breakout box and a lot of luck you have to hold your mouth right.

On the other hand, the manual tells me that the Companion has two kinds of handshaking protocols, neither of which I normally use. My system is set up to do ETX/ACK, which my books tell me is pretty standard. We also use XON/XOFF protocol. According to the

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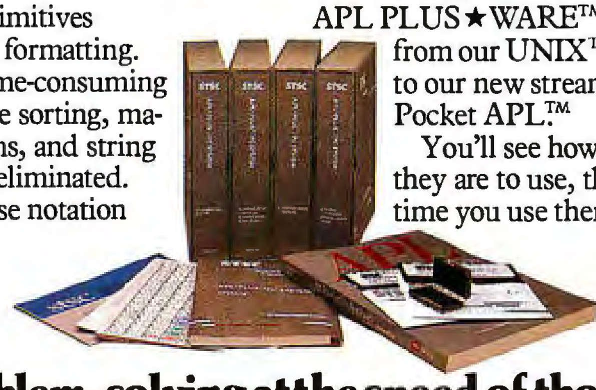

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manual, the Companion uses ENQ/ACK, which I've never heard of. The excellent little manual that comes with the Printer Optimizer knows about a dozen handshaking routines, including ETX/ACK, but not ENQ/ACK. There's nothing about it in the Spinwriter manual.

It's enough for me. If I had the BIOS source I might make another stab at it, but I don't.

SIGH...

In some ways the Companion falls between the cracks. It has some great features that might make it a good second machine for hobbyists and hackers, but there are also enough irritants to set a hacker's teeth on edge. Hackers don't need to have BDOS error messages removed, especially since the error trap doesn't allow the system to recover anyway. Given the BIOS source code (and the rest of the CP/M utilities such as SYSGEN and MOVCP/M), most of the problems should be fixable. You'd have to boot from a floppy rather than the ROM, but so what? But since there is no BIOS source, and no circuit diagrams, I don't think too many hackers will buy it.

On the other hand, the Companion has the potential to be a really great entry-level system, especially for writers who put a lot of importance on a good keyboard and screen. A beginner could shop around for just the right terminal. The Companion is inexpensive enough that you could buy a really good terminal, word-processing software, and a decent printer, and still have less invested than you'd spend on some of the all-up systems with a less aesthetic keyboard and display. Unfortunately, the manual wasn't written for beginners, and there are all those unexplained glitches. It badly needs an expanded, hand-holding manual if it's to be a beginner's machine.

That leaves me with a dilemma. For all its problems, I like this little machine. Partly it's aesthetics: I really would rather have this little machine and a good terminal than one of the

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"luggable" computers with a small screen. It runs the TeleVideo at 19,200 bps just fine, so that it scrolls faster than most luggables can manage.

Except for the weird business with terminal lockup, I never got into any trouble that Reset wouldn't cure, and since Reset does *not* wipe out the RAM disk, the only thing to really be afraid of would be a power failure. According to the manual, the Companion has a whole bunch of terminal programs to let it work with the TRS-80 Model 100 (and therefore the NEC counterpart to the Model 100); and the Companion is small and light. That suggests a number of interesting possibilities, including carrying the Companion along with a lapboard when I go on trips.

The bottom line is that I can't really recommend the Companion to naive users. If you don't get confused easily; have patience and a sense of humor and won't get irritated when the machine hangs up; are reasonably careful; won't panic; and are willing to put in some time learning CP/M and general computer vagaries, that's another story. There are some good points about this machine. The right user would like it a lot.

What I really wish is that Companion Computers would (1) release the BIOS, (2) support a users group, and (3) then sell a lot of these little machines. A good users group hacking on that BIOS could turn this into a really dandy little machine that would not only be an entry-level computer for writers but a good second machine for hobbyists and everyone else. The potential is there.

I have since found that the BIOS source is available—but it's written in FORTH. For some hackers I suppose that's a feature.

MacMouse

One problem with mice—at least one of my problems—is that I can never find any clear space on my desk. The Macintosh sits near my desk—I confess I'm fond enough of it that I haven't packed it away—but it isn't my primary system. As a result, the space

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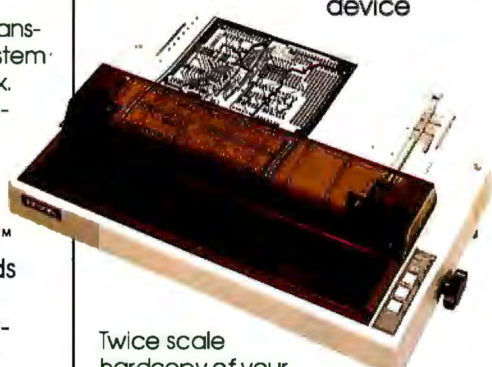
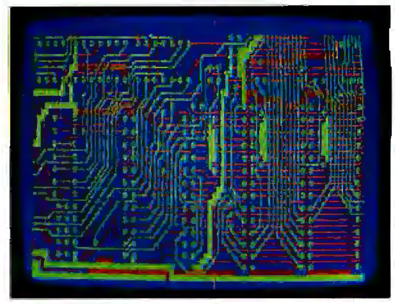


Twice scale hardcopy of your artwork is produced using the Epson dot-matrix printers or the Houston Instrument DMP-41 pen-and-ink plotter. Quick 1X check plot is also available from Epson printers.



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System Requirements

- ☐ IBM PC or XT with 192K RAM, 2 disk drives and DOS Version 2.0
- ☐ IBM Color/Graphics Adapter with RGB color or b&w monitor
- ☐ Epson MX-80/MX-100 or FX-80/FX-100 dot-matrix printer
- ☐ Houston Instrument DMP-41 pen-and-ink plotter (optional)
- ☐ Microsoft Mouse (optional)

WINTEK

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around the Mac is soon filled with papers, software, coffee cups, staplers, letter openers, and general mess. I have trouble even *finding* the mouse, much less finding a place to use it.

Mouse Systems A+ optical mouse offers one solution to that problem: simply pull out the little etched mouse pad (if you can find *it!*) and put it on top of the mess. The optical mouse is a wee bit more precise than the mechanical mouse that comes with the Macintosh; I find I have better control. When I first set it up, the A+ mouse cord had a tendency to stick against the optical pad on the "up" strokes, but that seems to have cured itself.

The A+ has a slightly thinner cord, and you need a small screwdriver to permanently attach it to the Mac; it doesn't have the big screw-knobs that are standard on the plugs that Apple provides. I don't know that I'd have bothered to replace the mouse that came with the Mac if Mouse Systems hadn't sent me one, but I do prefer it enough that I haven't put the mechanical mouse back into action. It's purely aesthetics, though, and I'd be hard put to explain the preference.

The Mouse Systems A+ mouse also works with the Apple IIc and Lisa computers.

MTBASIC

This is one of those programs that I got fascinated with even though I can't think of anything I'd use it for. MTBASIC is a compiling, recursive, multitasking BASIC that runs under CP/M on a Z80. An IBM PC and PCjr version was supposed to be out in March.

Z80 programs that require a terminal are a bit of a problem here. It isn't that we don't *have* Z80 machines and terminals, but they aren't set up. Just at the moment I'm surrounded by: the Lilith; the Macintosh; Lucy Van Pelt, the fussbudget IBM PC; a Zenith Z-160; and the two permanent machines, Zeke II the Z80 and the CompuPro 8/16. Zeke II uses memory-mapped video. The 8/16 uses a terminal. For all my mutterings about the

(continued)

Some of these expert systems are really very good.

TeleVideo 950 terminal, I went back to it in preference to the Qume, and I'm now ready to confess that I like the Telewidget. But while the 8/16 uses a terminal, it doesn't have a Z80 chip.

I had the Macrotech 80286/Z80 board in the 8/16 for a couple of months, but just now we're testing some new hardware and software; until that's done I'm using the standard CompuPro 8/16 processor. (Well, nearly standard; mine has Jim Hudson's piggyback 8087 support board.) Another alternative would be the Shirley (CompuPro 10), which has multiple Z80 processors, but until the new office construction is done she's in the back room. MTBASIC looked interesting enough that I tried getting it to run on the Companion, but that doesn't work either; there's something *very* odd about the Companion's BIOS.

Thus, a firsthand account of using MTBASIC will have to wait until the contractors finish building the new library, office, and workshop suite upstairs. When that's done I'll have room to keep several more test systems set up and running. Meanwhile, I know from other reports that MTBASIC does run, and that it's one of the more interesting language ideas. I still don't know what I'll *do* with it, but I expect anyone with hacker tendencies might be interested in it. A true multitasking BASIC (task control can be through hardware interrupt or through an automatically installed software timer built into MTBASIC) that supports windows and recursion has all sorts of potential. There are even built-in commands for saving and reloading windows, meaning that you can generate pop-up menus and that sort of thing.

Using MTBASIC is a bit like using CBASIC, but easier, because it's partly interactive. You can create a program using your own editor. Since line numbers are needed, you can use the Microsoft BASIC editor, provided, of course, that you save the result as an ASCII (American Standard Code for Information Interchange) file. Programs can be merged simply by loading them; lines with the same line number will be overlaid. The whole program has to be in memory, which restricts its size a bit. Once there, you tell it to run and the program is first compiled at a rapid clip, then executed. When debugging is done, you can compile into a more or less standalone COM file.

There are some limits. There are no string arrays, and strings are handled more in the manner of Pascal than BASIC. Variable names can be seven characters long, but there can't be more than 255 variables in any given program. A lot of the BASIC statements we're used to don't exist. On the other hand, there are some low-level commands for handling hardware interrupts that don't exist in any other BASIC, and of course there is tasking: that is, you give the machine several tasks, and it works on them all more or less simultaneously. Since there's only one processor, obviously it can't *really* do more than one thing at a time; but it can work on one task for a while, then switch to another, and so forth, many hundreds of times a second. It can also be doing other things while waiting for input.

Given my immediate problem of putting together a Z80 with a terminal, I'll probably wait for the IBM PC version before I do a definitive report. On the other hand, MTBASIC would be useful for controlling dedicated machines; I've already thought of a Z80-based security/control system I might use it for. We'll see. Meanwhile, if you like playing about with unusual and different languages, you might look into MTBASIC.

Expert-Ease

The artificial-intelligence community has done a number of wonderful things, but most of its practical contributions are yet to come. One exception to that is expert systems. An expert system is a program that "understands" some limited subject field, such as particular kinds of cancers, missile-checkout procedures, and the like. Some of these expert systems are really very good. The best will ask questions, reach conclusions, and explain the reasoning behind them.

A recent article in the *Wall Street Journal* quotes one major research firm's prediction that expert-system software sales—already more than $34 million in 1984—will continue to rise, becoming a mass market by the nineties. They also report on a program called Puff (Pulmonary Function), which assists a San Francisco lung specialist in diagnosis and prescription. My October 1983 column featured another medical program, Dr. Larry Weed's Problem-Knowledge Coupler.

There are not many micro-based expert systems because building the programs is not easy. Comes now Expert-Ease, which does that job.

Expert-Ease is a program that comes from Scotland. You sure can tell it, too. Not only is my copy decorated with a detail from Raeburn's painting "The Rev. Walker Skating on Duddingston Loch," but it also has, in huge red letters, the words "SAMPLE Not For Resale" stamped about 50 times randomly throughout the manual. The program is copy-protected and sells for 2000 bucks—plus $50 for shipping and handling. The disclaimer specifically states that it's not fit for any particular purpose but contains trade secrets. My grandfather MacInnie would have been delighted.

Whether the program is worth that much depends on how badly you need an expert system. Expert-Ease is based on some advanced AI research done at the University of Edinburgh, and it does seem to work. The manual is short on theory, but it's certainly adequate to let you run the program. Apparently they expect anyone who has paid $2000 for an expert-system generator to have a pretty good idea of what he wants to do with it.

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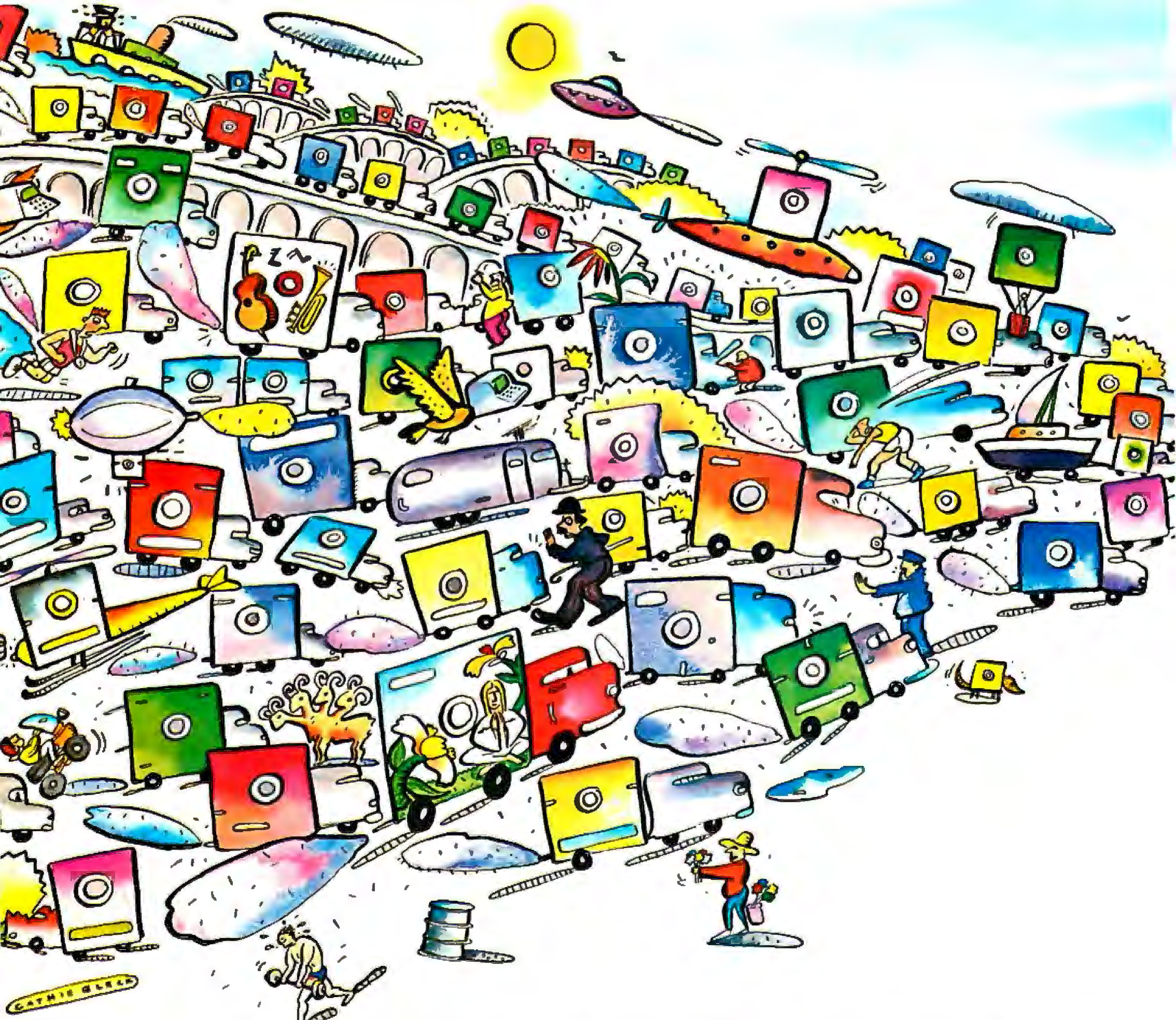

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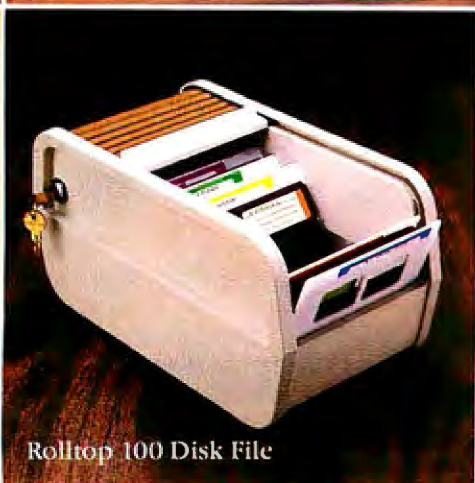
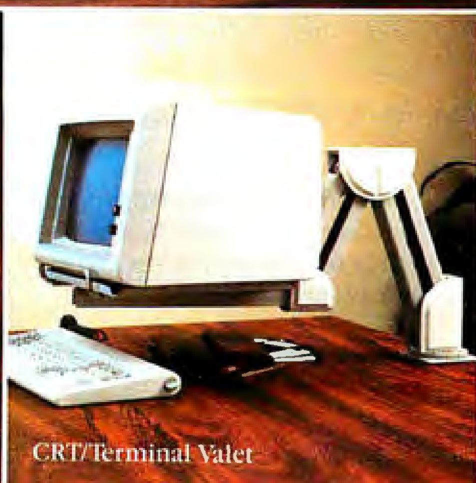
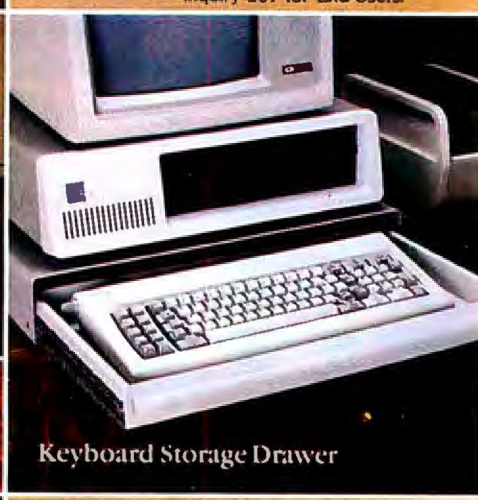


Rolltop 100 Disk File



CRT/Terminal Valet



Keyboard Storage Drawer

It works this way. First, you figure out what criteria you want the system to use to reach decisions. Then you give the program a bunch of examples in a matrix where the columns are the criteria and the rows are cases. The final column in the matrix is the recommendation an expert would make in each case. For example, you could take one of those tables of data from BYTE that give all the attributes of a computer, or a printer, or whatever; add your requirements and recommendations; and generate an "expert" system that would in theory make the same recommendations you would. Now anyone could use it to enter data about a new machine and see what you would say about it.

You don't have to enter all the cases you know about. When you think you have enough cases, you tell the machine to go to work. It trundles for a while and comes up with a decision rule. There's no "explanation" as such, but the rule is tree-structured, and you can examine it to see what the machine has done. If there aren't enough cases, the program will tell you by making "null" recommendations in the rule tree. This shows where new examples are needed.

If there are contradictory examples, the program will tell you. Contradictions usually mean you don't have enough criteria to establish an actual rule.

So far, so good.

Unfortunately, the program doesn't know how to handle incomplete data or probabilities. It wants absolute certainty with no ambiguities. Worse, you can't *weight* the criteria. In fact, the program weights them for you according to their position in the matrix, with the left-hand criterion getting the greatest weight. New criteria (called attributes) can be inserted at any column position, so you can get the effect of weights by the placement of criteria. I tried to simulate probabilities, after a fashion, by adding an integer variable with a range of 0 to 100; but that didn't work well for me.

The manual is clear, and there are examples. The program is reasonably easy to understand but not so easy to use because the editing capabilities are abysmal; the worst spreadsheet I know of has better editing functions. You can get the job done, but if it's a big job, you'll curse the program before you're done.

I'd think a Bayesian decision-analysis program, which asks for criteria and weights and includes probabilities, could be altered to produce something considerably more powerful than Expert-Ease. Several single-decision Bayesian-theory programs were published in computer magazines back in the seventies, and at least one was sold for less than $100. Having said that, I confess that I'm not ready to sit down and write such a program. Expert-Ease does work, and if you need to generate an expert system from a large mass of cases and variables (up to 32 attributes, each with up to 32 values for logical variables, and a range of −32,766 to +32,767 for integer values), I don't know of anything else that would do the job.

My copy of Expert-Ease came from Export Software International Ltd. of Edinburgh, but I understand that the program is marketed in the U.S. exclusively by Human Edge. This is the outfit that advertised the "expert" program called Mind Prober by promising, "We'll get you into her mind; the rest is up to you," until a number of magazines refused the advertisement. Human Edge also publishes Sales Edge, Negotiation Edge, Management Edge, and Communications Edge, all "expert-system" programs based on your responses to a series of questions very similar to the questions on a standard psychological test. The programs work fine, as programs, but I have serious reservations about the theory on which they're based; that's

(continued)

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Inquiry 148

a large enough subject that I'll get to it another time.

OMNITEL ENCORE AND CROSSTALK

We have 1200-bps capability at last. Actually, I bought a U.S. Robotics 1200-bps modem nearly a year ago, but Alex took it to San Diego before I ever got it hooked up. He says it works fine, too. One day I'll get it back . . .

Anyway, we recently received an OmniTel Encore 1200B, which we installed in the Zenith Z-160. It went into that particular machine because the IBM PC has no open slots—I really should get an expansion box—and the Zenith Z-150 is still under Mrs. Pournelle's control. Installation was simple. The Encore can be addressed to ports COM3 or COM4 as well as the standard COM1 and COM2. This means that if you already have two serial ports, as the Zenith machines and the Columbia PC do, there's still no problem putting in an internal modem.

The Encore came with Crosstalk XVI, so that's what we used. Crosstalk is a perfectly adequate communications program. I prefer Mycroft Laboratories' MITE, because I find it easier to use; but I've been using MITE for years, too, so there's a familiarity factor there. I certainly didn't have any problems using Crosstalk, and I appreciated the terminal-emulation capability built into the program, since I was able to log onto the ARPANET (Advanced Research Projects Agency Network) without changing the initialization file that tells MIT I'm using a Telewidget terminal.

There isn't a lot you can say about a modem. The Encore was simple to install, the price looks good, and it has worked just fine nearly every night for the past two weeks. I'm sending to Mycroft for a MITE program geared up for it. The Encore is compatible with the Hayes Smartmodem—much more so than the U.S. Robotics modem, has a built-in speaker that lets you hear what's going on (phone tones, dial tones, busy signals, etc.), and works just fine with Crosstalk. OmniTel also makes 300-bps integral modems for Apple and PCjr and both 300- and 1200-bps stand-alones.

SEMIDISK

We've had the SemiDisk RAM disk in the Epson QX-10 for some time now. Works fine, but, alas, only under CP/M; it can't hook into Valdocs 1.8, which is the Epson system that really needs a RAM disk. In fooling around with the SemiDisk, we learned that its implementation takes up 3328 bytes of the temporary program area (TPA), which can be significant on a big assembly or load. However, all you have to do is type

```
SEMIDISK R [cr]
```

and the memory is recovered. Getting the RAM disk implemented is just as simple.

The SemiDisk comes with instructions on how to use part of its memory as a printer buffer. Installation is simple, but you should read the manual a couple of times. They also have an automatic way to patch their COM file to include a whole bunch (about four pages!) of customization options you can install.

If you run an Epson QX-10 as a CP/M system, the SemiDisk will speed things up considerably.

Last-minute good news for Epson owners: SemiDisk now has software to let you use the RAM disk with Valdocs 1.9.

MUSIC . . .

Mrs. Pournelle teaches music, sings opera, and directs musicals at her school. She's thus very interested in music programs.

Tunesmith came about two hours ago. Alas. It's copy-protected. You can make backups, but you have to have

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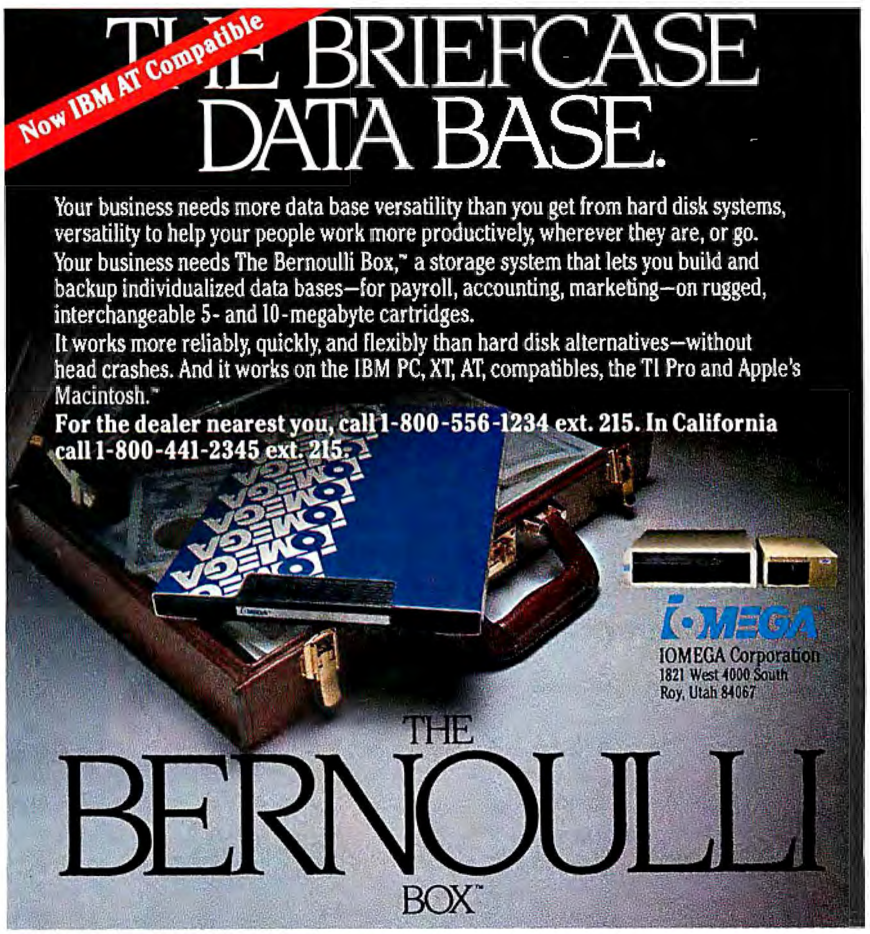

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the original system disk to put into drive A:, not merely the first time you use the program in a session, but *every* time you want to play a tune. Naturally I didn't make any backups.

Doesn't seem to have harmed the disk to run off it. The program plays a passable rendition of "Malaguena," a pretty bad one (according to rock/jazz enthusiast John F. Carr) of "Foggy Mountain Breakdown." Every time I play a tune and want to hear another—there are about 18 on the disk, including "Clair de Lune," Fucik's "Entry of the Gladiators," etc.—I must (1) insert a disk with the Command files on it; (2) insert the original system disk.

I don't feel good enough to do that.

While the program is playing, it shows a display of the notes played. They are not, alas, in standard musical notation, but consist of strings of data statements (complete with the word "DATA" and the quotation marks) that the cursor runs through, resting briefly on each note (ABEF etc.) as it is played. There are also numbers and on the right side of the screen a standard musical notation shows one—and only one—note as it is played.

I can see how it would be a lot of fun, but I am determined not to get addicted to copy-protected programs. Alas.

FONTS!

Now one that is not copy-protected. Fontrix, which works only on PCs with a color monitor. Since Lucy Van Pelt, our fussbudget IBM PC, has only the high-resolution green screen, we can't tell if Fontrix will work with the Orchid Technology PCturbo 186 board.

Fontrix works *fine* with the Z-150, which has a color screen. After you've bought Fontrix, you can get a whole mess of very nice fonts, from Arabic to Russian to a bunch of electronics symbols, for $20 a disk. The program allows you to modify existing fonts or create, name, and save your own.

It's supposed to print, and there's a menu of printers, including the really high-resolution Toshiba. The printer connected to our Z-150 is an MPI Sprinter dot-matrix, not listed on the Fontrix driver list; I'm sure the MPI emulates one of the many that *are* on there, but it's too late to call MPI tonight. More next time.

Meanwhile, Peter has had an hour to play with it and wants to get a copy for the Hewlett-Packard Touchscreen; connect that to the HP LaserJet printer and you'd have some *really* nice fonts, graphics, designs, and all kinds of stuff.

I think we're going to like it, but this is an early report.

WINDING DOWN

I've decided that if I have products of the year I should also have a folly of the year.

It was awfully close; in fact, a tie. The Chaos Manor Folly of the Year Award for 1984 is shared. Winner number one is W. Krag Brotby, chairman of the Vault Corporation, for his threat to market Killer Prolok, a copy-protection scheme that will "create a variety of nasty effects" for people who use unauthorized copies. The effects would include planting software worms that would cause the computer to malfunction at random times and under random tasks.

Winner number two is Craig McClure, vice president of Defendisk of Denver, who also threatens programs that insert worms into your operating system. They wouldn't necessarily surface for quite a long time. Mr. McClure says, "Our booby traps will make Vietnam look like a birthday party."

I understand that whole teams of lawyers are anxiously awaiting the appearance of these products. I'm sure Defendisk and Vault will take lots of precautions to see that the original copies of software they protect won't hurt your system. What could go

(continued)

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TUNESMITH $49.95
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wrong? But just to be safe, I think I'll take the precaution of not using them at all.

The book of the month is *Pascal for BASIC Programmers* by Charles Seiter and Robert Weiss (Addison-Wesley Microbooks, 1984). I wish I'd had this one years ago. It's clearly written, well organized, and has good examples, and one of the best discussions of pointers I've seen anywhere. If you're into noncomputer reading, I recommend *In Search of Schrodinger's Cat* by British science writer John Gribbin (Bantam New Age, 1984). It's a layman's-level discourse on modern physics and quantum mechanics. The cat in question is in a sealed box, and it will be killed if a particular atom emits a particle of radiation, but will be alive otherwise. It turns out that until the box is opened there may be two cats, one alive and one dead.

Coming up is a look at the Hewlett-Packard Touchscreen and ThinkJet ink-sprayer printer. The Touchscreen is a nice computer all by itself; and used as a high-resolution terminal in connection with the CompuPro Shirley, it allows us to run SCADA, a professional-level computer-assisted-design program that rivals some of the best available on big minicomputers. More on that another time.

Meanwhile, Tony has my copy of the CompuPro PC Video Board that lets an 8/16 S-100 computer run IBM PC software, and they swear I'll have it Real Soon Now; the contractors have poured the foundations for the new office addition and partly filled up the moat where the grapefruit tree used to be; the software stack has grown another foot; and there seems to be no end to the marvels the computer revolution pours forth. I love it. ■

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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Inquiry 309

Inquiry 353

C·H·A·O·S M·A·N·O·R M·A·I·L

NEW SOFTWARE

Dear Jerry,

Enclosed is a complimentary copy of our new product, CLUBware Diskette #1. I am sending it to you for a couple of reasons.

First, I would like to thank you for your many humorous and useful insights into the microcomputer industry. I, as do many of my acquaintances, always open BYTE to your column first.

Second, I hope you will find both our CLUBware concept and the first product intriguing enough to write about.

This release of CLUBware is an attempt to unbust the IBM PC's BASIC. (Guess what newsletter we have been reading.) That is, Microsoft made some poor design decisions in implementing the screen I/O of its BASIC. It is understandable, if for no other reason than that it was under considerable time pressure from Big Blue. We have essentially reverse-engineered the product and can dynamically apply a fix that accelerates screen output.

At any rate, please take an opportunity to run CLUBware on some IBM PC BASIC applications. I think you will discover that even a poor little IBM PC can really shine.

JOE RAYHAWK
Rayhawk Automation, N W, Inc.
11600 Southwest Barnes Rd.
Suite 230
Portland, OR 97225

Great routines. If you put that good of a stuff on all your disks, you ought to get a lot of subscribers. Thanks.—Jerry

SCIENTIFIC COMPUTING

Dear Jerry,

After reading the letter by Steve Maas in the August 1984 BYTE, which is the second letter in recent months trying to convince you that FORTRAN is the one and only language for scientists and engineers, past, present, and future, I decided that I finally had to overcome my laziness and write an opposing letter. I too am a scientist, and I have worked for 24 years in research for one of the largest corporations. However, I am not a member of the Moral FORTRAN Majority but belong to the Immoral Pascal Minority because I had the benefit of starting with ALGOL-60 as my first computer language, back in the early sixties on a Burroughs B-5500. Later, I too had to convert to FORTRAN, and still later I learned BASIC because these languages were all that were available on the computers I was using. When I finally graduated to a CompuPro microcomputer and had my own choice of languages, I ran, not walked, to get a Pascal compiler. Comparing these four languages, I know from experience that Pascal is by far the best choice for science and engineering, for all the well-known reasons that you already have pointed out.

I submit that the dominance of FORTRAN in science and engineering is by no means an indication that it is the best language, or even a good language, but came about only by historical development. The FORTRAN myth is based on a vicious cycle: In the IBM-dominated world of mainframe computers, all that was available to scientists and engineers was FORTRAN. Therefore, in the past, the universities taught them to program in FORTRAN. Therefore, large libraries of existing programs, all written in FORTRAN, were built up. Therefore, in order to avoid duplication, all scientists and engineers are using FORTRAN. FORTRAN forever! No progress possible!

Well, not all is lost yet! This vicious cycle is being broken now. The universities seem to be teaching mainly Pascal, and with the microcomputer revolution, Pascal is available to everybody. For the first time, individual programmers can make their own choice.

However, FORTRAN cannot be simply ignored: There is, after all, this large mass of existing programs and subroutines. Ways must be found to integrate FORTRAN modules into modern languages, such as Pascal, Modula-2, Ada, and C, so that FORTRAN can be used for existing programs. All new programs can, and should, be written in one of the modern languages. For this purpose, the design of Ada includes a language pragma, i.e., a compiler directive telling the Ada compiler to compile FORTRAN source code within an Ada program. The implementation of this pragma, however, seems to be in the future or, as you would express it, in the Real Soon Now category. What is available right now are the "common back-end" compilers by Microsoft and, more recently, by Digital Research. These compilers are designed so that only the first pass is different for each language, while the second pass is the same for all languages supported. Thus, modules written in different languages can be linked together into one executable program.

All developers of Ada, Modula-2, Pascal, and C compilers should include a facility that allows you to link in compiled FORTRAN modules, folllowing the example given by Microsoft. Most of these systems do provide for linking in assembly-language modules.

I was using Digital Research's Pascal MT+86, but I switched to Microsoft's MS-Pascal partially because of its interlinkability with MS-FORTRAN77 and partially because it allows using the full address space of the 8086. Both compilers are written in MS-Pascal, and both produce object modules that can be linked together by the MS-DOS linker. The main program can be either in Pascal or in FORTRAN. Both languages support separate compilation of modules. The Pascal part supports modules (like Pascal MT+86) as well as units (like UCSD Pascal). Procedures in the modules or units can be external and can be in FORTRAN or assembly language. Thus, I write the main program and all new work in Pascal and use the FORTRAN compiler for existing scientific subroutines that are made part of a Pascal unit as separately compiled external procedures. This works very well. The MS-FORTRAN77 compiler compiled a large FORTRAN IV program, ported from a mainframe, essentially without changes—no complaints at all!

In order to run MS-Pascal and MS-FORTRAN, I had to switch my CompuPro 8/16 system from CP/M to MS-DOS, and I do not want to miss this opportunity to point out to you and all other CompuPro enthusiasts the availability of MS-DOS and, more recently, IBM PC-DOS on CompuPro systems from Computer House in San Rafael, California, under the trade names MS-PRO and PC-PRO. Both systems are simply wonderful, and I hope that you will review them in your column when time and space permit. You can boot up either MS-DOS (MS-PRO) or PC-DOS (PC-PRO) on any standard CompuPro 8/16 system without losing your CP/M-80 or CP/M-86 capability.

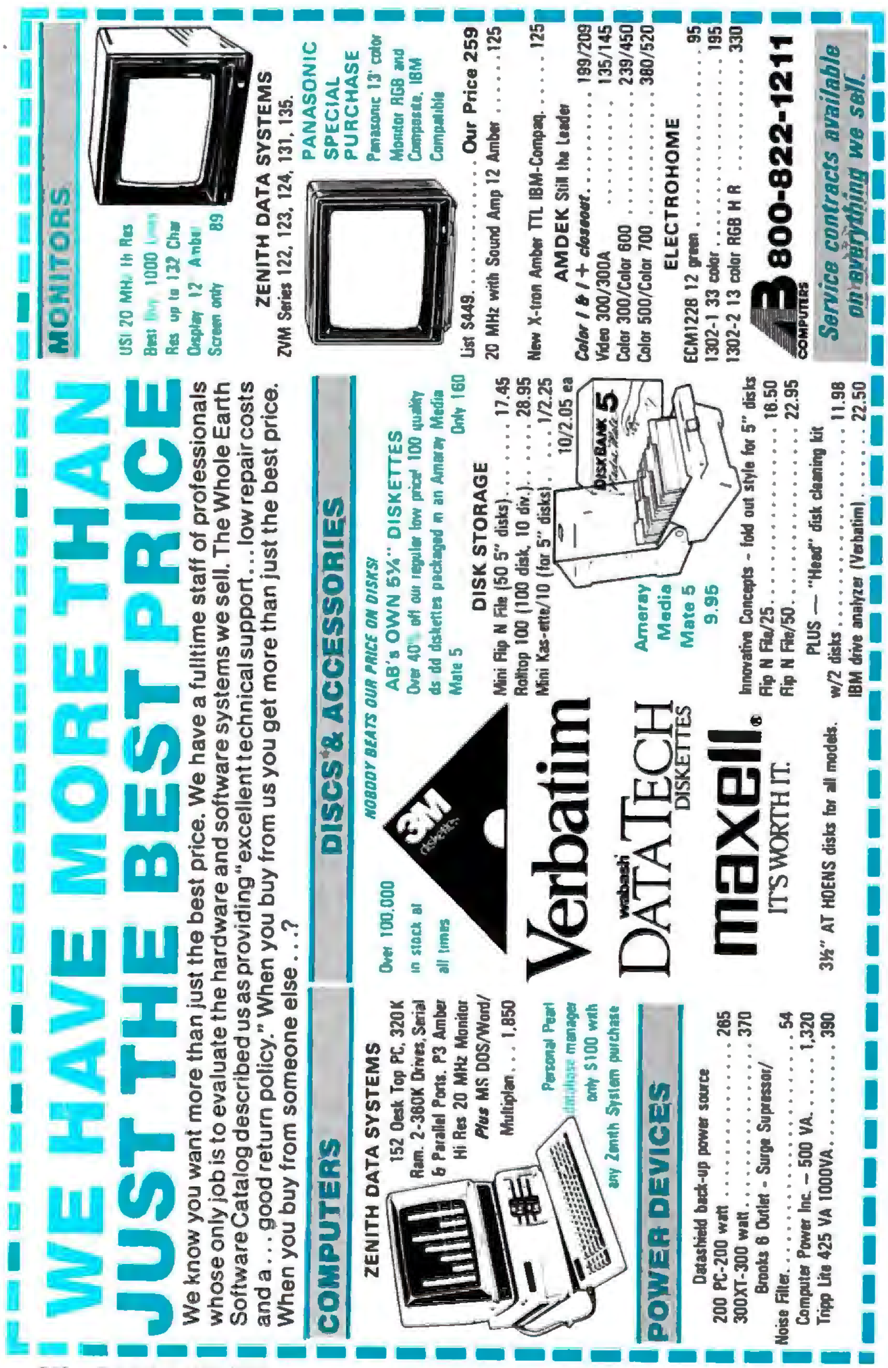
Please keep up your support of Pascal, Modula-2, and Ada and tell all your letter writers from the scientific and engineering community that, yes, FORTRAN and BASIC programs are difficult to read, difficult to debug, and difficult to maintain, and let them know that they don't know what they are missing if they do not try something that is new to them. After all, science is the search for new frontiers, which would also include computer programming.

GUNTHER E. MOLAU
Clayton, CA

Thank you for a very thoughtful letter. Your point is well made.

I hadn't known about MS-PRO and PC-PRO; the difficulty we've always had running PC-DOS is teaching the machine to talk to whatever terminal we had running at the time. Now, though, I have Concurrent DOS, which does have MS-DOS as well as allowing me to run CP/M 8/16, giving me the best of both worlds. I'll try to get MS-PRO and compare.

Best.—Jerry



U.S. CONTACTS

Dear Jerry,

I hope you will be able to help me. I represent a small group of French computer and data-network (not hackers, of course) enthusiasts.

We are looking for contacts with American fans, and we could give them access to a French electronic mailbox (free of charge!) on our national computerized data network (0208075040371 or 0208075040864).

PASCAL LAGADIC
Residence Cornouaille
28, Bd Bougainville
F.29110 Concarneau,
France

Anyone out there interested? Please keep me posted.—Jerry

WRITING AND EDITING

Dear Jerry,

I am half of an information-center support group responsible for microcomputers at a power company. The staff consists of two groups: mainframe support and microcomputer support. We provide a monthly newsletter to all corporate users of either mainframes or microcomputers. Presently, we are creating and editing this letter on our IBM mainframe using a full-screen editing product (ISPF). As you have said often, any form of word processing, even a very crude one, is better than a typewriter.

What would you recommend to streamline the writing and editing process? We have access to several IBM PCs and compatible computers. Some members of our group use various word-processing programs (WordStar, WordPerfect, EasyWriter), and I have convinced the rest that we could produce a better newsletter on a PC with less effort. To add to the problem, many of our users submit articles. They submit them in a printed format, but most are generated on some type of microcomputer. The articles could come off of non-compatible machines. Do you know a word-processing program that would allow all our writers to use any program they want and still make it fairly easy to bring it all together for formatting, spelling checking, indexing, etc.? I believe this would also be useful to the company's PC Club, which is open to members with *any* kind of computer. Our company has 5000 employees, so you can imagine the cross section of machines and programs we could be looking at.

Thanks for your time and keep up the great work!

KEVIN WANDTKE
Milwaukee, WI

My guess is that your common denominator is going to be WordStar. What you need is a series of filters that will turn foreign files into something that WordStar can eat.

Those are not difficult to come by. I wrote my own for the Z80 (in assembly language, yet; just use the "Copy" program example in DR's MAC document as a base and start adding features). It shouldn't be hard to write 8088 filters; use Turbo Pascal or Logitech's Modula-2. After you've done a couple of filters you'll find the rest are easy.

The filter should take text from one editorial format and write a new file with the text in WordStar format. From there it's easy.

Best.—Jerry

CP/M-80 AND 8-BIT MACHINES

Dear Jerry,

What is the future of CP/M-80 and the 8-bit machine? I have been following software developments very closely for the past eight months, and it appears that aside from KAMAS, Turbo Pascal, and the three C compilers covered in the June 1984 BYTE, there has not been a new software product introduced for CP/M-80 in two years. Even the latest public-domain software packages have 1982 dates in the copyright notices, NSWP206 excluded, of course.

Is CP/M-80 on the way out, or is it alive and well, hiding behind an impenetrable barrier of high-hype 16-bit advertisements? What do you see CP/M-80 being used for in the future?

Finally, one more question: Has the supply of new CP/M-80 software dried up for good?

ALLEN STANBURY
Barrie, Ontario, Canada

Glad you asked.

Some of the best bargains in computing are 8-bit CP/M machines, new or used.

Their advantages: they're plenty good enough for a lot of really interesting work. I managed my affairs for years with Ezekial, my friend who happened to be a Z80, and you can get a better machine than he was (sorry, old friend) for a lot less than I paid for him.

There is a lot of software out there for 8-bit CP/M machines; particularly for those with a Z80 processor (which most now have). Most of that software is low-cost, and much of it is free or nearly so. You can even get ZCPR-3, which revamps the operating system into something a heck of a lot nicer than MS-DOS. There's

(continued)

a lot more software that was published by companies that no longer support it and that has effectively fallen into the public domain: no one will give permission for swapping it, but no one cares much either. And, of course, most 8-bit machines come bundled with some really good programs.

Finally: when you do upgrade, you can go the 8/16 route; machines like the Z-100 and the CompuPro line immediately come to mind. These will run all your old familiar software; I'm writing this with an 8-bit text-editor program called WRITE that I prefer to anything else I've seen.

Disadvantages: you won't upgrade easily, and probably not at all. There's little new commercial software being written for 8-bit CP/M machines; that means you'll have to join user groups and scrounge about; and even so, as time passes you'll see more and more about the newest programs with fancy features that your 8-bit system just won't handle.

There's not a lot of support for either software or hardware. You'll have to learn a bit more of what you're doing. CP/M takes a couple of days' study before you can do much with it and a couple of weeks' use before it becomes automatic. Most of the 8-bit software was written in times when computer users were expected to put some effort into learning about computers.

Should you get an 8-bit machine? Like most questions, the answer is "That depends." If you're one of those people who has to have the latest and best, no; but if you just want to get some jobs done while holding down costs, you'll think hard about 8-bit CP/M systems. They'll be around for years yet.—Jerry

MISCELLANEA

Dear Jerry,

I enjoy your observations on the industry, your user viewpoint, and the generally good advice on products and systems. I am now involved in the computerization of a law office for my father. Because of your column, I have looked at the Zenith Z-150 plus network (four workstations) and the CompuPro System 10. Either system will be built around a 40-megabyte hard disk. The Zenith would run under Concurrent DOS. We have not made up our minds yet. My dad's office is less than 20 miles from the Heath factory that makes the units.

In the December volume of the *ACM Sigplan Notices on Programming Languages*, David V. Moffat of North Carolina State University wrote a paper on Modula-2. As you have been writing about how great a programming environment Modula-2 is, I wonder if you feel Mr. Moffat's concerns have any merit.

When you discuss text editors you have not mentioned WordPerfect by Satellite Software. Have you used this package?

I think that Borland should get a company-of-the-year award for its fine products. My System Engineer wife has gone exclusively to Turbo when programming in Pascal. Turbo is very popular with the computer science students at Old Dominion University.

ROBERT ADAMS
Norfolk, VA

(continued)

Alas, I haven't seen WordPerfect.

Thank you for including Professor Moffat's paper on Modula-2. I can share some of his unhappiness about the lack of I/O within the Modula-2 language itself. I'd like it better if there were richer I/O functions built in, or, failing that, if there were a defined standard I/O library (set of I/O definition modules) every compiler publisher had to implement.

Of course, what Moffat does here is to reject Wirth's most basic philosophy of keeping compilers small and simple. Perhaps he's right. I don't think so.

In my early days with this column, I explicitly refused to examine languages per se and confined my attention to particular implementations that I could run on my own machines. This got me into considerable trouble with the Pascal lovers. When Modula-2 came around I changed my rule: I liked what I saw of Modula-2 from the first instant. I was influenced in that by the ease with which you can translate programs from Pascal to Modula-2.

I did not care for the lack of I/O within Modula-2, but I was assured that there would be, with any implementation, a library of I/O procedures adaptable to the particular machines (and I/O devices!) the compiler would support. Alas, Moffat has a point: there seems to have been little standardization of the libraries. I expect that to change; if it doesn't, Modula-2 will not become the language of the future for microcomputers.

It may not anyway. In the three years since I gave Modula-2 my support, small computers have changed radically. They are faster, have more memory, and can access much larger files. As a result, we have got better and better versions of BASIC, with debugging tools and compilers; and while no one will ever write an operating system in BASIC, it has also taken longer than I would have bet to get the Modula-2 operating system implemented on anything I can run it on.

Part of Moffat's objections regarding portability seem founded on an insufficient understanding of the difference between definition and implementation modules. His ad hominem arguments—the only Modula-2 enthusiasts are those who will somehow profit from its success—are untrue and not worth commenting on.

His final observation, that there is no "final" computer language, is probably true; but it fails to answer the question, "What should the user learn after BASIC?" For Moffat to tell us that SNOBOL and APL handle many problems perfectly is probably not much use to the general public.

For now, my advice to readers is to learn some BASIC, then get Borland's Turbo Pascal and a good introductory Pascal text. Follow that up by getting some books with Pascal source code and examine how good programs are written. Even if you never write any major programs in Pascal, learning the language will teach you a lot about program structure.

We also have good Modula-2 implementations now. I already have review copies of professional programs written in Logitech Modula-2 for the IBM PC.

Best regards.—Jerry ■

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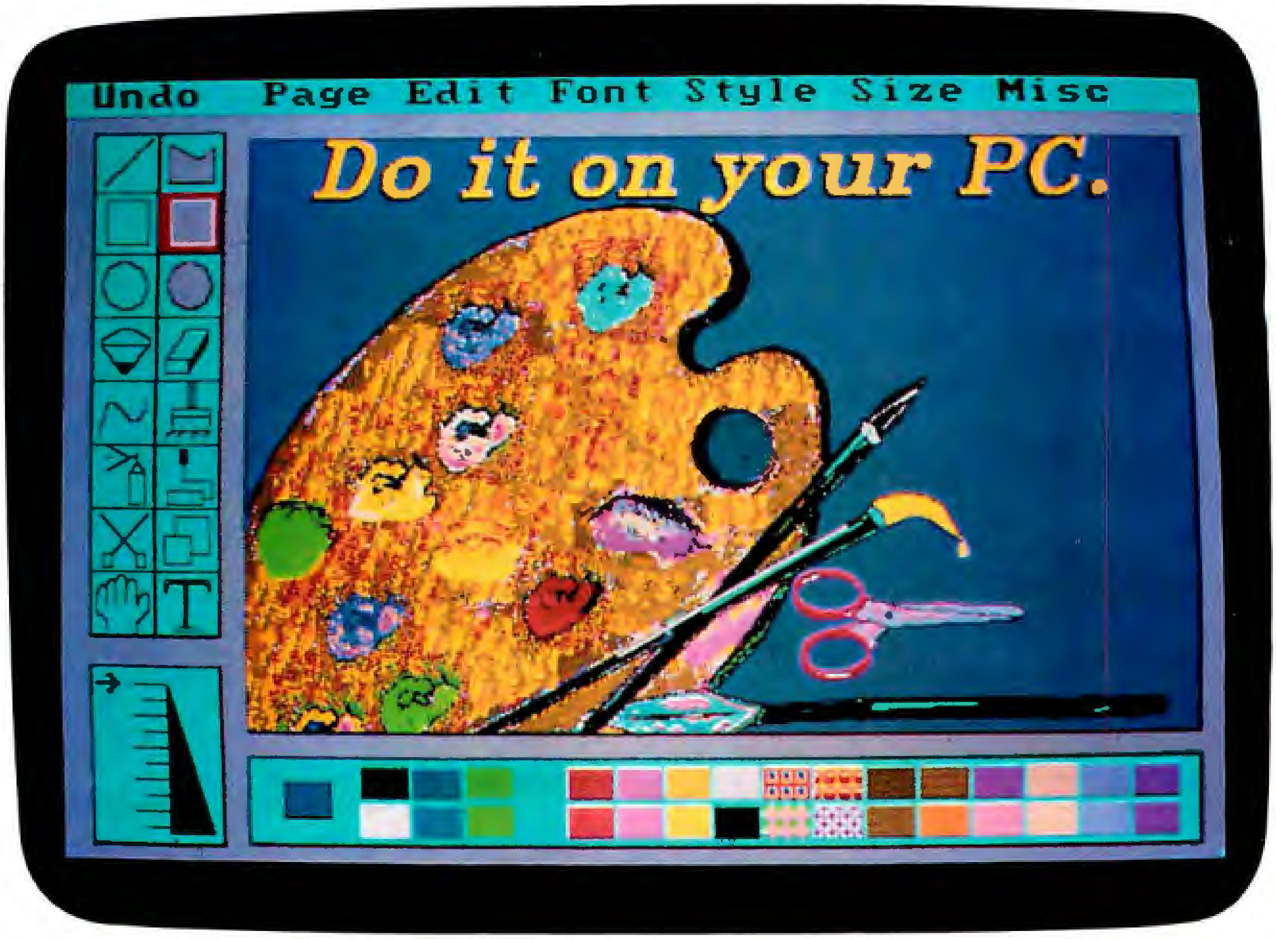

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Inquiry 202

バイト

Megabits and Gigaflops

New RAM chips and computers

BY WILLIAM M. RAIKE

For about a week, Japan was closed for business. But that's not as strange as it sounds; the week was January 1–7, and virtually all stores, restaurants, and other businesses here close for the New Year holidays. After a frantic few weeks of *bonenkai* (literally, "forget-the-year parties"), Tokyo's crowds vanish, with many people going off to visit relatives in rural areas.

After my customary New Year's Eve visit to a neighborhood shrine, listening to the drums heralding the new year and sipping sake from a traditional little square wooden box, there was plenty of peace and quiet for writing columns, and even time to get around to some long-delayed software chores.

Before the holidays, though, there were a number of computer-related developments in the news. In addition to announcements of a new supercomputer and of the test production of 1-megabit memory chips, both NEC and Fujitsu introduced new personal computers.

MEGABIT RAM CHIPS FROM IBM JAPAN

The latest round in the ongoing competition for large-scale memory chips was the start of IBM Japan Ltd.'s test production of 1-megabit dynamic RAM (random-access read/write memory) chips. Quantity production is still probably at least a year away; the entire output is destined for in-house consumption, with the chips to be installed in computers manufactured by IBM Japan. The plant, located in Shiga Prefecture in western Japan, has produced both 64K-bit and 256K-bit dynamic RAM chips for the past year or so.

NEW SUPERCOMPUTER

Fujitsu Ltd. is the second-largest manufacturer of personal computers in Japan (well behind NEC); however, the company is the largest manufacturer of mainframes. It now claims to be the fastest, too, after having just announced a new supercomputer. The new behemoth is called the VP-400, and Fujitsu claims that it is capable of computing at the rate of 1 gigaflop (one billion floating-point operations) per second. Like the Hitachi S-810 supercomputer I talked about in BYTE Japan last month (see "The Fifth Generation in Japan," page 401), that is a peak rate, dependent on taking the greatest possible advantage of the pipeline structure of the hardware. The actual processing rate for the Hitachi machine can be as much as six times slower than the peak rate, depending both on the specific application and on how finely the software is tuned. Fujitsu is undoubtedly just as adept at playing the specifications game as Hitachi is. From the viewpoint of peak processing speeds it may look as if Japan's supercomputer manufacturers are in a position to compete with the U.S.'s Cray Research Corp., but unless their software (and documentation) improves soon, the impact of Japanese supercomputers outside Japan is unlikely to be economically substantial.

NO NEC-COMPATIBLE FROM IBM?

IBM Personal Computers (PCs) are downright rare in Japan, for reasons that include relative technical inferiority, inability to support the Japanese language, high prices, poor distribution, and high-priced maintenance. The JX computer introduced by IBM Japan late last year has not been enthusiastically accepted for some of the same reasons. In addition to the MSX standard for very low priced computers, there is a de facto standard in Japan for powerful, multipurpose personal computers: it's the NEC 16-bit personal computer family, the PC-9801 series. In the 16-bit personal computer market here in Japan, the PC-9801E and PC-9801F command more than a 70 percent share of the market. (NEC's APC III, introduced last year in the U.S., is similar to the PC-9801F2 except for the floppy-disk capacity and the hardware features that

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William M. Raike, who holds 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 United States. In 1980, he went to Japan looking for 64K-bit RAMs. He has been there ever since as a technical translator and software developer.

NEC *has trumped its own ace with the* PC-9801M2.

support the Japanese language.)

When new software or peripheral equipment is introduced in Japan, the versions for the PC-9801 are invariably the first to hit the market; if you go to a computer show, most of the software and peripherals vendors demonstrate their wares on a PC-9801F2. (The F2 designation indicates the model with two built-in floppy-disk drives. There are also F1 and F3 models; the F3 has one floppy disk and one 10-megabyte hard disk built in.)

So dominant is the position of this machine that I've only half-jokingly suggested that IBM Japan, instead of bringing out the JX, should have borrowed a trick from the IBM PC's imitators and introduced a machine of its own that was fully NEC PC-9801–compatible.

THE LATEST AND GREATEST NEC MACHINE

In the past month, NEC has apparently trumped its own ace by introducing the PC-9801M2. It's not really a new machine, but it represents several technical refinements over the F2 model, along with a substantial price reduction.

The two biggest differences are that the floppy-disk drives in the M2 hold 1 megabyte each instead of 640K bytes as in the F2, and the basic price (the list price is equivalent to about $1650) now includes a standard 256K bytes of memory instead of the F2's 128K bytes. A mouse interface is included with the M2; it was optional in the F2. Since adding 128K bytes of memory to the F2 costs about $160 and takes up one expansion slot, the extra memory on the main board of the M2 is a real advantage. And my own experience with the 1-megabyte disk drives in my Fujitsu computer has been very satisfying; it's a great relief not having to swap disks or remember which program is in which drive during an edit-compile-debug cycle.

The central processing unit of the PC-9801M2 is an 8086-2 running at 8 MHz, although you can switch to a 5-MHz clock rate for compatibility with earlier versions of the PC-9801 computer. NEC offers an optional 8087-2 numeric coprocessor (there's a socket for it on the main board) that runs at 8 MHz, but the price for the chip is a hefty $325.

Main memory is expandable to 640K bytes. That may seem like a lot, but I'm spoiled; my Fujitsu can handle up to a megabyte (it has 768K bytes installed now), and I use 512K bytes of that as a RAM disk. Fujitsu's version of the CP/M-86 operating system "knows" that drive M: is the RAM disk, so I normally load any necessary files onto drive M: when I boot up the computer; then I just forget about waiting for disk I/O (input/output). The trouble with NEC's limit of 640K bytes is that many programs need at least 256K bytes to run in. That leaves only 384K bytes free for a RAM disk, which is squeezing things a bit if you want to load something like Digital Research's C compiler and its associated linker and library files, in addition to an editor and various utilities.

In addition to the standard 96K bytes of ROM (read-only memory) containing the BASIC interpreter, the PC-9801M2 comes with a kanji ROM board with the 2965-character JIS (Japan Industrial Standard) No. 1 kanji-character set; the JIS No. 2 set of 3384 additional characters is available as an option for less than $50. Japanese characters are displayed on the screen in a 16- by 16-dot font, with 40 characters per line. As is common with personal computers in Japan at this price level, the operating system supports the full Japanese language; the basic price does not include an operating system, but both Japanese-language CP/M-86 and MS-DOS are available as options for about $40. You can also buy the PC-UX operating system, which is essentially a UNIX System III; it costs about $1200 and requires at least 384K bytes of memory and a 10-megabyte hard disk. (The hard disk costs an extra $1775.)

The rest of the PC-9801M2 is unchanged from the F2 version; 192K bytes of graphics video RAM is standard—graphics are in eight colors with 640- by 400-dot resolution. An 8-bit parallel printer interface is, of course, standard, as is an RS-232C serial interface and a calendar/clock with battery backup. There are three expansion slots.

NEC offers a wide selection of display monitors and printers. For example, there's a 14-inch high-resolution (640- by 400-dot) monochrome display that lists for about $230, while a 14-inch high-resolution color display goes for about $670. The PR-101 printer is a very high quality 24-pin dot-matrix printer that prints 80 characters per line and lists for about $950 (it also prints beautiful kanji characters), while the new PR-201CL is a 24-pin dot-matrix printer that prints 136 characters per line in eight colors and lists for about $1300. (The printers use conventional 8-bit parallel interfaces and print either alphanumeric or kana/kanji characters.)

FUJITSU'S BETA

You'd think that one FM-16 would be like another FM-16. It's not necessarily so. Fujitsu's new FM-16β, known as the Beta, bears little resemblance to the FM-16s that's sold in the U.S. This new computer is Fujitsu's answer to the NEC PC-9801M2, and it's quite a machine. If I hadn't just bought my FM-11BS, I'd want to own the FM-16β.

To begin with, the Beta uses Intel's 80186 microprocessor. The basic architecture of the 80186 is similar to the 8086, and it can run all 8086 software, but the 80186 has some features that make it quite a bit faster than the 8086. For example, the reduced number of instruction-execution cycles lets it perform integer multiplication and division about three times as fast as the 8086. From the hardware engineer's standpoint, the on-chip interrupt controller, timer, clock generator, and DMA (direct memory access) channel let

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the 80186 chip perform functions all by itself that otherwise would require additional chips. Finally, the 80186 offers some additional machine instructions, called stack-frame instructions, that could potentially improve the efficiency of programs written in high-level languages. This last advantage is largely an illusion, though; at this writing I don't know of any compilers that take advantage of this feature.

In addition to the 80186, the Beta incorporates an MBL68B09 coprocessor running at 2 MHz to manage the display, graphics functions, and keyboard, relieving the main processor of these burdens. All of the functions handled by the coprocessor are accessible from application programs via BIOS (basic input/output system) function calls.

You get as much standard RAM with this computer as with any other personal computer I know—half a megabyte (512K bytes). Main memory is expandable to a full megabyte, and additional 256K-byte RAM boards cost only about $240 each. Since the machine has four expansion slots (three in the hard-disk version), expanding the system up to the maximum memory capacity doesn't use up all the slots, as is unfortunately the case with the NEC PC-9801M2. Kanji-character support is excellent; both the JIS No. 1 and No. 2 standard character sets are supported from standard ROM, giving a total of over 6800 characters in addition to the full alphanumeric and kana character sets. The standard operating system is Japanese-language CP/M-86, which offers full kanji support at the operating-system level. It also includes RAM-disk support; just as in my FM-11BS, you can reserve up to 512K bytes of main memory for use as a RAM disk. In addition to all the other memory, you get 192K bytes of graphics video RAM. Custom LSIs are used to speed up graphics functions like drawing lines and circles, too. Besides the printer and RS-232C interfaces, the Beta includes mouse and light-pen interfaces. Finally, it gives you a calendar/clock with battery backup, a feature that's missing from my FM-11BS.

The Beta comes in two models: one includes two built-in 1-megabyte floppy-disk drives, while the other has one floppy-disk drive and one 10-megabyte hard disk. You can partition the hard disk between two different operating systems if you're so inclined (Japanese-language MS-DOS is available as an option), but I'd rather be drawn and quartered than run a computer under two operating systems.

For a new computer, especially in Japan, the Beta is well supported by software from independent vendors. In addition to all the CP/M-86 and MS-DOS public-domain software, over 350 major software packages are available from over 60 different cooperating vendors. They include business software, languages, utilities, English- and Japanese-language word processors, database managers, spreadsheets, communications programs, and graphics packages. A large percentage provide full Japanese-language interaction with the user. Unfortunately, the prices for the language processors imported from the U.S. (Japanese-language manuals are usually available) are very high, often double or triple the cost of the same software in the U.S. This situation is tantamount to an open invitation to piracy; I haven't yet been able to find out whether tariffs, greedy (but short-sighted) distributors, or some other factors are at the root of the problem.

Considering its power, the FM-16β is a bargain. The list price for the version with two floppy-disk drives is just under $1700; the hard disk version goes for just under $3000. In view of the stiff competition from the new NEC machine, discounts are prevalent; the typical 20 percent discount on computer equipment here in the Tokyo area is bound to extend to the FM-16β very soon. ■

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Homebrew Chips

MOSIS, two packages for the Mac, Turtle Talk, and Concurrent DOS-286

BY JOHN MARKOFF, PHILLIP ROBINSON, AND DONNA OSGOOD

Have you ever wanted to make your own VLSI (very large scale integration) chip? Do you think you have a foolproof design for an IBM PC AT compatible on a chip, but no one will take you seriously until you show them a working sample? Maybe you're in luck. The Syracuse AI coprocessor chip was actually fabricated through MOSIS (MOS Implementation System), a brokerage that connects chip and board designers with chip and board fabricators. MOSIS is an outgrowth of both the Arpanet and an idea from Xerox's Palo Alto Research Center (PARC). If you follow the MOSIS rules and can afford the prices, your chip could be sitting on your desk just a few months from today.

Before VLSI was more than a twinkle in anyone's eye, the defense department's ARPA (Advanced Research Projects Agency) set up ARPANET, a computer network that connected a number of universities and defense contractors. Later, ARPA changed to DARPA (Defense Advanced Research Projects Agency), but the network retained its original name.

In 1980, Xerox PARC offered to organize VLSI fabrication services for the ARPANET community. The PARC researchers knew that university engineering and computer science departments were getting shut out of much of the microelectronics revolution because they couldn't afford the equipment necessary to manufacture silicon chips. Even those universities that could afford some equipment could never keep up with the rapidly advancing state of the art. VLSI students and professors had been reduced to designing chips on paper and then seeing those designs languish in libraries.

At the same time, many chip manufacturers in Silicon Valley were fretting over their unused manufacturing capabilities. The best way to pay off millions of dollars of wafer-fabrication equipment is to run it as much as possible and the manufacturers had more idle machine time than they wanted.

While a single batch of wafers is too expensive for a university to buy, the engineers at Xerox PARC figured that if enough designs could be gathered together and made on a single wafer-fabrication run, the price per design would be affordable. Besides, while designers would be delighted to see their creations become hardware, the manufacturers would be thrilled to make some extra money with their equipment. Another advantage for the chip makers was that students would graduate with some hands-on chip-design experience.

So Xerox PARC invited the DARPA community to send in chip designs that Xerox would then organize into wafer runs. The first run was a bunch of student designs from a VLSI course taught by Lynn Conway in 1978 at MIT. The first masks were made by Micro Mask and the first run was fabricated at Hewlett-Packard's Deer Creek Road facility. The service was immediately successful and DARPA wanted to see it continue, but Xerox didn't want permanent responsibility. The Information Processing Techniques division of DARPA had a VLSI design research program and was an ARPANET node. DARPA let ISI (Information Sciences Institute) take over from Xerox and called the new service MOSIS. Although chip designs were initially only accepted from the DARPA community, other groups were gradually added to the fold. First the NSF (National Science Foundation), then any government organization with DARPA permission, and finally, practically anyone was permitted to submit VLSI designs.

MOSIS puts out a schedule of the wafer-fabrication runs for six months into the future. Those scheduled runs will be made even if too few designs show up to fill the wafers (the extra space will be devoted to test structures). That commitment assures designers that they can plan around fabrication dates and allows wafer-fabrication factories to schedule equipment time. However, demand has been so great that the

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wafers have always been full of actual chips.

You can choose from NMOS (negative-channel metal-oxide semiconductor) 3- or 4-micron, CMOS (complementary metal-oxide semiconductor) 3-micron, and CMOS-SOS (silicon-on-sapphire) 4-micron processes. A new, experimental CMOS 1.2-micron process should be in limited use by the spring of 1985. MOSIS will provide you with the design rules, process specifications, and device specifications for the process you choose.

MOSIS has masks made from your design and then gives the masks to any of 11 different Silicon Valley chip fabricators. The finished wafers are accepted on the basis of test-structure specifications. If those meet agreed-upon levels—indicating that the process was properly executed—the wafers are accepted, whether or not the customers' chips actually work. MOSIS also extracts Spice (a low-level circuit-simulation language) parameters from each and every run so there is a database of actual device parameters from which designers can take cues.

While many chips are made on share-the-silicon wafer runs, some runs have only a few or even a single type of chip. Some MOSIS customers only need a few chips to verify a design. Others need more to stuff a prototype board or a prototype system. Finally, some customers need to get a small production run of the chips.

Chip fabricators used to be stuck with judging whether to take on a new, small customer. It was hard for them to gear up for a small run, but they didn't want to miss out on a small firm that might grow into a major account. Now, if a chip fabricator works with MOSIS, it doesn't have to deal with small outfits: MOSIS handles that for them. "We save them time and money," says Dr. George Lewicki of ISI. Plus, the manufacturer doesn't have to worry about competition from MOSIS. According to Lewicki, "We are a broker, nothing more than a broker."

As Dr. Oldfield of the Syracuse SUM (Syracuse Unification Machine) team told us, "It's becoming easier for universities to think of building experimental systems. It's an interesting historical point. If you go back to the 1950s and 1960s, a number of universities built machines. But the complexity overwhelmed them. Now, thanks to these custom CAD [computer-aided design] aids, it's feasible, though still very difficult, for a university to think about designing a real system without having an army of technicians to put it together."

So you want to make some chips? How many? MOSIS will make two or more if you send them your design in either CIF (Caltech Intermediate Format) or Calma-GDS 2-stream format. In 4 to 12 weeks, the packaged chips will be delivered to you. The turnaround time depends on which process you choose and how well the economy is doing. Choose 4-micron NMOS and you'll get your chips sooner than if you choose 1.2-micron CMOS. Even so, if the chip fabricators have long production queues, you'll have to wait longer.

As for the price—your chips will probably cost less than you think. For the DARPA, NSF, and DOD (Department of Defense) communities, the service is free. DARPA pays the whole freight for those lucky customers. For the rest of us, MOSIS has a price schedule. Remember, however, that MOSIS is a nonprofit service. All you have to pay is your proportional share of the run's cost (there are about 900 chips in a run). Dr. Lewicki estimates that a batch of 20 chips would cost about $5000. If your chip is so successful that you need "zillions," MOSIS encourages you to deal directly with the chip manufacturer.

MOSIS is an impressive example of

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a new, information-age public utility. It brings together people with complementary needs. So what's keeping you? Get some time on a VAX (or a personal computer) with the right CAD tools, scrape together the $5000, read "Introduction to VLSI Systems" by Carver Mead and Lynn Conway (Addison-Wesley, 1979), and join the VLSI age.

PC Board Drafting System on the Macintosh

Now that a flood of mainstream Macintosh software has arrived, it is worth taking a look at some of the less-obvious programs being written to take advantage of the Macintosh graphics interface.

We recently visited the San Leandro factory of Douglas Electronics. If you've ever done any printed-circuit (PC) prototyping or breadboarding you may be familiar with Douglas. For 20 years they have supplied designers with circuit prototyping and interfacing products and manufactured custom PC boards. Douglas also manufactures the Ap'seed, a modular dedicated microcomputer system based on the Apple II.

At Wescon last year Douglas introduced a PC-board-design software package called QuikCircuit for the 128K-byte Macintosh. The new CAD package will make it possible for a designer to create a prototype board on the Macintosh, save it on a 3½-inch floppy disk, mail the disk to Douglas, and then receive a finished prototype board in return. Douglas president Chad Pennebaker estimated that the Macintosh design system will cut the time involved in the design cycle by half and yield a significant savings in board cost because Douglas will be able to manufacture directly from the floppy disk by using Macintoshes to drive their equipment. Currently, plans call for Bishop Graphics in Westlake Village, California, to market the CAD program and shortly other PC board houses around the country and internationally will also be able to manufacture directly from disk.

The design system makes extensive use of the Macintosh user interface and builds on many of the features found in generic drawing programs like MacPaint and MacDraw. Referred to by Douglas as a printed-circuit-board layout and manufacturing system, QuikCircuit allows the user to specify the type of PC board he or she wishes to design from a range of options including the Apple II, IBM Personal Computer, Digital Q-bus, VME (virtual machine environment), and a variety of special Douglas breadboard designs. It is also possible to design your own custom board shape and edge connector.

After selecting the proper board outline, the designer can place pads and patterns anywhere on the board with the aid of a grid that constrains movement. A variety of common pads and patterns are available from a menu of options or it is possible to design custom options. A MacDraw-like feature permits specifying a common feature such as a RAM (random-access read/write memory) IC (integrated circuit) pattern and then quickly replicating it many times on the board. Many of the MacPaint-style editing features are included in the program, so it is possible to continously alter the PC board layout. Edit commands let you select an item or a group of items, cut and paste, and they include a special pattern editor.

Once pads have been placed, the user selects a trace width and then routes the trace. All traces are automatically constrained to vertical, horizontal, or 45-degree placement. To go through the board and continue a trace on the other side, the user presses a keyboard command and the

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board is flipped on the screen, letting the trace continue on the other side. This command places a special feed-through pad at that point. Traces on the current side of the board are displayed in black, while traces on the reverse side appear in a lighter gray shade. It is possible to select a variety of background grids ranging from 0.001 inch to 0.156 inch.

In addition to being able to flip the board from solder side to component side, it is possible to change the scale of the view, zooming in and out to focus on various portions or view the entire board. At any time it is also possible to view a special *x-y* locator in the bottom left corner of the screen. This locator can be zeroed.

Currently it is only possible to get hard copy from the Macintosh Imagewriter printer. The quality is not high enough for many professional applications. Plans call for the development of a driver for the program to enable the Macintosh to produce a finished-quality pen plot.

Pennebaker acknowledges that the Douglas Macintosh design system is missing some of the bells and whistles of the most sophisticated CAD tools but points out that the system costs only a fraction of the cheapest systems now available.

"This is a drawing program," he says. "It's actually electronic drafting." He contrasts this against systems where the designer enters information and then the computer routes traces automatically (but not in real time). Frequently a system like that will fall in the $100,000 range, he adds.

When the program was first introduced at Wescon it was priced at just $10, on the assumption that Douglas would make its profit from PC boards manufactured from disks that designers sent to the company. Now that Bishop Graphics has taken over the commercial marketing, the price has risen to $895. However, Martin Salvin, president of Bishop Graphics, said that his company plans on selling special Macintosh systems that include the Macintosh machine, Imagewriter, and pen plotter for performing checkplots for "under $5000." Bishop Graphics is also preparing to manufacture photoplotting and drilling systems that are compatible with QuikCircuit for PC board manufacturers. Salvin says they will cost about one-third of the price of equivalent commercial systems. In the future, plans call for a network of manufacturers around the country offering what Salvin says is the PC-board equivalent of "one-hour photo service" based around the QuikCircuit and the Macintosh design system.

One of the program's most unique

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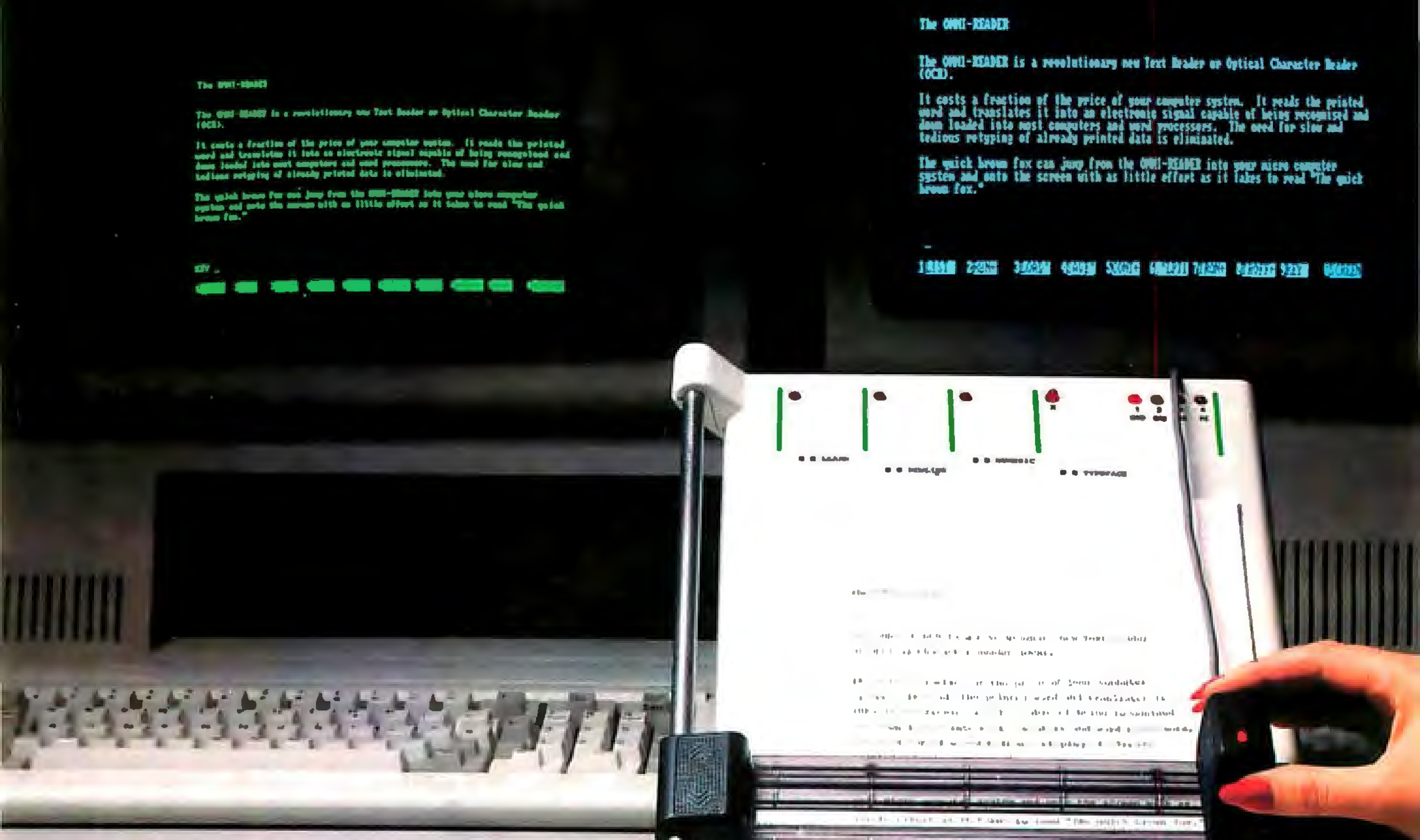

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features is the ability for the user to get an automatic price quote on the cost of a PC board from Douglas over the telephone, yet without a modem. It works like this: First the user calls up the PC board manufacturer, then the user places the mouthpiece of the telephone handset near the Macintosh speaker. When a special command is given, the program transmits information on the complexity of the board directly to the manufacturer's computer, which then estimates the cost. An employee can then give an accurate price quote to the designer in a few moments.

DESKTOP PUBLISHING WITH THE MACINTOSH

The introduction of the Apple LaserWriter laser printer has paved the way for "desktop publishing" on the Macintosh. According to Paul Brainerd, president of the Seattle-based Aldus Corporation, the combination of relatively low cost laser printers and graphics-oriented personal computers will make it possible for small companies or corporate work groups to produce production-quality multipage documents without doing mechanical pasteup or resorting to outside typesetting and printing services.

In January, Apple announced the LaserWriter, and Aldus also introduced PageMaker for the 512K-byte Macintosh. PageMaker is a full-page composition software program for the Macintosh that allows the user to blend text and graphical documents on an "electronic layout board" displayed on the Macintosh. It is intended for professional publishing of small jobs such as newsletters, data sheets, price lists, training manuals, etc. Priced at $495 and scheduled for release during the second quarter of 1985, the Aldus system will permit Macintosh users to integrate diverse documents from MacWrite, MacPaint, MacDraw, Microsoft Word, or virtually any program whose data can be stored in the Macintosh Clipboard, a special system buffer used for passing information between programs.

PageMaker is intended to serve the same market as electronic composition systems now being marketed by corporations like Interleaf and Compugraphic. PageMaker is priced significantly lower than these systems, however. A complete system consisting of the newly introduced Macintosh XL (formerly the Lisa 2/10), PageMaker software, and the LaserWriter will be priced at approximately $11,500.

Aldus is currently writing its own drivers to take advantage of the Postscript device-independent page-description language that Apple has

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placed in the half megabyte of ROM (read-only memory) in the Apple LaserWriter printer. Postscript was developed by Adobe Systems in Palo Alto, California, and has recently been adopted by a variety of hardware manufacturers and software publishers in the personal computer industry. Initially, PageMaker will work with the Imagewriter dot-matrix printer, the LaserWriter, and also with at least two commercially available typesetting machines, Allied and Mergenthaler Linotype. This will make it possible for users to proof and review pages on the LaserWriter and then get finished copy output from a commercial typesetter.

PageMaker uses the Macintosh user interface to present an image of an 8½- by 11-inch page surrounded by a layout board area for temporarily setting text and graphic elements while working on page design. The program uses the Macintosh mouse for positioning elements of the page design. It is possible, for example, to open a window on the display, select headlines, text, or graphics stored in files on disk, and then position them on the page with accuracy. Each selected item is represented by a special icon. The cursor can be represented by a small paintbrush within a half-rectangle when a MacPaint document is selected, or it is represented by a text icon when a MacWrite file is selected. PageMaker permits the designer to set custom column guides and then "flow" text from a MacWrite document directly onto the page layout area. A special positioning indicator permits proper alignment of text at the bottom and top of each column, and the text flow can be continued in new columns or pages or interrupted for the insertion of graphics or charts. "Window shades" allow the user to adjust each separate text block. A "+" sign indicates that the text continues. A "#" icon indicates the end of a document.

To aid in positioning on the screen, both the column guides and up to 10 adjustable rules have a "snap-to" feature that causes a text block or graphic that is moved close to a boundary to automatically align itself with that edge. For precise alignment PageMaker also permits the page to be displayed in five different scales. The largest scale is magnified 200 percent, while the greatest reduction permits the user to view the entire page. At most levels of magnification, text is easily visible. The user can also pop up a set of horizontal and vertical rulers that will display in inches, centimeters, or picas and points.

PageMaker will also provide limited text-editing tools to alter copy while

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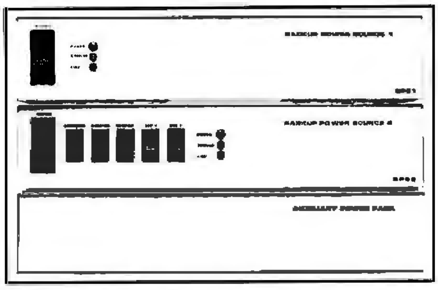

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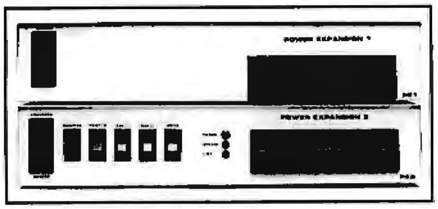

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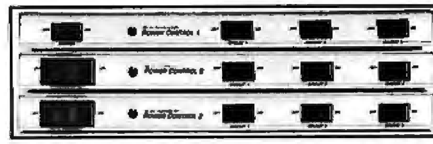

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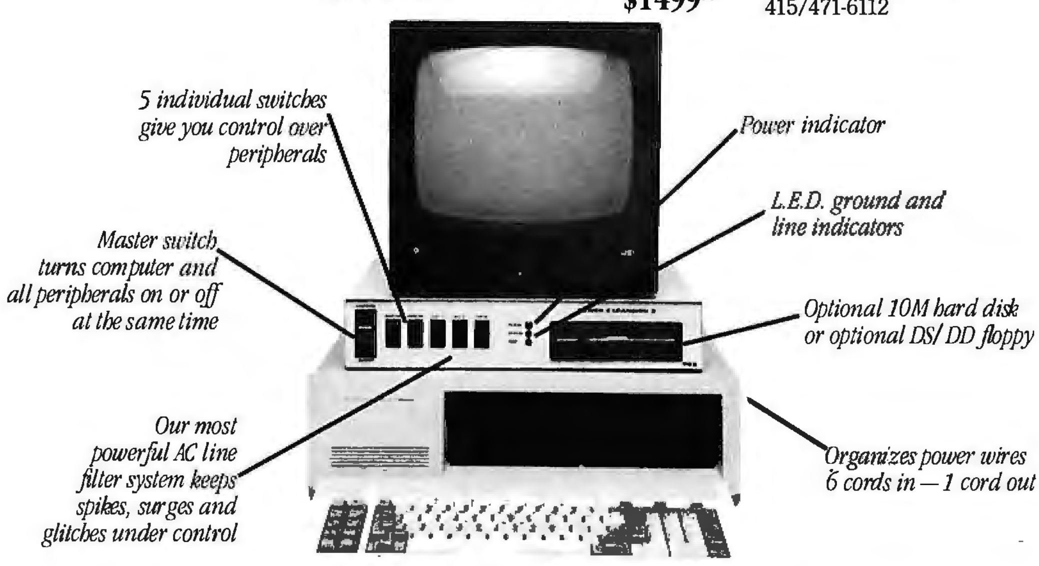

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it is being "pasted up." A small movable toolbox window offers a text-editing cursor, a cropping tool, and box-, circle- and line-drawing functions. There is also a set of line and shade menus on the menu bar across the top of the display that permit the user to define and fill areas and shade behind text and graphics.

Icons in the lower left corner of the display represent up to 16 different pages and it is possible to alter the numbering scheme for even larger documents. Two special page icons permit the user to lay out page information that will appear on all pages, similar to running headers and footers, but more extensive.

Brainerd says that he expects to see the development of commercial electronic printing centers that can directly receive PageMaker files and return either finished laser-printer or typeset copy.

Aldus says that it also has plans to develop PageMaker for the IBM PC AT with the enhanced graphics display at some time in the future.

TURTLE TALK

From a teacher in Berkeley, California, we learned that Logo has become the language of the playground. A Logo version of "Simon Says" has evolved among the children in her school: One child calls commands and the others are the "turtles." As in other children's games, the rules are fluid and are passed from child to child, in a sort of playground folklore, without interference or coaching from adults. All right everybody, REPEAT 4 [FORWARD 10, RIGHT 90]!

CONCURRENT DOS-286 CHALLENGES UNIX

In January, Digital Research (of CP/M fame) unwrapped the latest product in its Concurrent DOS line of multitasking operating systems. Concurrent DOS-286 is a multitasking, real-time, network-compatible operating system for single- or multiuser, 80286-microprocessor-based systems and is written in the C language. With that mouthful of attributes, Concurrent DOS is plainly in line to compete with the new microcomputer versions of UNIX. While ROM implementations of UNIX (see "The HP Integral Personal Computer" by Phillip Robinson, February BYTE, page 98) and new programs that allow UNIX to run PC-DOS programs (see BYTE West Coast, January, page 415) are moving that powerful minicomputer operating system down into the microcomputer world, Concurrent DOS-286 is moving microcomputers up into the world of multitasking and passwords.

Concurrent DOS-286 is not just a

(continued)

revision of the earlier Concurrent operating systems; it has an entirely new architecture. Specifically, it is built around advanced hardware features of the Intel 80286 (also known as the iAPX286) microprocessor. Those features—descriptor tables, call gates, and protection levels (see "The 80286 Microprocessor" by Paul Wells, November 1984 BYTE, page 231)—allow speedy context switching as well as protection of files and programs.

COMPATIBILITY

Concurrent DOS-286 provides a migration path for PC-DOS or CP/M-86 users who need more power; it can run both CP/M and PC-DOS applications. Gary Gysin of Digital Research explained to us that "To start. . . , our strategy is one of following what IBM does. So, if they come out with PC-DOS 2, PC-DOS 3, PC-DOS 3.1, whatever it is, our operating-system strategy is to embody whatever they're doing and at minimum to be compatible with [it]." An example of that strategy is Digital Research's new hierarchical file system: CP/M files have been left behind. The file system, all the system calls, and all of the utilities are a superset of those in PC-DOS 3.0. Because of this change, if you want to run CP/M applications, you have to transfer them to PC-DOS disks (the native media of Concurrent DOS-286). Concurrent DOS is compatible with PC-DOS 3.0; with the PC-DOS front end it will run PC-DOS 1.1, 2.0, 2.1, and 3.0 applications.

Although more will be available in the future, the two most important front ends, one for CP/M-86 users and one for PC-DOS users, will be available immediately. This lets you run applications from those operating systems on Concurrent DOS-286. However, as Gysin further explained, "Theoretically, if we wanted to add some other front end to the operating system, be it UNIX, XENIX—whatever might become an industry-standard operating-system front end—then that possibility is there," because of the modular design of Concurrent DOS-286.

Cross-compilers and cross-assemblers for the VAX are not available, but the source code we're told can easily be moved to a VAX. All Digital Research languages will be available for Concurrent DOS-286. Also, if you know CP/M, you may be interested to know that ED is gone. Digital Research had a funeral for the text editor that is now replaced by DR EDIX—a function-key-driven editor.

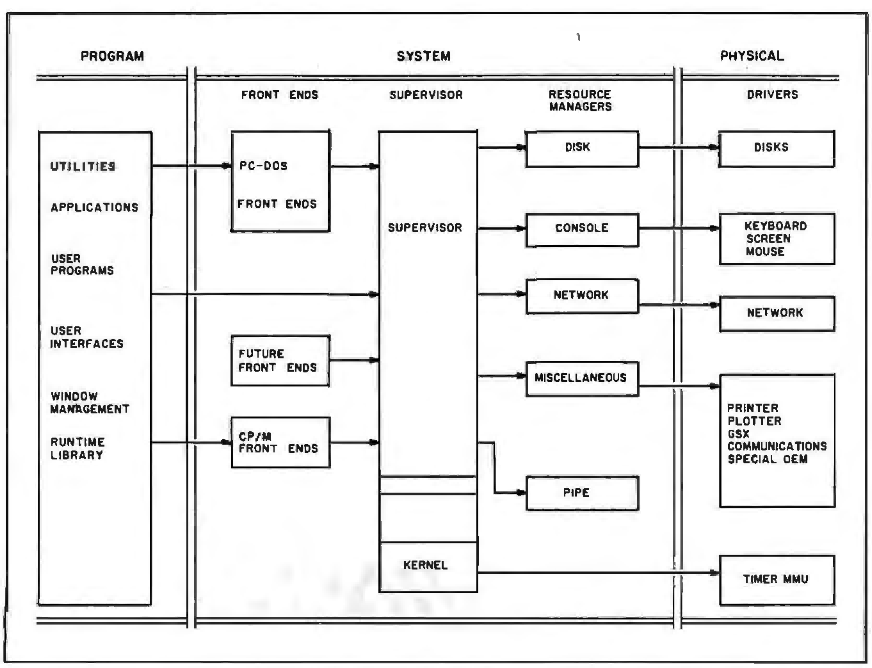

Figure 1: *A diagram of the three functional units,* program, system, *and* physical, *and two primal interfaces of Concurrent* DOS-286.

ARCHITECTURE

As shown in figure 1, Concurrent DOS-286 has three functional units and two primal interfaces. The functional units are termed *program, system,* and *physical* hardware. The system receives requests from the programs and translates them into instructions for the physical hardware. Optional front ends let the operating system run PC-DOS or CP/M applications. The *supervisor* portion of the system controls the flow of services to the underlying *resource managers,* which in turn control the actual physical peripherals.

Concurrent DOS-286 can run multiple applications using virtual consoles on each physical console, handle asynchronous events and software-interrupt handling, and deal with interprocess communications and synchronization. Storage depends on a hierarchical, shared-disk-file system with record and file locking. File ownership is controlled through user and group IDs requiring log-on with passwords.

The console is a standard VT52 interface with character and bit-mapped screen interfaces. The keyboard interface uses both standard 16- and 8-bit codes including function keys, numeric keypads, and multikeyed characters. Also, Concurrent DOS-286 supports windows, mice, graphics (raster and vector), and networks as well as file sharing, file locking, record locking within a file, locking a specified number of bytes within a file, and even overlapping locks.

Concurrent DOS-286 with floppy- and hard-disk drivers, character-mapped and bit-mapped consoles, and a printer driver requires about 160K bytes of RAM. The minimum suggested system configuration has 512K bytes of RAM. The operating system is ROMable.

The kernel is based on an event-driven dispatcher. Time slicing by a

(continued)

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timer event occurs once per tick (16 to 20 milliseconds), and scheduling of equal-priority processes is based on a round-robin scheme. Process communication and synchronization are done through named *pipes* that pass messages from one process to another or synchronize processes by acting as semaphores. The 80286 chips have a protection mechanism based on address manipulations. On-chip calculations handle the translation of virtual and physical addresses. Certain segments of memory can be marked as exception areas for particular users or programs. Whenever a program tries to address an exception area, the central processor is interrupted, a trap is generated, and processing is forced to another routine.

STOPPING THE OPERATING SYSTEM BYPASS

Trapping is a vital element in Concurrent DOS-286's ability to handle poorly behaved programs. Programs that employ operating-system routines to handle the computer hardware are termed *well behaved*. Programs that bypass operating-system routines and make direct calls to hardware—for instance, to the screen—are *poorly behaved*. While bypassing the operating system sometimes improves a program's execution speed, it hurts program portability. A program written around the operating system works on any computer running that operating system. A program tailored to a specific computer by means of direct hardware calls only runs on that computer and its nearly identical copies—poorly behaved programs are the waterloo of clone-makers. Concurrent DOS-286, however, can trap the calls made directly to the *physical* hardware and route them to *virtual* hardware.

For example, Lotus 1-2-3 is a poorly behaved program that assumes it owns the entire computer display screen. Gysin pointed out that if you tried to run both Lotus 1-2-3 and WordStar concurrently on a system that couldn't trap hardware calls, "you'd have trash all over the screen." Lotus 1-2-3 wouldn't let WordStar have a window. In Concurrent DOS-286, however, whenever a program tries to control the screen, the operating system traps the call and sends it to a window instead. The program thinks it is running on a full IBM Personal Computer, but instead it is running on a virtual console manager—a part of the Concurrent DOS-286 system. This is another advantage for computer companies that want to sell IBM-compatible personal computers. As Gysin tells competitors, "Go ahead and build whatever kind of screen you want, go ahead and build whatever kind of super-duper machine you can, we can still guarantee you we'll run PC-DOS applications, given that you've got a 286 chip."

The 80286 provides you with both compatibility and practical concurrency. All the fancy trapping could be done entirely by software, but it would take much longer than the hardware trapping. Trapping and rerouting signals could slow programs down to the point that they don't work properly. Because all of the trapping chores are handled within a single chip (the 80286), Concurrent DOS-286 doesn't have that problem. According to Gysin, Digital Research's quest to have applications run as fast under Concurrent DOS-286 as they do under PC-DOS has been successful. He claims, "We've gotten there, there's no difference."

The 80286 provides both compatibility and concurrency.

Context switching—changing the active program by suspending one pro-

(continued)

gram, saving the registers, restoring the registers, and then restarting another program—is now done in software. Digital Research estimates that each software context switch takes between 200 and 400 microseconds. Digital Research plans to take advantage of the 80286's on-chip context-switching hardware that can handle the switch in only 20 microseconds.

DYNAMIC DRIVERS

Another big change in Concurrent DOS-286 is that the device drivers are dynamic. In previous incarnations of CP/M and Concurrent DOS, all the drivers were in a single section of code called BIOS (basic input/output system) or XIOS (extended input/output system). You had to load the drivers into the operating system before starting up. Dynamic loading means that you can add or modify device drivers while the operating system is running.

USER INTERFACE

Digital Research is also presenting a new user interface for Concurrent DOS-286 and Concurrent PC-DOS. It is essentially a menu system and a file manager that allows you to control all system utilities and all running applications with the function keys. "What we're trying to do is take away the A> prompt," says Gysin. But if you prefer the standard CP/M-style prompts, just press the Escape key to get back onto familiar ground.

TOPVIEW, GEM, AND GSX

What Digital Research calls "desktop primitives," which support such application environments as Microsoft Windows, Visi On, TopView, or "unannounced products from Digital Research" (Gysin's words), are built into Concurrent DOS-286. Gysin adds, "Whatever becomes standard, that is something that we'll map to our operating system. If some other bit-map graphics type of interface is the standard, then we'll also support that one." Digital Research's new GEM (Graphics Environment Manager) is a Macintosh-like interface that fits that bill.

Digital Research's GXS (Graphics System Extension) software is also supplied with Concurrent DOS-286. This graphics operating system lets you write to a standard set of graphics calls so you don't need to know at programming time which specific peripherals you will have.

INTERNATIONAL FLAVORS

Concurrent DOS-286 has three features that should delight software engineers outside the United States: All the system messages are kept in a separate pool, the user tables have a *country* code, and the keyboard interface supports 16-bit character I/O (which is required for kanji, for example). Those design tidbits are understandable when you realize that 40 percent of Digital Research's business is done overseas.

SUMMARY

What's new with Concurrent DOS-286? The architecture has changed. Previous versions of Concurrent DOS provided support for PC-DOS 1.1 and CP/M-86 applications. Concurrent DOS-286 provides support for PC-DOS 1.1, 2.0, and 3.0 applications as well as memory protection, log-on and log-off, dynamic local device drivers, a hierarchical file system, completely modular design, pipes, I/O redirection, and an address-exception mechanism. In essence, Concurrent DOS-286 is intended to release you from needing IBM hardware or a clone to run IBM Personal Computer programs such as Lotus 1-2-3. Now, any system that can run Concurrent DOS-286 can run IBM Personal Computer programs.

How well does Concurrent DOS-286 work? We don't know. The descriptions in this article are based on discussion with Digital Research and Intel technical experts, not on a review of the operating system itself. When we do get into testing Concurrent DOS-286, our first consideration will probably be its use of memory. Although Concurrent DOS-286 is supposed to run as many programs concurrently as the hardware can handle, BYTE staff members have had problems with the voracious memory appetite of previous versions of Concurrent DOS. ■

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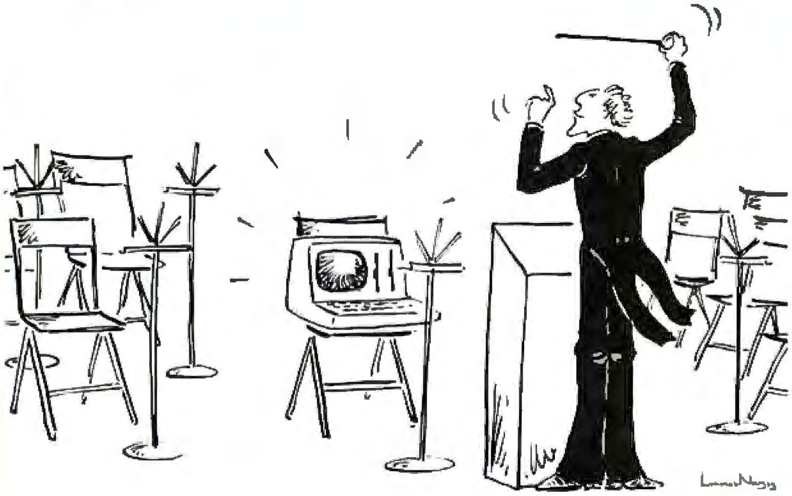

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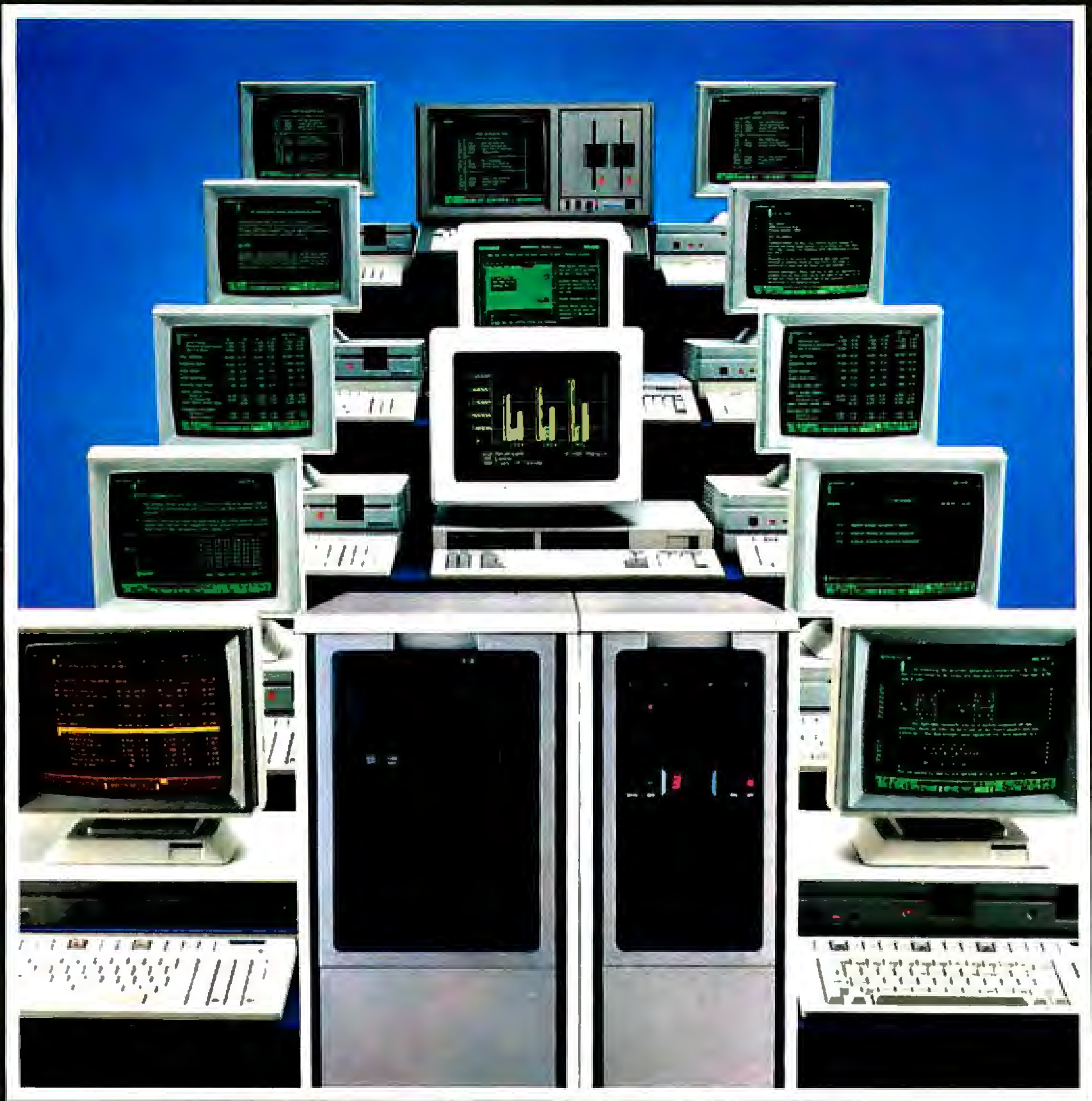

Parallel Processing

A look at the ALICE hardware and Hope language

BY DICK POUNTAIN

In the August 1984 BYTE U.K. (page 361), I mentioned a team at London's Imperial College that was working on a parallel-processing computer that would run fifth-generation functional languages. Since this month's theme is multiprocessing, this is a good time to make proper acquaintance with that machine—ALICE.

The name ALICE is an acronym that stands for Applicative Language Idealized Computing Engine. The machine uses a number of processors working in parallel to execute functional and logic languages like Hope, LISP, and Prolog efficiently. Such languages, which are of great importance to current computer science research, tend to be inefficient when run on conventional sequential computers, a fact that has prevented their widespread use and has already led to the development of custom hardware such as the LISP Machine (which uses a microcoded instruction set optimized for LISP).

ALICE is a modular design, with possible configurations ranging from a single-user workstation up to a multiuser mainframe. The first machine will be an experimental vehicle using 64 processors to test the principles involved. The performance goal is to have a single-user ALICE workstation run applicative languages at speeds comparable to that of Pascal on a VAX-11/750, and with a very favorable cost/performance ratio.

Performance may be increased simply by adding more processor modules. The processor elements will be INMOS Transputers, two of which together with 256K bytes of RAM (random-access read/write memory) make a unit, and two units are installed on a single-board module. The intention is that a future design phase will further integrate these processor/memory/network modules onto single VLSI (very large scale integration) chips, which should allow performance to be increased substantially. In 1983, INMOS published encouraging performance projections of a two-dimensional array of Transputers. The projected price/performance ratio of the initial design is already claimed to be 30 times better than current mainframes and superminicomputers.

The ALICE team is headed by Dr. John Darlington and is funded by the U.K. Science and Engineering Research Council. The prototype machine should be nearing completion at about the time this article is published.

APPLICATIVE PROGRAMMING

I can't explain how ALICE works without first discussing what applicative languages are and how *they* work. In the December 1984 BYTE U.K. (page 355), I touched on the importance of declarative languages using the example of Prolog. In a nutshell, such languages try to replace the traditional programmer's activity of telling the computer what to do with the more productive activity of describing one's problem in a formal way that also happens to be an executable computer program. Prolog is representative of one family of declarative languages (*relational* or *logic* languages) in which predicate logic is the formalism used.

There is, however, another family called applicative or functional languages, of which LISP is a well-known, though not pure, example. In such languages, the only activity permitted is the definition, *application*, and combination of *functions* (hence the alternate names).

In particular, a strict applicative language does not allow the use of variables or assignment to variables, and the only control structure that is permitted is recursion. Many programmers' first thought will be that it's not possible to write programs without using variables; however, this is not so. It means that all data must be passed as arguments to functions or returned as results from functions, without being stored permanently; in other words, data is produced and consumed "on the fly." To com-

(continued)

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pute the hypotenuse of a triangle from sides X and Y we would say

```
PRINT( SQRT( SUM( SQUARE(X),
   SQUARE(Y) ) ) ) ;
```

rather than

```
Z := SQRT( X^2 + Y^2) ;
PRINT Z ;
```

Those of you who know LISP will recognize that it tends in this direction, but most modern dialects allow assignment (using SET and SETQ) and iterative loops.

It's possible to get some of the flavor of functional programming by getting your Pascal compiler out and trying to write programs using only function (*not* procedure) declarations and using recursion instead of while . . . do, repeat . . . until, etc. You won't find it particularly useful though, for Pascal restricts the types of objects that can be passed to or returned by a function.

Why bother with functional programming then, since it seems so restrictive? It turns out that purely applicative programs have some interesting properties. Because they don't use variables or assignment, they are free of side effects (the alteration of a program's environment by parts of the program). In a sense, applicative programs don't *do* anything, they merely return values. This makes it possible to *reason* about the correctness of such programs, and in particular, it opens up the possibility that we could use the computer to check programs for correctness, to modify them, and even to write them.

Since debugging and program maintenance now account for most of the time and money spent worldwide on computing, such developments would be of the greatest significance.

Of equal importance is the fact that the absence of side effects renders each part of a functional program independent of every other and of the order in which they are evaluated, which means that these parts can be evaluated in parallel. Conventional procedural languages (like BASIC and Pascal) don't lend themselves to parallel processing; because routines typically depend on one another, most of the code ends up being devoted to making routines wait for the others or stopping them from fighting each other for resources.

Parallel processing is now widely held to be the way forward in computer performance; we can't just keep making faster sequential von Neumann machines forever, because we'll soon be running up against physical obstacles like the speed of light and the melting point of the conductors. Even from what puny infor-

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Hope is a strongly typed, pure, higher-order applicative language. It doesn't allow assignment and is side-effect-free.

mation we have at present about the human brain, it seems clear that it couldn't achieve its staggering performance without its millions of neurons working in parallel.

HOPE

Let's now take a look at a particular functional language called Hope, which will be run on ALICE. Hope is a strongly typed, pure, higher-order applicative language. All this means is that it has data "types" as in Pascal. The data types must be declared and are checked by the compiler; the language doesn't allow assignment and is side-effect-free; it allows functions to be passed as arguments to other functions or to be returned as results.

Hope was designed at Edinburgh University by Burstall, McQueen, and Sannella. Burstall also developed the language POP-2 (see the October 1984 BYTE U.K., page 381). McQueen now works at Bell Laboratories in the U.S. I should stress that Hope is a purely experimental language right now, and it lacks some of the features required for production programming.

Unlike LISP and Prolog, Hope source code looks quite familiar to programmers with a knowledge of, for instance, Pascal. Some of this familiarity is illusory, however, as the symbols don't mean what you'd expect from experience of a procedural language. As an example, take the factorial program

```
dec fact : num -> num ;
--- fact( 0)          <= 1 ;
--- fact( succ( n))   <=
        ( succ( n) x fact( n)) ;
```

The first line declares a function called fact, which takes an argument of type num and returns a result of type num. The next two lines are equations that define the function's value for all possible cases (type num represents positive integers so the negative case doesn't arise). In the case that its argument is 0, then it returns the value 1. In any other case the factorial of one-more-than-n is

(continued)

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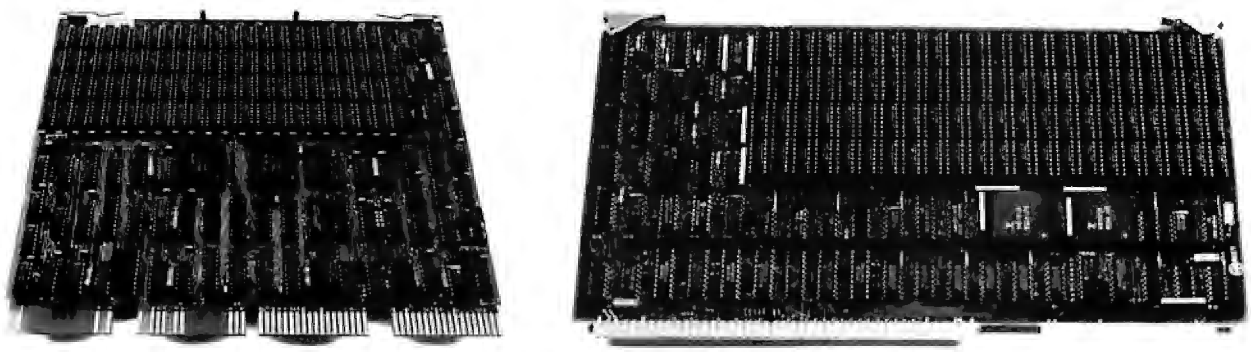

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Strong typing in Hope is called polymorphic typing and is of a different and more flexible sort than that in Pascal and Modula-2.

one-more-than-n times the factorial of n.

The function succ (for "successor"), which returns a number one more than its argument, is called a "constructor" function; in particular it is a constructor function for the positive integers. Every data type in Hope is built by its own constructor function(s). When we write a constant like 3, we are, in fact, evaluating a function called 3 whose value is, not surprisingly, 3, but that 3 is shorthand for the expression succ(succ(succ(0))).

The identifier n doesn't refer to a variable in the traditional sense but is a formal parameter that refers to the argument passed to the function at run time and has meaning only for the duration of the function application.

Two other things are important to note. The < = symbol does *not* refer to anything being assigned to anything but means "is defined as," "could be replaced by," or "could be rewritten as." Such program lines, introduced by ---, are called "recursion equations." The second point is that the order is quite unimportant; I could as easily write

```
dec fact : num - > num ;
--- fact( succ( n))    < =
        (succ( n) x fact( n)) ;
--- fact( 0)           < =  1 ;
```

with the same effect.

Strong typing in Hope is of a different, more flexible sort than that in Pascal and Modula-2. It's called "polymorphic" typing, which means that you can write functions that will work on any type, while still controlling the relation between argument and result type. This is accomplished by using type variables in place of actual types in the declaration. For example,

```
typevar any;
dec member : any X list (any)
     - > truval ;
--- member ( x,nil)< =
                         false ;
--- member ( x, y::z) < =
   true if x = y else member ( x, z);
```

(continued)

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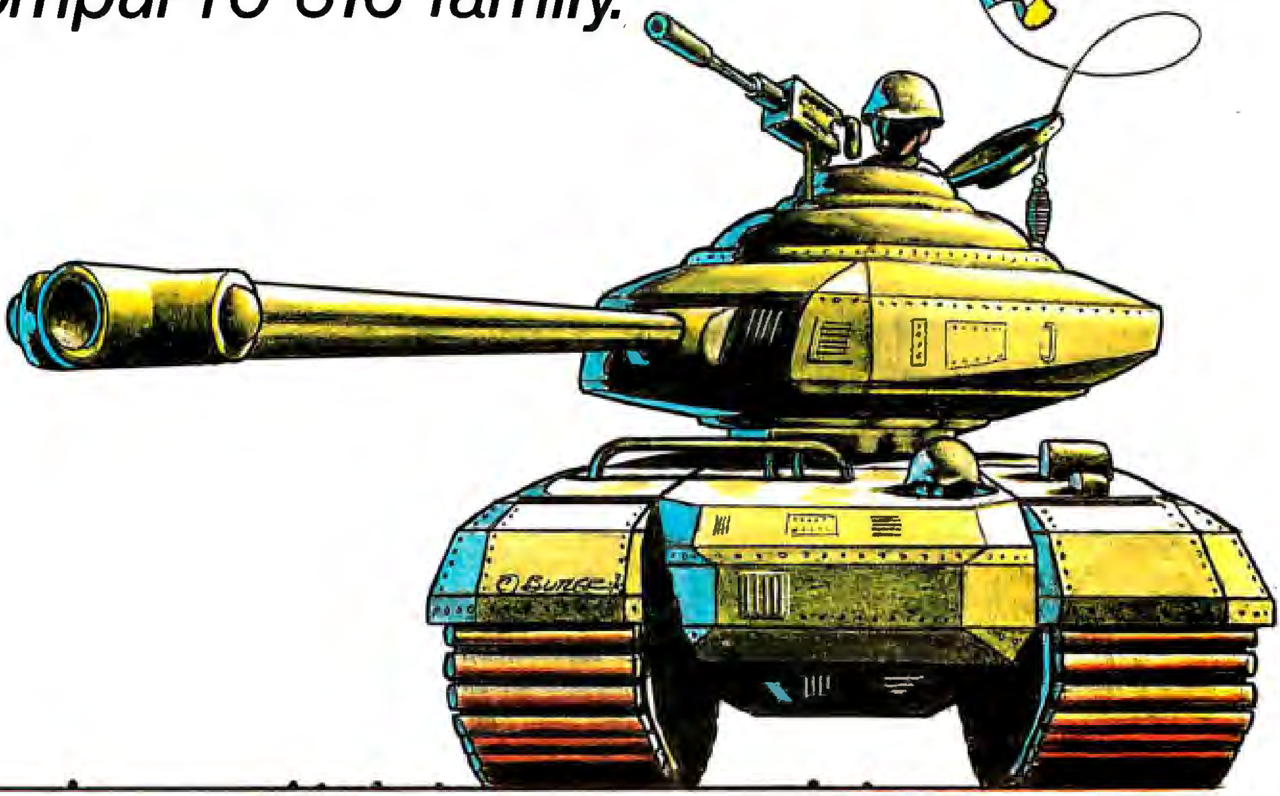

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3506 Breakwater Court, Hayward, CA 94545 · Call 800/VIASYN-1 · In CA, 415/786-0909 yields a function that tests whether its first argument x is a member of the list that is its second argument. The type declaration says that member must receive as arguments an object of type any, and a list of the same type of objects, and it returns a result of type truval (the Hope equivalent of Boolean). For instance,

member(2,[1,2,3]);
true : truval

is the same as saying

member ('b',"aardvark");
false : truval

and any will be replaced at run time by type num or type char, respectively (notice that strings are lists of char). The constructor function :: is for lists (y::z means "the list whose head is y and tail is z") and is itself polymorphic, as is nil, the empty list constructor. You use :: like an infix operator rather than a function ::(y,z)—this privilege can be extended to any user-defined function in Hope.

There is much more to Hope than this brief glimpse. Unlike Pascal, it enables you to pass structured data types to functions and return them as results. Data types of any complexity can be defined by the user, and they can be made polymorphic. So you could define a type tree(alpha)—a binary tree of objects of arbitrary type—and then write functions that operate on such trees regardless of the type of objects they contain. It also supports proper mathematical sets in addition to lists.

There is not room here to go any further, but I have discussed enough here to give you some understanding of how ALICE works.

REDUCTION

You'll notice that in all the preceding examples the left-hand side of the equation is merely an application of the function being defined to some pattern describing a possible form of its arguments; for example, member (x, y::z) says "the first argument can be anything at all, but the second must be a list with at least one element." The equation's right-hand side

identifier	function	arg list	status	signal list	ref count

Figure 1: *Packet structure.*

describes an expression that can be substituted for a call of this sort (i.e., one whose actual arguments match the pattern).

The execution of a program proceeds by progressively rewriting expressions, using the appropriate recursion equation as a *rewrite rule*. Let's see how it works on member ('a',"bat").

1. member('a',"bat") doesn't match member(x,nil) because "bat" isn't nil. Try another.
2. member('a',"bat") does match member(x,y::z) if x is 'a', y is 'b,' and z is "at". The equation says we can therefore rewrite it as true if 'a' = 'b' (which it doesn't) or else as member('a',"at"). Do the latter.

In this process we have successfully *reduced* member('a',"bat") to the simpler member('a',"at"). If you perform a second reduction of *this* expression, you'll end up with true, which can't be reduced any further because it doesn't involve the application of a *reducible function* that has rewrite rules. Constructor functions are the equivalent of constants in Hope and are not reducible—true is a constructor for type truval.

This process of reduction of expressions permits parallel evaluation because, in a side-effect-free language, subexpressions on the right-hand side of an equation can be evaluated (i.e., reduced) independently of one another.

THE ALICE IMPLEMENTATION

In ALICE, expressions are stored as *packets*, which are fixed-size blocks of data each divided into a number of fields. The overall structure of a packet is shown in figure 1.

A pool of these packets is maintained in RAM, and the processing agents sit around this pool fishing for packets. A processor pulls a packet out of the pool and checks what function is referred to in its function field. If it is a reducible function, the processor will try to reduce it and then throw it back into the pool. As long as there is work for them to do, all the processors can operate at once.

Of course it isn't quite that simple. For one thing, reduction of a packet often creates several packets (the joke among the ALICE team is that it's called reduction because it makes things bigger). In fact, this is necessary to exploit parallel processing.

Let's see how fact(3) gets evaluated in terms of packets. (This is not exactly as ALICE would do it; I've simplified the schema in some details to increase clarity.) The reductions involved are

```
# of packets    fact(3)
                  ⇩
3 :-          3   *   fact(2)
                        ⇩
5 :-  3  *'         2   *   fact(1)
                              ⇩
7 :-  3  *'  2  *"        1   *   fact(0)
                                    ⇩
7 :-  3  *'  2  *"   1  *"'         1

answer   6
```

The packet representing fact(3) gets rewritten to contain * instead of fact, and it spawns two new packets whose identifiers are put on its argument list. These contain 3 and fact(2) and are created from two empty packets grabbed from the pool. There are now three packets. The one for fact(2) then is rewritten and spawns two more offspring, making five, and so on until seven packets exist.

The packets containing the integers 3, 2, and 1 are not reducible and the * packets can't be reduced further while one of their arguments is still

(continued)

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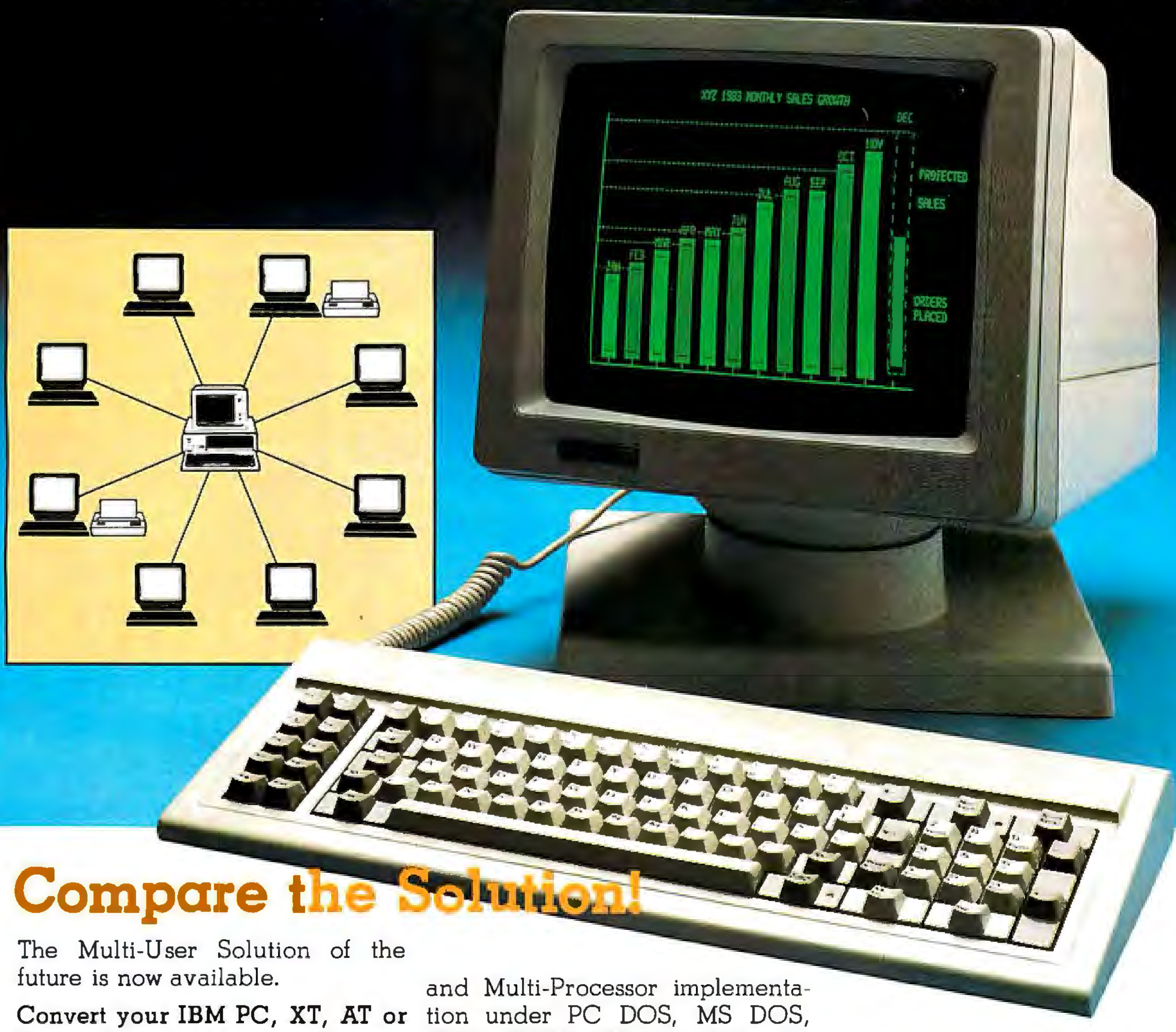

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Inquiry 226

ALICE's network allows packet-pool segments and any pair of processing agents to communicate and operates at 200 megabits per second.

not an integer. In this situation, the thwarted parent packet puts its name on the signal list of the offending offspring packet, which means "let me know as soon as you have a value," and goes to sleep. When the final fact(0) packet is rewritten to 1, these signals are sent out and all the * packets know their arguments are ready, at which point they flag themselves as being reducible and are snapped up by the next free processor.

This program doesn't exploit parallelism as well as it might, because at each generation there is only one immediately rewritable packet created, thus providing work for only one processor during the middle part of the evaluation.

The function factlist, which returns a list of the factorials of a list of numbers, will perform better.

```
dec factlist: list(num) -> 
  list(num);
--- factlist(nil)     <= nil;
--- factlist(x::y)    <=
  fact(x)::factlist(y);
```

When this program is run, two rewritable packets are created (one for fact and one for factlist) at each generation

```
              factlist([2,3,4])
                     ⇩
fact(2)              ::           factlist([3,4])
  ⇩                                   ⇩
 etc.                                etc.
```

and these can be reduced in parallel, in turn creating work for more processors. You'll see that the full benefit of parallelism is only obtained by writing programs with the maximum possible number of recursive subexpressions.

There are other more complex considerations, which cannot be fully dealt with here, relating to this evaluation mechanism. Sometimes it's necessary that subexpressions on the right-hand side of an equation be evaluated sequentially. For instance, in the expression 0 if x = 0 else 1/x, a divide-by-zero error would occur if both parts were always evaluated, so the test must be done first. Similarly, during I/O (input/output), it's necessary to print things in sequence, not all at the same time.

ALICE provides an alternative mode of evaluation (which is flagged by the programmer in the source code) that suspends execution of a subexpression. This also makes "lazy evaluation" possible; data structures with an infinite number of elements can be defined, but only those elements that are needed are ever generated.

HARDWARE

ALICE is conceptually composed of just a packet pool and a gang of processors, but the real hardware is organized into four types of functional units; a number of processing agents and packet-pool segments, an interconnection network, and a distribution system.

Processing agents and packet-pool segments are implemented by the same hardware unit consisting of two Transputers (see "The Transputer" by Paul Walker on page 219) and 256K bytes of RAM; the memory segments are therefore "intelligent." Two such units are mounted on a single board. Which role a unit will play is determined by Occam programs loaded into its Transputers at initialization.

The packet pool is thus not a contiguous memory block but is distributed throughout the system in discrete 256K-byte segments. This is preferable to the alternative that would require the RAM to be multiported as many times as there are processors. Instead a network is used to allow the segments and processors to communicate.

Designing this network was one of the big challenges of the project, as its performance crucially affects system throughput. The final design is a delta network whose building block is a four-by-four crossbar switch, implemented as a custom chip in ECL (emitter-coupled logic). This network allows any pair of processing agents and packet-pool segments to communicate and operates at 200 megabits per second.

The distribution system is a multichannel system bus upon which the identifiers of both processible and empty packets are circulated (as separate streams). Any processing agent can grab the next packet that comes along and start to process it, communicating over the network to find the packets containing its arguments and the rewrite rules. Once reduced, the packet is put back onto the bus (as are any newly created packets), to be picked up and processed further elsewhere.

Garbage collection is performed by reference counting; a field (ref count) in each packet records the number of other packets that refer to it. When this count falls to zero, the packet can be put on the "empty" stream. Garbage collection is thus happening all the time, concurrently with processing, and all through the system.

ALICE doesn't actually execute Hope directly but uses an "assembly language" called CTL (compiler target language).

Compilers have been written to compile Hope, Prolog, Parlog (parallel Prolog), and LISP into ALICE CTL. The ALICE hardware has a special mode that permits direct assignment to packets and, together with suspended evaluation for sequencing, this enables conventional procedural languages like Pascal to be supported if required. In this case, the multiple processors could be used (given a suitable operating system) to serve multiple users, as they would not otherwise provide any performance benefit. ■

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The Sale of Computer Products

A self-help guide for buyers and sellers

BY ROBERT GREENE STERNE AND PERRY J. SAIDMAN

In this column we will discuss the legal aspects of buying and selling computer products, an important concern because each stage of the distribution network is involved. We'll deal with computer products—microcomputers of all types, off-the-shelf software packages, printers, floppy disks, computer furniture, and the like—but not services—customization of software, service calls, and so on—since services are treated somewhat differently. We hope you find this a concise self-help guide to be retained and consulted when buying or selling computer products.

We'll examine both pre-sale activities and the sale itself. We'll attempt to present as balanced a view as possible, one that is neither pro-buyer nor pro-seller. However, the subject is, by nature, very buyer-oriented, since sellers in many respects have forced the marketplace to be seller-biased. For clarity we will cast you, the reader, in the role of buyer.

The buyer being discussed is the individual person or business buying for personal or business use. The seller can be in the business of selling computer products—a local store, a mail-order house, a hardware manufacturer, or software publisher—or an individual or business selling computer products on a one-shot basis. This second group is growing exponentially as older products are being supplanted.

THE LAW OF COMPUTER SALES

The legal aspects of computer sales involve a hybrid of federal and state laws. One part is in the form of statutory rules as interpreted by actual court cases. And another part is *judge-made* laws that have evolved over the centuries and trace their ancestry back to England. When you apply this patchwork quilt of legal rules to a given sales situation, you must examine the facts carefully, since it is not uncommon for a single fact to radically alter the end result.

The primary source of federal law is the Federal Trade Commission's (FTC) Rules and Regulations relating to mail-order sales and to warranties. At the state level, it is Article 2 of the Uniform Commercial Code (UCC) that makes up the bulk of sales law. In certain states, additional laws govern deceptive trade practices. In each state, judge-made laws control those areas not addressed by federal law, the UCC, or the deceptive trade practice laws (if present).

THE BUYER'S RESPONSIBILITIES

As a buyer, your first rule is to check out the product you intend to buy and the various sellers from whom you could buy it. Buyer advocates stress that much pain and aggravation can be avoided if you observe this simple rule.

Take the time to read reputable and in-depth reviews of the product, preferably from a nonpartisan journal. Some buyer advocates recommend that you avoid products that have just been released unless you have the wherewithal to deal with the product shakedown risks.

Find a way to use the product—examine the manual, try to run some functions, and determine if it will operate in its intended environment. You should try to talk to a person currently using the product; reputable sellers will put you in touch with such users.

Check out possible sellers. Price and product availability usually are not the only factors to be considered. Local stores are attractive, since they offer the advantages of product inspection and evaluation, support, and service as well as off-the-shelf delivery. But you should determine whether the product requires support or service. Obviously, a printer does and a floppy disk does not. If support and/or service are important, then you should evaluate the local store's capability to provide them. How well established is the store? What kind of staff does it have and how experienced are they? What reputation do the store and staff have? Do they stand behind the products they sell? Local stores constantly complain

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to us that they do all the pre-sale work for mail-order houses, hardware manufacturer, and software publishers who get the sale due to their lower pre-sale overhead. If you intend to use the computer products in a business context where downtime is costly, you should be sensitive to this. You should try to determine if the local store will be loyal to you if you are loyal to it. As a buyer, you should remember the time-tested adage of being penny-wise and pound-foolish.

Mail-order houses are the real wild cards in the seller's game. As a buyer, you should take a minute to look at magazine advertising. Any computer product imaginable can be purchased by mail order. And look at those low, low prices. They are often from 10 to 40 percent lower than those available from other sellers. But the support and service are not available, according to many buyer advocates and some seller attorneys. And even more importantly, you should be aware that there is a significantly higher risk that you may get a late delivery or *no delivery at all.*

Mail-order houses argue that they are the force that keeps the marketplace truly competitive, resulting in the amazing gains in the performance/price curve that the microcomputer industry has enjoyed in its 10-year life span. Without them, they argue, the local stores would conspire with manufacturers and publishers and artificially raise prices in the name of support and service. Apple Computer has been on the receiving end of such allegations in the lawsuits spawned by Apple's termination of dealers engaged in so-called *transshipping*—sales through the mail or by phone by sellers who provide little or no pre- or post-sale support or service.

Hardware manufacturers and software publishers make up the third group of regular sellers. They will be glad to talk to you about selling you their products. You should call them up, ask to talk to their sales departments, and get price and delivery quotes. Dealing with the manufacturers offers several advantages. Often they are the ultimate sources of support and service. In other words, the local stores are really fronting for them. You also stand a greater chance of getting the latest version of a product directly from the manufacturer. This is particularly true with small manufacturers and publishers who may not have the dealer network that warrants using a local store. Larger manufacturers may operate company stores in your local area.

Suppose you are about to buy or sell a computer product and the person you are negotiating with is not yet 18 years old. As any experienced seller knows, this is one of the danger points in the law of computer sales.

(continued)

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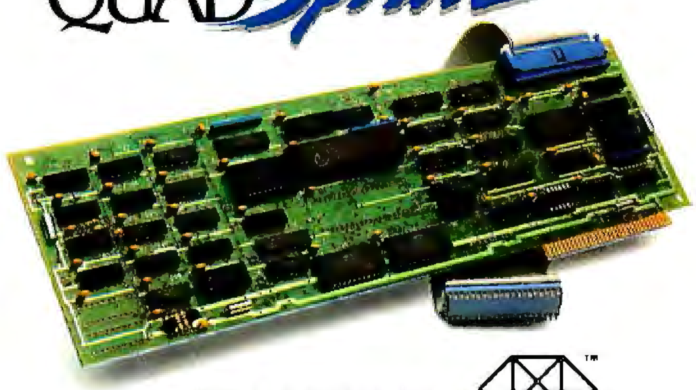

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And with the rapidly expanding used-product market, there is a significant possibility that you may find yourself buying a product from a minor. The rule here is that you should *always* make sure that an adult (a person 18 years or older) signs the written sales contract for the minor. The reason is that a minor is not allowed by law to contract. In effect, a minor could buy or sell a computer product and then void the sale and get his money or product back even though he has made full use of the money or product for a considerable period of time. This rule traces its lineage back to the days when the law sought to protect minors from unscrupulous adults and from themselves. Minors today seldom repudiate their deals, but when big-ticket product purchases are involved, it's prudent to be on the safe side and make sure an adult signs the sales agreement.

THE SALES AGREEMENT

Whether you are the buyer or the seller, you should always use a written sales agreement—a must if the transaction is for more than $500. And you should always get the other party to sign it or initial it. Sometimes, one party to a sale of over $500 will try to get the other party to sign the agreement but will try not to sign it himself. A section of the UCC says that a contract for more than $500 must be in writing and signed by the party that is on the *receiving* end of an enforcement action. Thus, if one party does not sign, that party can enforce the contract against the other party but can prevent it from being enforced against himself.

A sales agreement can be as simple as an itemized note or sales slip or as elaborate as the multisheet printed form with carbon paper that has become commonplace. If you are a buyer, it is imperative to get everything in writing to be able to prove those items that have been agreed upon. On the other hand, if you are the seller, only put in writing that which you intend to provide and nothing more. The reason for this is that the UCC explicitly states that all discussions that lead up to a written contract are deemed to be contained in the written contract, unless otherwise stated. Most printed agreements, however, contain an integration or entire-agreement clause. This clause is part of the boldface, capitalized verbiage usually found on the front of a form contract near the price or near where the buyer's signature goes. This clause states in effect that the paper being signed is the entire agreement, understanding, and representation between the buyer and seller and *supersedes all* previous discussions, promises, and understandings. In other words, if it's not in the written

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The seller should let you read and understand the boilerplate before you sign the contract.

contract, it's not part of the deal.

If you are the buyer, you cannot always trust the salesperson to adequately document the deal, so take these simple precautions. It is perfectly reasonable to require that the salesperson let you read and understand the boilerplate of the contract and to have all of the particulars of your deal entered on the contract *before* you sign it, pay any money, or take possession of the computer products. If a printed form contract is used, make sure all deletions and additions are initialed and dated by the seller in the margin beside the change on all of the copies. Also make sure that the contract is signed by an agent of the seller who has the authority to sign contracts.

Prudent sellers should pay great attention to making sure they have legally strong, well-drafted, and plain-English standard contracts and that their sales personnel are diligent in completing them and having them executed in each computer-product sale. This cannot be overemphasized. In the event of a dispute with a disgruntled buyer, a seller, particularly if selling is the seller's regular business, will be at a great disadvantage if he doesn't have such a written agreement. Furthermore, if a buyer tries to cheat the seller out of money owed, the buyer must have a written contract. And if a seller should be unfortunate and become involved in a defective-computer lawsuit where the buyer may quite legitimately claim consequential and punitive damages in the millions of dollars, a written contract can be the seller's main shield against such liability.

Buyers often tell us that sellers will not change their standard contracts. This is a negotiation as much as a legal issue. If a seller will not document the terms of your deal—the computer products involved, price, delivery date, the name and address of the buyer and seller, any special terms, and the like—then you should probably find a different seller. However, if boilerplate language is the problem, then the issue is much more difficult. Many sellers just won't deviate from their standard agreement, particularly on single-system deals, because they are afraid that if they give in to one, they will have to give in to all future buyers. One way to get around this impasse may be to create a side letter that specifically incorporates the standard agreement but states that the modifications con-

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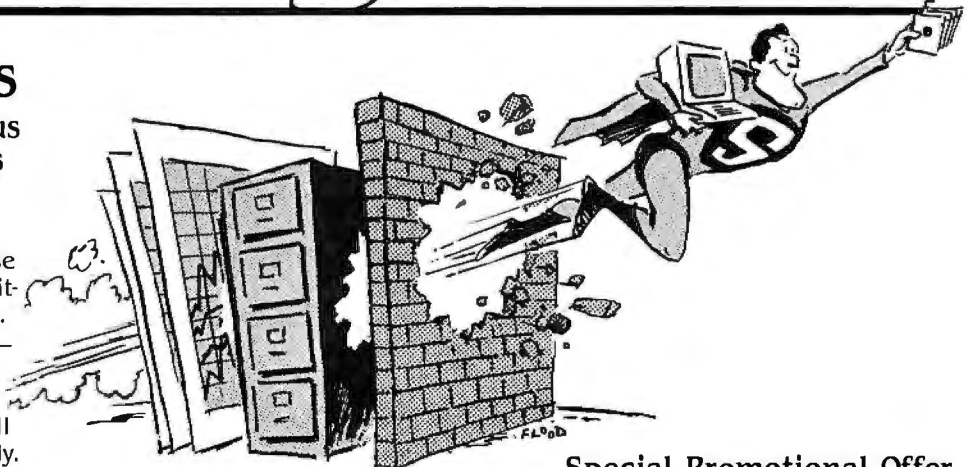

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tained in the letter supersede comparable terms in the standard agreement. The letter should be dated the same day as the standard agreement and should also be signed by the seller.

ADVERTISING

Another problem that causes anguish for both buyer and seller involves advertisements. The seller is not obligated to provide an unlimited number of buyers with a particular product at an advertised price. The law recognizes that product supplies are not limitless. To be on the safe side, sellers should make sure that their advertisements specify the number of products that will be available at a sale price or state minimally that "quantities are limited."

RAIN CHECKS

What happens when the seller issues a rain check to the buyer? Must he sell the product to the buyer at a later date? Seller lawyers argue that there is no obligation under state law, since the rain check is considered merely an offer, revocable by the seller prior to the actual purchase. Buyer advocates disagree but have little legal precedent on which to rely. To be on the safe side, buyer advocates suggest that you either purchase the products in full and await delivery or put down a partial payment and get a written rain check. The partial payment turns that written rain check into a binding contract.

MAIL ORDER

Many buyers are scared of dealing with mail-order houses. They are afraid of being burned. Buyer advocates suggest the following strategy to minimize this. First, always deal with a seller whose business is located out of state to avoid paying sales tax. Second, call the seller, negotiate the terms mentioned below, and follow up with a letter documenting the oral agreement. One important term is the exact description of the product being purchased (model or version number, etc.). Another is the price, including handling and shipping. Make sure the product is shipped "FOB your address" (so risk of loss only passes to you upon delivery). If the seller insists on "FOB shipping point," make sure he gets sufficient insurance. Specify the delivery date required and include the magic words "time is of the essence." Also state that the seller is not to deviate from the terms in the letter without your prior written permission. Third, always keep a copy of your letter along with your notes and all correspondence received from the seller.

The FTC has rules requiring a mail-order seller, after receiving a complete sales order, to deliver the product either within the time specified in

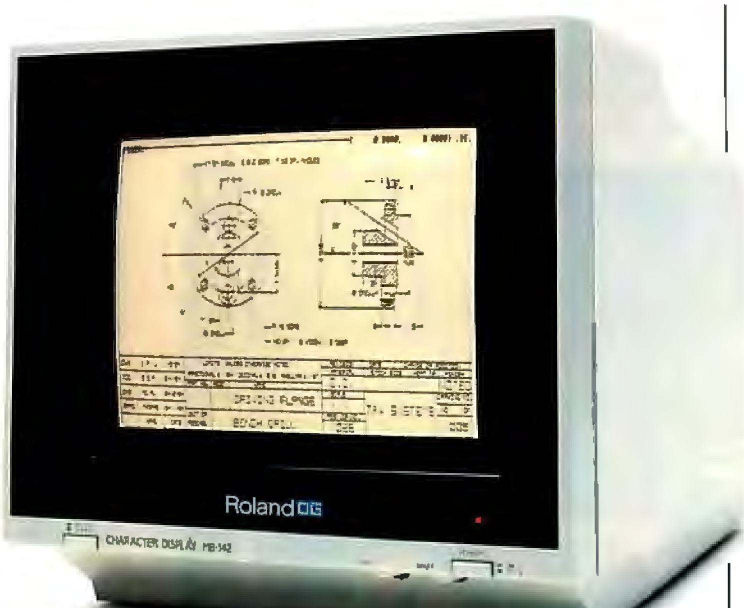
(continued)

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.

Because of the MB-142's advanced electronic circuitry, you even have the ability to mix graphics and text on the same display when using graphics and text boards from leading manufacturers such as Persyst, STB, Paradise, Hercules, AST and many others. What makes it all possible? The same sophisticated technology used in color monitors.



Actual screen image

MODEL
MB-142

Push a button for instant reverse screen

The MB-142 supports all the winning cards

For business, black and white makes more sense than green and black

The big difference is that the MB-142 monitor does the job for significantly less money. The MB-142 is designed to interface economically, too. Imagine seeing your favorite business graphics or CAD/CAM packages, such as Lotus 1-2-3, Energraphics, Chart-Master, AutoCAD, CADDraft and VersaCAD, in ultra-high resolution black and white. Also, take full advantage of your program's windowing capability using the large 14-inch screen.

Take a good look at the differences that set the MB-142 apart from the rest. No other monochrome monitor gives you the fatigue-free black and white viewing, text and graphics capabilities and easy interface. Naturally enough, the MB-142 is from Roland DG—the new computer peripherals company that's pointing the way to the future. Look for this and other Roland products at fine computer dealers everywhere.

For more information, contact: Roland DG, 7200 Dominion Circle, Los Angeles, CA 90040. (213) 685-5141.

The software programs listed are trademarks of the following companies: AutoCAD, AUTODESK, Inc.; CADDraft, Personal CAD Systems, Inc.; Chart-Master, Decision Resources, Inc.; Energraphics, Enertronic Research, Inc.; Lotus 1-2-3, Lotus Development Corp.; VersaCAD, T&W Systems, Inc.

Roland DG

the advertisement or within 30 days if no time is specified. The FTC rule is superseded when you specify a delivery date. But what happens if the delivery date is missed? First, if the delivery date was specified along with "time is of the essence," the order becomes null and void. The seller must make a refund within seven business days (or within one billing cycle for a credit card) after the contract cancellation. If you did not specify a delivery date, then the FTC rule requires that the seller notify you of the delay. If the seller says shipment will occur within 30 days, then you have the option to cancel and get a refund. If you fail to respond to the seller's notice, the new delivery date takes effect. However, if the seller says shipment will occur in *more* than 30 days, you are off the hook automatically unless you agree otherwise. Furthermore, the seller must refund your money within the 30-day period.

FORMS OF PAYMENT

Buyer advocates argue that the payment mechanism is one of the most effective ways for guaranteeing that a seller delivers the desired computer product. They rank payment mechanisms from most to least attractive for the buyer as follows: credit card; cash on delivery (COD) (without deposit and with payment by personal check); personal check; other instruments, such as certified or cashiers' checks or postal or private money orders; wire transfer; and, as a last resort, cold hard cash. In descending order, each offers you less in control and protection.

By comparison, a seller prefers cash because it is immediate payment with no strings attached. A wire transfer, where your bank electronically sends the money to the seller's bank account, is practically cash since you cannot stop payment. Because you also cannot stop payment on certified or cashiers' checks or money orders, they are the next most attractive to the seller. On the other hand, many sellers will not accept personal checks, and those that do typically require that the check clear—two weeks is common—before the product is shipped. This is because sellers fear that you could stop payment on a personal check or might have insufficient funds to cover it. In a COD transaction, you pay for the product when it is delivered. When United Parcel Service (UPS) is the carrier, the seller can specify the mode of payment, such as cash or certified check as opposed to personal check.

Credit cards are attractive to sellers since the credit-card company is on the hook unless you (the buyer) successfully protest some aspect of the transaction. Furthermore, some marketing people believe that through

(continued)

What every Apple owner should know about WORD JUGGLER.™

If you own an Apple IIe or IIc—or you're planning to buy one—here are a few things you should know about Quark's Word Juggler word processor.

First of all, Word Juggler is the only word processor that gives you a powerful spelling checker *and* a built-in telecommunications feature. So you can create a document—check it for spelling errors—and then send it via electronic mail. All with just one program.

Plus, Word Juggler is the most easy-to-use, professional word processor you can buy for your Apple. Even complicated "cut-a d-paste" tasks can be accomplished with just a few keystrokes.

There's nothing to memorize, either. Because Word Juggler comes with replacement keycaps—and a special keyboard template—which identify principal editing and formatting commands. So you can focus your efforts on using the program, not learning it.

Fact is, no other word processor for your Apple IIe or IIc gives you this unique combination of power, functionality and ease of use. And if all these advantages aren't compelling enough, check the price. Suggested retail is only $189.

So visit your favor te dealer today. Ask for a complete demonstration—and for a copy of our brochure, "What Every Apple Owner Should Know About Word Juggler." If you don't have a favorite dealer, but would like one, just call 1 (800) 543-7711. We'll fix you up.

Quark™ INCORPORATED

2525 West Evans, Suite 220
Denver CO 80219

Inquiry 338

Quark and Word Juggler are trademarks of Quark Incorporated. Apple is a registered trademark of Apple Computer, Inc.

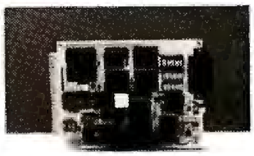
Ask about our specially-priced educational version.

Photography by Barbara Kasten

The Micromint Collection

TERM-MITE ST SMART TERMINAL BOARD

TERM-MITE is a completely self-contained video display controller.



All you need to build a Smart Video Terminal equivalent to the types advertised for $1000 or more is a Term-Mite ST circuit board, scanned or parallel keyboard, video monitor and power supply.

- Uses brand new Nat'l Semi NS405 Terminal Processor.
- 24 lines by 80 characters, 25th reverse-video status.
- Upper & lowercase. Line (block) graphics.
- Selectable data rate, parity & display options.
- Reverse video, half intensity, double height & width, underline, blinking and/or blank character.
- Separate sync or composite video output. Self Test.

TERM-MITE ST Video Display Terminal Board
BCC22 Assembled & Tested............$284.
BCC23 Complete Kit.................. $244.

MPX-16 MICROCOMPUTER IBM PC COMPATIBLE

As featured on the cover of BYTE Magazine. Also featured in Ciarcia's Circuit Cellar November, December 1982 & January 1983

The Computer with a Split Personality

– Use it as an IBM PC look alike that directly boots PC DOS 2.0 and accepts all expansion boards designed for the IBM PC.
– Use it as a powerful 8088 single board computer for all your OEM applications. Just add serial terminal, disk drive and power supply. Directly boots CP/M-86.

Buy the MPX-16 in the form that best meets your needs or budget. As a bare board, as a wave soldered board that contains all components less ICs, as an assembled and tested circuit board or as a complete system.

- Directly boots PC DOS 2.0 and CP/M-86.
- Most IBM PC software executes with no modifications.
- IBM PC bus compatible +9 expansion slots.
- Intel 8088 16-bit microprocessor.
- Optional Intel 8087 math cocprocessor.
- 256K bytes on board memory.
- Up to one megabyte of system memory.
- Up to 64K bytes of system ROM/EPROM.
- 2 RS-232C Serial & 3 Parallel I/O ports.
- Disk controller for 5¼" or 8" drives.
- Sixteen levels of vectored interrupts.

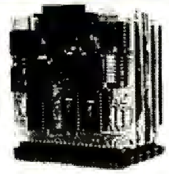
MPX-16 Circuit Board Assembled
w/64K RAM......................$1,200.
OEM 100 quantity price............... 840.
MPX-16 Circuit Board Assembled
w/256K RAM....................1,400.
MPX-16 Semi-Kit (wave soldered circuit board w/all components) Less ICs....... 595.
Complete Kit of ICs w/256K RAM....... 595.
MPX-16 Unpopulated (bare) PC Board.... 300.
CP/M-86 Operating System + Manuals..... 80.
MPX-16 Switching Power Supply........ 300.
MPX-16 Technical Reference Manual...... 50.
MPX-16 Metal Enclosure with Fan....... 225.
Tandon TM 100-2 Double Sided/Density Drive............................300.
IBM/PC Keyboard Interface Adapter..... 100.

Shipping and handling additional on MPX-16 orders.

IBM PC is a trademark of International Business Machines Inc.
CP/M-86 is a trademark of Digital Research Inc.
Z8 is a trademark of Zilog Inc.

Z8 COMPUTER SYSTEM

BASIC System Controller



The Z8 Basic System Controller is an updated version of our popular BCC01. The price has been reduced and features added. The entire computer is 4" by 4¼" and includes a tiny BASIC interpreter, up to 6K bytes of RAM and EPROM, one RS-232C serial port with switchable baud rates and two parallel ports. BASIC or machine language programming is accomplished simply by connecting a CRT terminal. Programs can be transferred to 2732 EPROMs with an optional EPROM programmer for auto start applications. Additional Z8 peripheral boards include memory expansion, serial and parallel I/O, real time clock, an A/D Converter and an EPROM programmer.
- Uses Zilog Z8 single chip microprocessor.
- Data and address buses available for complete peripheral expansion
- Can be battery operated.
- Cross assemblers for various computers.

BCC11 Assembled & Tested............$149. New Low Price

FORTH Language Version

With the new Z8 with on board 4K FORTH you can program high speed control functions in a few simple high level language commands. Perfect for data reduction, process control and high speed control applications.
BCC20 Z8F FORTH Microprocessor chip. $150.
BCC21 Z8F FORTH System Controller (This board is a BCC11 with a BCC20 installed) Assembled & Tested.................. 280.

Memory, I/O Expansion, Cassette Interface

- 8K bytes of additional RAM or EPROM.
- Three additional 8 bit parallel ports.
- Cassette interface – 300 baud K.C. Standard.
- Software real time clock.

BCC33 w/0K RAM Assembled & Tested... $150.
BCC34 w/6K RAM Assembled & Tested... $180.

Eprom Programmer

- Transfer BASIC or Assembly Language application programs from RAM to 2716 or 2732 EPROM.
- Comes with programming & utility routines on EPROM.
- Requires Z8 I/O Expansion Board for operation.

BCC07 Assembled & Tested........... $145.

Analog to Digital Converter

- Uses Analog Devices 7581 IC, 8-channel 8-bit.
- Adds process control capability to the Z8 system
- Over 1,000 conversions per channel per second.
- Monitors 8 analog signals in one of two 10v Ranges.

BCC13 Assembled & Tested........... $140.

Serial Expansion Board

- Adds additional RS-232C and opto-isolated 20 ma. current loop serial port to the Z8 System.
- Runs at 75 to 19,200 baud in all protocols.
- Comes with listings of sample serial I/O routines.

BCC08 Assembled & Tested........... $160.

16K Memory Expansion Board

- Add up to 16K of additional memory, RAM or EPROM, to your Z8 System Controller in any multiple.
- Accepts 2016, 6116, 2716, or 2732 memory types.
- Four 16K cards may be installed on the Z8 System bringing the total memory to 64K.

BCC14 Assembled & Tested w/4K RAM. $120.

Cross Assemblers

From Micro Resources
IBM PC, APPLE, 6502 Systems 5¼",
CP/M 2.2 8" .... $75.
From Allen Ashley
TRS-80 Model I, III, Northstar 5¼"....... 75.
CP/M 2.2 8"........................150.

Five Slot Mother Board

- Expand your Z8 BASIC System with minimum effort.
- Contains five slots complete w/44 pin connectors.

MB02 Assembled & Tested............$69.

Triple Voltage Power Supplies

+5V @ 300 ma. +/- 12V @ 25 ma.
UPS01 Assembled & Tested............. $35.
UPS02 Complete Kit.................. 27.
+5V @ 1 Amp. +12V @ .5 Amp. -12V @ 50 ma.
UPS03 Assembled & Tested............. 60.
UPS04 Complete Kit................... 50.

SPEECH PRODUCTS

Lis' ner 1000 Voice Recognition Board

Uses the new, high performance SP1000 voice recognition chip.

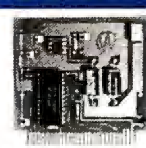
The LIS' NER 1000 provides voice input capability for your computer. The unit functions in the same manner as your keyboard, serving as a data entry device for application programs or the normal operation of the computer.

The LIS' NER 1000 recognition system works by analyzing human speech and extracting the most important features. These impressions of words are compacted into "templates" which can be stored and later compared to someone talking to the recognition unit. The LIS' NER 1000 supports a 64 word vocabulary in speaker dependent, discrete utterance mode. The recognition accuracy is greater than 98%. Each unit comes with a professional quality headband style electret microphone to assure accuracy, software on diskette and a user's manual.

The APPLE II LIS' NER board has provision for an SSI 263 phonetic speech synthesizer chip with text-to-speech algorithm. This addition provides all the features described for the Sweet Talker II as well as speech recognition.

APPLE II LIS' NER 1000 with SP1000 recognition/synthesis components only
VR01 Assembled & Tested............$189.
VR02 Complete Kit.................$149.
APPLE II LIS' NER 1000 with SP1000 recognition/synthesis components and SSI 263 phoneme synthesizer chip with text to speech algorithm.
VR03 Assembled and Tested........... $259.
VR04 Complete Kit.................$219.
COMMODORE 64 LIS' NER 1000 with SP1000 recognition/synthesis components
VR10 Assembled & Tested.............$149.
VR11 Complete Kit..................$119.

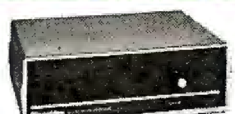
Sweet Talker II Text-to-Speech Synthesizer



SWEET TALKER II, a 3rd generation speech synthesizer, is based on the SSI 263. SWEET TALKER II directly drives a speaker to provide music, sound effects and continuous speech of unlimited vocabulary at data rates as low as 50-70 bps.
- SSI 263-based Apple II compatible speech synthesis board
- Comes with text-to-speech algorithm on disk (DOS 3.3)
- Appropriate control inputs for mapping with several buses
- On-board 1 watt amplifier with volume control
- Measures 3" x 3¼"
- Operates on +5 and +12v

ST22 SWEET TALKER II Apple II compatible speech synthesizer with text-to-speech algorithm on disk..............................$104.

Microvox Text-to-Speech Synthesizer



Microvox is a professional voice quality text- to speech synthesizer that is easily interfaced to any computer, modem, RS-232C serial or parallel output device and provides speech of unbelievable clarity.
- Unlimited vocabulary.
- 64 programmable inflection levels.
- 6K text-to-speech algorithm.
- Full ASCII character set recognition and echo.
- RS232C and parallel input.
- 1000 Character buffer, 3000 optional.
- Adjustable baud rates (75-9600).
- Spelling output mode.
- 7 octave music and sound effects.
- On board audio amplifier & power supply.
- X-On/X-Off handshaking.

MV01 Assembled with 1K buffer....... $349.
MV02 Complete Kit with 1K buffer..... $269.
Add $15.00 for 3K buffer option.

Speech Synthesizer IC's

The SC-01A Speech Synthesizer is a completely self-contained solid state device that phonetically synthesizes continuous speech of unlimited vocabulary.
SC01A Quantity 1-99.................. $32.
100+................. $24.
1000+................ call

The Silicon Systems SSI 263 Speech Synthesizer Chip is a third generation speech synthesizer chip that produces even more intelligible speech than did older devices. The SSI 263 has improved intonation, inflection and filtration.
SSI 263 Quantity 1-9...............$42. ea.
10-99............$34. ea.
100..............$30. ea.

The Micromint is stocking thousands of SP1000 voice recognition chips. Call us for a quote.

MICRO D-CAM DIGITAL TV CAMERA

Give your computer the dimension of sight.
- Interprets, enhances and stores images.
- 256 x 128 digital image sensor.
- Plug-in boards for the IBM-PC, APPLE II or e.
- Software includes utilities for auto exposure, multi-level greyscale, screen dump and image enhancement.
- Includes interface card, 4 foot extension cable camera assembly, manual, and software on diskette.

DC01 IBM PC Assembled & Tested......$299.
DC02 IBM PC Complete Kit.............$264.
DC03 APPLE II Assembled & Tested.... $299.
DC04 APPLE II Complete Kit......... $264.

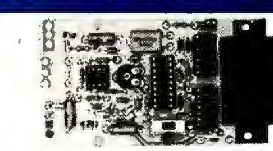
ULTRASONIC RANGING SYSTEM

The Micromint Sonar Ranging Experimenter's Kit is an updated and higher functioning version of the Polaroid SX-70 Camera sonar ranging circuit used in the original Polaroid Ultrasonic Ranging System Designer's Kit. There are similar performance characteristics but this unit requires far less support circuitry and interface hardware.

The TI ranging module can function between 4.5 and 6.8v. With a 5v supply, the ranging module I/O is TTL compatible and can be connected directly to most computers with one input and one output bit.

The Sonar Ranging Experimenter's Kit includes one SN28827 ranging module, one Polaroid 50 KHz electrostatic transducer, and user's manual with data sheets.
TI01 Sonar Ranging Experimenters Kit... $60.

300 BAUD ANSWER/ ORIGINATE MODEM KIT



Micromint's latest 300 Baud Modem Kit is crystal controlled, uses the TI TMS99532 IC, contains just 25 parts and requires no calibration or adjustments. Use with acoustic coupler or in direct connect mode.
MD04 Complete Kit as shown.......... $60.
MD05 Transformer for Direct Connect Mode $9.
AC01 Acoustic Coupler Kit............ $20.

***MICROMINT INC.** 561 Willow Avenue, Cedarhurst, NY 11516*
***To Order:** Call Toll Free 1-800-645-3479*
***For Information Call:** 1-516-374-6793*
Call: Monday-Friday, 9-5 PM

credit-card transactions, larger sales occur because you can withhold payment—a buyer advantage—if you feel a delivered product is defective or does not meet your intended purpose. If you dispute the transaction, the credit-card company withholds that money from the seller. Regardless of whether you ultimately prevail, the cash-flow loss hurts the seller.

TAKING DELIVERY

Typically, you receive computer products in sealed containers. This effectively prevents you from inspecting the products at the store or before the deliveryman leaves. Because some sales agreements say that you have accepted the products merely by taking possession of them, buyer advocates warn that you should make sure such language is stricken from any sales agreement in order to allow reasonable inspection prior to acceptance. Where a written contract does not contain such language or there is no written contract, you are allowed a reasonable amount of time to perform a reasonable inspection before accepting the products. This includes, for example, operating hardware or running software to demonstrate that it fulfills the terms of the agreement.

Where the terms are not fulfilled, you have the right to reject the products. Buyer advocates caution that such rejection should be done as soon as possible by telephoning the seller and following up with an explanatory letter. Buyer advocates also recommend that the goods be returned, especially when they have been purchased by credit card. Sellers are protected from unreasonable buyer rejection where you accept the products knowing that they do not conform to your agreement, where you don't inspect them within a reasonable amount of time, or where you use the products beyond the acceptance period or modify them. When you have accepted the products, you can only revoke your acceptance where the product defect was difficult or impossible to discover through reasonable inspection or short-term use.

A PRACTICAL APPLICATION

Let's apply all these rules to a typical situation as if we had an expert system for the law of computer sales. Doc is a computer hobbyist who plays the stock market. After careful research, he decides to buy a new computer system from a mail-order house. Doc orders by phone and pays by certified check to get immediate shipment. Five weeks go by and he has neither heard nor received anything. Doc calls and is told by the

(continued)

seller that the computer is out of stock for the "foreseeable future" and that the price has gone up. Reluctantly, Doc pays the higher price and receives the machine six weeks later. The machine arrives four days before he goes on a one-month vacation. When Doc returns, he unpacks the machine, only to discover that it does not work. What should he have done differently?

First, Doc should have called several sellers and negotiated not only the best price but the most favorable payment and delivery terms. He should have paid by credit card and sent a confirmatory letter setting forth all the terms of the deal. The letter should have explicitly stated the magic phrase "time is of the essence." After not hearing from the seller for two weeks, Doc should have called to confirm that shipment had taken place. Having learned that it had not, Doc had the option of canceling or demanding immediate shipment. In either case, he should have confirmed his decision in writing. If he had foolishly waited more than 30 days, he could have canceled under the FTC mail-order rule.

Second, Doc did not have to pay the higher price since the seller cashed his original check implying acceptance of the order for that price. Had he paid by credit card, he could have protested the change in price from the original agreement. Unfortunately, Doc accepted the computer by failing to inspect it within a reasonable time after receipt. He cannot revoke his acceptance since the defect was obvious. His vacation does not serve as a valid excuse for his failure to inspect the product, which he should have inspected *immediately* upon receipt. Then he could have rejected the defective goods and demanded a working replacement. Such rejection should have been made immediately by telephone and followed up in writing. The defective computer should then have been returned. If the seller did not provide a working replacement within a reasonable amount of time, Doc could demand that the credit-card company issue him a credit, thereby canceling the transaction.

IN CONCLUSION

This column has addressed the rights and responsibilities of both buyers and sellers of computer products. Most buyers and sellers are honest and most transactions go smoothly. The law of computer sales, however, must provide a set of rules that operate when transactions don't go smoothly. We will deal with the legal ramifications of an unsatisfactory transaction in a future column. ■

MICROWAY'S 8087 RUNS 1-2-3™!

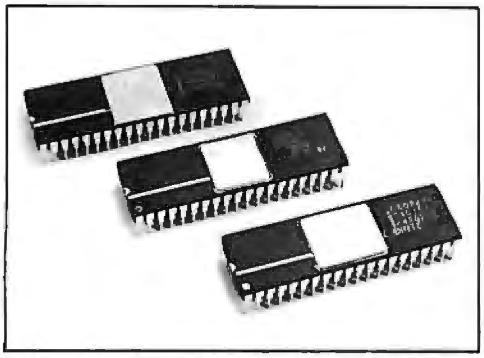
MicroWay is the world's leading retailer of 8087s and high performance PC upgrades. We stock a complete selection of 8087s that run at 5 and 8mhz. All of our coprocessors are shipped with a diagnostic disk and the best warranty in the business – 180 days! We also offer daughterboards for socketless computers such as the NEC PC and PCjr, and a board which increases the clock speed of the80287 in the PC AT. Our new NUMBER SMASHER™ includes 512K ram. It will run the IBM PC at clock speeds up to 9.5mhz and achieves a throughput of .1 megaflops with 87BASIC/INLINE, Intel Fortran, or Microsoft Fortran. Software reviewers consistently cite MicroWay software as the best in the industry! Our customers frequently write to thank us for recommending the correct software and hardware to meet their specific needs. They also thank us for our same day shipping! In addition to our own products which support the 8087 and 80287, we stock the largest supply of specialized software available anywhere. For information call us at

617-746-7341

FASTBREAK™

MicroWay's daughterboard turns on your 8087 during 1-2-3™ execution and extends DOS functionality. Recalculations run up to 33 times faster. Includes an 8087 chip. When used with the NUMBER SMASHER™ it can provide a total increase in 1-2-3™ execution speed of up to 80 to 1.

FASTBREAK™ 5mhz **$339**
FASTBREAK™ 8mhz **$479**
FASTBREAK™ for NUMBER SMASHER **$239**
FASTBREAK™ BOX Option **$60**



Micro Way™ 8087 Support

For the IBM PC, PC XT, PC AT and Compatibles.

87FFT™ performs Forward and Inverse FFTs on real and complex arrays which occupy up to 512K bytes of RAM. Also does convolutions, auto correlations, hamming, complex vector multiplication, and complex to radial conversions. Callable from MS Fortran or 87BASIC/INLINE..... **$150**

87FFT-2™ performs two-dimensional FFTs. Ideal for image processing. Requires 87FFT...**$75**

MATRIXPAK™ manages a **MEGABYTE!** Written in assembly language, our runtime package accurately manipulates large matrices at very fast speeds. Includes matrix inversion and the solution of simultaneous linear equations. Callable from MS Fortran 3.2, 87MACRO, 87BASIC/INLINE, and RTOS .... each **$150**

GRAPHICS PACKAGES

Energraphics (stand alone) 295
Grafmatic for MS Fortran or Pascal 125
Plotmatic for Grafmatic 125
Halo for Basic, C or Fortran .... each 150

OTHER TOOLS

Alpha Software ESP 500
Borland Sidekick, Toolbox, or Graphics 35
SuperKey 70
COSMOS Revelation 850
smARTWORK 895
SPSS/PC 695

MAYNSTREAM **1695**

DFixer
A disk utility which thoroughly checks PC or AT hard disks for bad sectors and updates the MS DOS file allocation table accordingly...... **$149**

87DEBUG™ - a professional debugger with 8087 support, a sophisticated screen-oriented macro command processor, and trace features which include the ability to skip tracing through branches to calls and software and hardware interrupts. Breakpoints can be set in code or on guarded addresses in RAM **$150**

HARDSCOPE™ includes a version of 87DEBUG which interfaces a Breaker Box which makes it possible to reset your PC and break program execution independent of DOS... **249**

87BASIC/INLINE™ converts the output of the IBM Basic Compiler into optimized 8087 inline code which executes up to seven times faster than 87BASIC. Supports separately compiled inline subroutines which are located in their own segments and can contain up to 64K bytes of code. This allows programs greater than 128K! Requires the IBM Basic Compiler and Macro Assembler. Includes 87BASIC **$200**

87BASIC™ includes patches to the IBM Basic Compiler and both runtime libraries for USER TRANSPARENT 8087 support. Provides super fast performance for all numeric operations including trigonometrics, transcendentals, addition, subtraction, multiplication, and division.... **$150**

87MACRO™ - our complete 8087 software development package. It contains a "Pre-processor," source code for a set of 8087 macros, and an object library of numeric functions including transcendentals, trigonometrics, hyperbolics, encoding, decoding and conversions. For the IBM Macro Assembler, Version 1.0 or 2.0...... **$150**

OBJ →ASM™ - a multipass object module translator and disassembler. Produces assembly language listings which include public symbols, external symbols, and labels commented with cross references. Ideal for understanding and patching object modules and libraries for which source is not available **$200**

RTOS - REAL TIME OPERATING SYSTEM
RTOS is a multi-user, multi-tasking real time operating system. It includes a configured version of Intel's iRMX-86, LINK-86, LOC-86, LIB-86, OH-86, and MicroWay's 87DEBUG. Runs on the IBM-PC, XT, PC-AT and COMPAQ **$400**

INTEL COMPILERS[1]

FORTRAN-86 750
PASCAL-86 750
PL/M-86 500
87C (LATTICE/MICROWAY) 750
ASM-86 200

[1]Requires RTOS or iRMX-86. All Intel compiler names and iRMX-86 TM Intel Corp.

HARDWARE AND LANGUAGES

8087 5mhz $129
Including DIAGNOSTICS and 180-day warranty For IBM PC and compatibles.

8087-2 8mhz $275
For Wang, AT&T, DeskPro, NEC, Leading Edge

80287-3 5mhz $275
For the IBM PC AT

64K RAM Set $15
256K RAM Set $89
128K RAM Set PC AT ... $169
NUMBER SMASHER™ ... 1590
9.5mhz 8087 coprocessor board with 512K

FORTRAN and UTILITIES

Microsoft Fortran 3.2 229
IBM Professional Fortran 545
Intel Fortran-86[1] 750
FORLIB+ 65
STRINGS and THINGS 65

C and UTILITIES

Lattice C 299
Microsoft C V 3.0 .... CALL
C86 299
C TOOLS 85
C Trigs and Trans 150

BASIC and UTILITIES

IBM Basic Compiler 270
87BASIC/INLINE 200
Summit BetterBASIC™ 175
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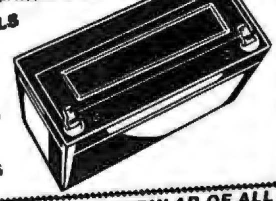

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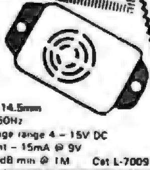

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An Exercise in BASIC Bitwise Logic Operation

The game of Nim is used to teach the use of the logical AND, OR, and NOT

BY ROBERT T. KUROSAKA

The April artificial intelligence (AI) theme got me thinking about Nim, one of the first strategy games that programmers tried to teach computers to play. Nim is one of the oldest two-person games and is believed to have originated in China. Objects such as matches or coins are placed in rows before the two players, who take turns removing objects until none remain. The winner is the player who takes the last object. The rules are simple: You must not skip a turn, and you may take as many objects from any one row as you wish, up to, and including, the entire row. The number of rows is arbitrary (but less than three is trivial), and the number of objects in a row is up to you (but letting all rows have the same number is also trivial).

Some strategies become obvious within the first few games. If you can reduce the board to an even number of equal rows, you will win. If your opponent faces a board like the one shown in table 1, he or she cannot win if you simply echo his or her move in the other row. Other winning patterns become apparent: the 1-2-3 and 1-4-5. In table 2, you have just created the 1-2-3 pattern. No matter how your opponent plays, you can make two equal rows. If he takes one from row one, you take one from row three; if he takes one from row two, you take all of row three, and so on.

In the 1-4-5 pattern, no matter how your opponent plays, you can always make two equal rows or the 1-2-3 pattern. Similarly, with a 1-6-7 pattern, you can make two equal rows, the 1-4-5 pattern, or the 1-2-3 pattern on your move.

It is tempting to think that the 1-7-8 must also be a winning pattern. But your opponent will take two objects from the last row, leaving you to face a 1-7-6 pattern.

With more rows and objects, the winning patterns become far too numerous to learn. Instead, of course, we prefer to learn the winning strategy.

The elegant strategy was first proved in 1901 by Charles Leonard Bouton, then associate professor of mathematics at Harvard University. He also gave the game its present name, "Nim."

Every position can be considered to be "safe" or "unsafe" to the player facing it on his turn. If you can create a safe position and continue to do so, you will win. Every unsafe position can be made safe by a single move. Every safe position will be made unsafe by *any* move. Therefore, once you make a safe position, your opponent cannot help but make it unsafe with his move; you can make it safe with your next move, and so on.

BINARY ANALYSIS

The analysis of the patterns is as follows: The number of objects in the rows are written in binary notation and stacked vertically, as if preparing for addition. Reading down the columns, if every column has an *even* number of 1s, the position is safe. We will denote an even-parity column with a 0, and an odd-parity column with a 1.

This procedure is simpler than it sounds. Consider the number 13. The largest power of two contained in 13 is 8: think "one 8." The remaining 5 contains one 4, no 2s, and one 1 (don't forget 2 to the 0 power). Hence, 13=8+4+0+1, or in binary, 1101.

Now consider table 3, where the pattern is 13-12-4. The numbers have been converted to binary and stacked. Reading down the columns, the first (leftmost) column has an even number of 8s, so its parity designation is 0, and so on. The column-parity pattern is 0101. For a safe position, all column-parities must be even. That is, a safe position will have a column-parity value of 0000. Thus, the table 3 position is unsafe, and may be made safe by one move. How do we find this move?

Find the leftmost odd-parity column. In our example, it is the 4's column. We must remove one of the 4s to make that column even parity. We have three choices of 4s. If we remove the 4 from the first row, we must

(continued)

Robert T. Kurosaka teaches mathematics in the Massachusetts State College system. He invites your correspondence (c/o BYTE, POB 372, Hancock, NH 03449).

also remove the 1 from its last column to make the last column of even parity. The move would be "row 1, take 5." The resulting board is shown in table 4. All the column parities are even: the position is safe.

Alternatively, we could choose to remove the 4 from the second row in the table 3 position. In that case, we would have to replace 1 in order to make the last column even parity. The move would be "row 2, take 3" and the resulting board would be that of table 5. Once again, the position is safe.

To familiarize yourself with the strategy, play solitaire fashion, making small random moves for your opponent and using precise binary analysis for your own moves.

Now, it may appear that the analysis used in playing from row 1 was different than the analysis used when we played from row 2. In the first case, we only *removed* column bits and in the second we had to *replace* some column bits. Actually, we can perform both operations with one procedure. Here's how. Take row 1 and the column-parity number in table 3 and create a new number by comparing the parity of the row 1 number and the column-parity number. That is, write a 1 for the 8's column because there is an odd parity between the 13 and the column-parity number in that column.

BASIC *has three kinds of bitwise logical operators:* AND, OR, *and* NOT.

Write 0s for all the other columns because they have even parity. The resulting number is 1000, or 8 in base ten. Notice that this is the number we wanted to end up with in row 1 to make the position safe. Try the same procedure with the 12 in row 2 and the column-parity number of table 3. You end up with 1001, or 9. This is the number we should leave in row 2 if we play there.

What we have done with the row and column-parity number is a kind of bitwise logic operation known as an *exclusive-OR* (XOR to assembly-language programmers). An exclusive-OR operates on two arguments and returns a 0 for each column in which both binary representations have the same value (either both 0s or both 1s) and returns a 1 for each column in which one number has a 1 and the other number has a 0. Unfortunately, BASIC does not have an exclusive-OR operation in it.

However, BASIC does have three kinds of bitwise logical operators. The first is NOT, which operates on a single argument and returns a 1 for each column that contains a 0 and returns a 0 for each column that contains a 1. Try having your computer PRINT NOT a bunch of numbers. You will find that −1 is NOT 0. Why? Computers use a kind of binary representation called two's complement. For the sake of simplicity, assume that your computer uses one byte to represent a number. Zero would be stored as 00000000. NOT 0 is then 11111111. This is called the one's complement of 0 and looks like 255. However, computers need to be able to represent negative numbers as well as positive numbers. So any integer that has a 1 in the most significant bit

(continued)

TABLE 1

row 1:	/////
row 2:	/////

TABLE 2

row 1:	/
row 2:	//
row 3:	///

TABLE 3

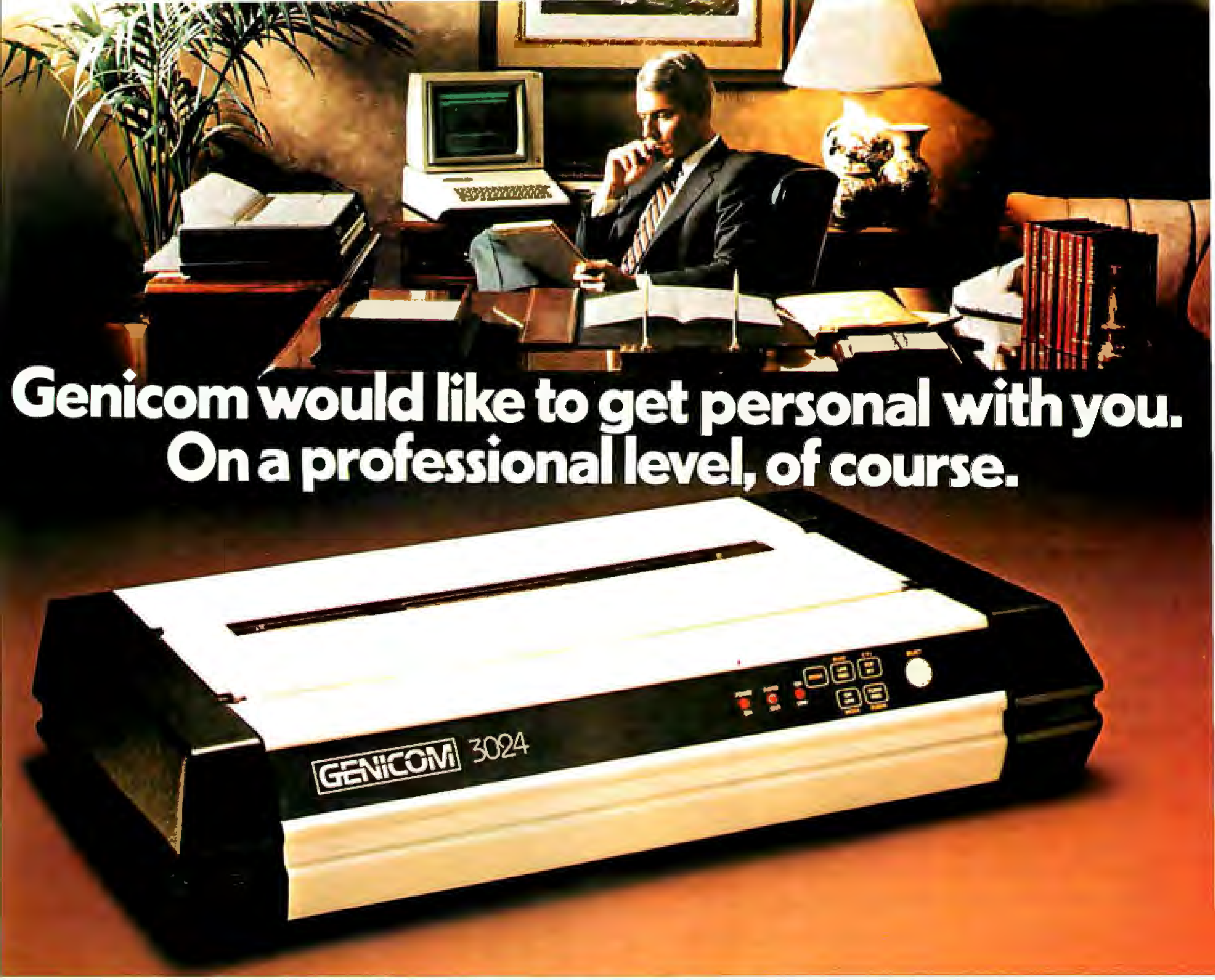
				8 4 2 1
row 1:	/////////////	13	=	1 1 0 1
row 2:	////////////	12	=	1 1 0 0
row 3:	////	4	=	0 1 0 0
		column-parities	=	0 1 0 1

TABLE 4

				8 4 2 1
row 1:	////////	8	=	1 0 0 0
row 2:	////////////	12	=	1 1 0 0
row 3:	////	4	=	0 1 0 0
		column-parities	=	0 0 0 0

TABLE 5

				8 4 2 1
row 1:	/////////////	13	=	1 1 0 1
row 2:	/////////	9	=	1 0 0 1
row 3:	////	4	=	0 1 0 0
		column-parities	=	0 0 0 0



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Inquiry 444

A computer uses the same circuitry to add and subtract.

(MSB) is defined to be a negative number. The MSB simply represents the sign of the number. So why isn't 1111111 = −127 then? It is cheaper to make a computer that uses the same circuitry to add and subtract than one that requires a different set of circuits for each operation. You can use addition to subtract if you take the one's complement of a number you want to subtract, add 1 to it (it is now called the two's complement), and add it to the number you wanted to take the original number from. Let's go through the steps to subtract 1 from 2. First, change 00000001 into its one's complement: 11111110. Now add 1: 11111111. Now add it to 2 (00000010). You get 00000001, carry the 1. Throw away the carry, and 2 − 1 is 1. As you experiment with NOT, you will discover that NOT 1 is −2, NOT 2 is −3, etc.

The second BASIC logic operator is OR. OR operates on two arguments and returns a 1 if there is a 1 in the corresponding column of one or both of the arguments, and a 0 if both arguments have a 0 in that column. Try experimenting with PRINT argument_1 OR argument_2 until you are comfortable with this operation.

The final operation we will discuss is AND. AND operates on two arguments and, reasonably enough, returns a 1 just in case both the arguments have a 1 in the corresponding column. In any other case, it returns a 0 for that column. Again, familiarize yourself with this operation using PRINT argument_1 AND argument_2.

So what good do these operations do us? We need an exclusive-OR operator. We can make an exclusive-OR out of NOT, OR, and AND in the following way (assume that our two numerical arguments are stored in variables A and B):

Listing 1: *The Nim program.*

```
10 '*************************************************************
20 '*                          NIM                              *
30 '*                    BY BOB KUROSAKA                        *
40 '*************************************************************
50 CLS
60 DEFINT A-Z:VICTORY$="NO"
70 REM DEFINE INITIAL BOARD CONDITIONS
80 INPUT "ENTER THE NUMBER OF ROWS (3<=ROWS<=18)";ROWS
90 IF ROWS<3 OR ROWS>18 THEN PRINT "MUST BE BETWEEN 3 AND
   18":GOTO 80
100 DIM ROW(ROWS)
110 FOR I=1 TO ROWS
120     PRINT "ENTER NUMBER OF OBJECTS (1 TO 59) IN ROW ";I
130     INPUT ROW(I)
140     IF ROW(I)<1 OR ROW(I)>59 THEN PRINT "NUMBER MUST BE
        BETWEEN 1 AND 59": GOTO 120
150 NEXT I
160 GOSUB 540:REM DRAW THE BOARD
170 INPUT "ENTER 1 TO MOVE FIRST, 2 TO MOVE SECOND";MOVE
180 IF MOVE<1 OR MOVE>2 THEN 170
190 ON MOVE GOTO 210,340
200 REM
210 REM PLAYER'S MOVE SEQUENCE
220 REM
230 PLAYER$="YOU"
240 INPUT "ROW";ROW
250 IF ROW<1 OR ROW>ROWS THEN PRINT "INVALID ROW":GOTO 230
260 INPUT "REMOVE";REMOVE
270 IF REMOVE>ROW(ROW) OR REMOVE<1 THEN PRINT "INVALID":GOTO
    240
280 ROW(ROW)=ROW(ROW)-REMOVE
290 GOSUB 540:REM REDRAW BOARD
300 IF VICTORY$="YES" THEN 500
310 REM PAUSE LONG ENOUGH TO SEE THE BOARD
320 FOR I=1 TO 5000:NEXT
330 REM
340 REM COMPUTER'S MOVE SEQUENCE
350 REM
360 PLAYER$="I"
370 REM DETERMINE PARITY OF THE BOARD
380 PARITY=ROW(1)
390 FOR I=2 TO ROWS
400     PARITY=(PARITY OR ROW(I)) AND (NOT(PARITY AND ROW(I)))
410 NEXT I
420 REM CHOOSE MOVE-SELECTION ROUTINE DEPENDING ON BOARD
    SAFETY
430 IF PARITY=0 THEN GOSUB 690 ELSE GOSUB 790
440 REM DRAW THE NEW BOARD
450 GOSUB 540
460 REM ANNOUNCE COMPUTER MOVE
470 PRINT "I HAVE REMOVED ";REMOVE;" PIECES FROM ROW ";ROW
480 REM LOOP FOR NEXT MOVE SEQUENCE
490 IF VICTORY$="NO" THEN 210
500 END
510 REM END OF MAIN PROCEDURE
520 REM BEGINNING OF SUBROUTINES
530 REM
540 REM BOARD-DRAWING ROUTINE
550 REM
560 CLS
```

```
570 STATUS=0 'HOW MANY ROWS ARE EMPTY?
580 FOR I=1 TO ROWS
590     PRINT "ROW ";I;"(";ROW(I);")";TAB(20);
600     IF ROW(I)=0 THEN STATUS=STATUS+1:GOTO 640
610     FOR J=1 TO ROW(I)
620         PRINT "/";
630     NEXT J
640     PRINT
650 NEXT I
660 IF STATUS=ROWS THEN PRINT PLAYER$;" WON":VICTORY$="YES"
670 RETURN
680 REM
690 REM NO GOOD MOVES ROUTINE
700 REM
710 REMOVE=0:ROW=0
720 WHILE REMOVE=0
730     ROW=ROW+1
740     IF ROW(ROW)>0 THEN REMOVE=1
750 WEND
760 ROW(ROW)=ROW(ROW)-REMOVE
770 RETURN
780 REM
790 REM FIND THE GOOD MOVE ROUTINE
800 REM
810 REMOVE=0:ROW=0
820 WHILE REMOVE=0
830     ROW=ROW+1
840     RETAIN=(ROW(ROW) OR PARITY) AND (NOT(ROW(ROW) AND PARITY))
850     IF RETAIN<ROW(ROW) THEN REMOVE=ROW(ROW)-RETAIN
860 WEND
870 ROW(ROW)=ROW(ROW)-REMOVE
880 RETURN
```

TABLE 6

			8	4	2	1
row 1:	//////////	12 =	1	1	0	0
row 2:	//////////	12 =	1	1	0	0
row 3:	//	2 =	0	0	1	0
		column-parities =	0	0	1	0

A XOR B =def (A OR B) AND (NOT(A AND B)).

In simple language, what this says is that A exclusive-OR B is by definition the same as A or B (there is a 1 in the appropriate column of A, or B, or both) except that XOR isn't true for the both A and B case. More formally, A XOR B is true if and only if A OR B is true and A AND B is false.

Notice that we can make use of the exclusive-OR for determining the parity of the Nim board as well as for plotting our best move. Successive applications of the XOR with the parity results for preceding rows will end up producing the parity of the entire board. Lines 380 to 410 of listing 1 show this procedure. [*Editor's note: The listing is available for downloading via* BYTE-*net Listings. The telephone number is* (603) 924-9820.]

Our procedure for implementing our strategy has one flaw. Consider table 6. If we XOR the 12 in row 1 with the parity value, we find that the number we want to leave in row 1 is 14. While that would make the board safe, it would also violate the rules of the game. The only sound move that makes the board in table 6 safe is to remove row 3. Thus, we must check to see that the value returned by the operation is a number less than the original number of objects in the row. The full unflawed strategy for a position that can be made safe is contained in the subroutine starting at line 790 of the listing. If we can't make the board safe, we just remove one object from the first row we can and hope that the opponent makes a mistake. (The subroutine beginning at line 690 includes everything but our hopes.)

Before leaving the program, look at line 320. Why is it there? After the player enters his move, the new board is redrawn and then the computer moves. Bitwise logic is what computers were born to do, so the computer will find the best move and redraw the position including its new move at approximately the rate that your computer can redraw a screen. You won't have time to see what the board looks like after your move if you don't slow the computer down. It's very irritating to people to be beaten by a machine that doesn't even appear to pause and think about the clever traps that they have devised. So I like to add a pause to make people feel better.

Now that you know the winning strategy to Nim, you might like to experiment with variations on the game. For example, you might limit the number of objects that can be removed from a row. What would be the optimal strategy for a game like that in table 3 if you could remove only 1 or 2 objects per turn? Alternatively, you might consider a three-person game. Would the ternary (base-3) number system hold the key to optimal strategy for the three-person game? Is there a winning strategy at all with a three-person game? I'd enjoy hearing your answers to any of these questions. Write me c/o BYTE, POB 372, Hancock, NH 03449. If I get some particularly clever responses, I'll report on them in a future column. ■


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A WORD FROM STEVE

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

MULTITASKING TIMEX

Dear Steve,

I'm one of them hackers, and I wonder if I can get a superhacker to consider a little problem of mine and point me in the right direction.

I have completed building a system using a Timex 1000 circuit board. I'd like to experiment with adding another Timex 1000 board to create a multitasking system. Any ideas you can offer I'll appreciate.

BILL JONES
Panama City, FL

A multitasking system usually contains system resources such as input and output devices that are used by all master and slave processors. Therefore, you will need some method of preventing more than one processor from accessing the same system resources at the same time.

There are several ways of avoiding this type of system clash. Two of the more common methods are to use an interrupt-driven system and to use a technique called temporary master access (TMA).

In an interrupt-driven system, an interrupt is initiated by a slave processor to the master processor when it requests use of the system resources. When the request is received by the master processor, it enters an interrupt mode and allows the slave processor the use of the system resources, depending on the priority of the requesting processor relative to any other processors making simultaneous requests. When the interrupt request is completed, the control of the system's resources is again returned to the master processor.

In a TMA system, the slave processor requests use of the system resources by sending a signal to a temporary master access control (TMAC) circuit. Again, depending on the priority of the request, the TMAC circuit will take control of the system resources from the master processor and allocate them to the requesting processor. The difference between a TMA system and an interrupt-driven system is that, during the TMA operation, the TMAC circuit becomes the system resource master.

These techniques are covered in detail in a book called Interfacing to S-100 IEEE 696 Microcomputers *by Sol Libes and Mark Garetz. If you intend to build a master/slave-type system, you should be familiar with the concepts offered in this book.*—Steve

SPEEDY RAM DISK

Dear Steve,

I enjoy your columns in BYTE, especially your responses to readers' questions. Your responses certainly educate. I hope my own inquiry can provoke a response of similar general utility.

A few months ago I purchased a Morrow MD-3, with which I am contented. The problem is that the thing is slow. For instance, it takes several minutes to back up two 20K-byte files using the public-domain "squeeze" utility. I'd like to install a RAM disk in my Morrow to speed it up, but I don't know how. Can it be done easily, perhaps as a Circuit Cellar project?

CHANDOS BROWN
Cambridge, MA

A RAM disk will speed up your operation considerably when you are saving and recalling data from the RAM disk. However, it will not increase your speed when you finally save or back up your data to the physical disk since the same software that you are presently using will still have to be used for that operation. Several minutes to back up two 20K-byte files does seem a little long, and it may be the "squeeze" utility that is causing the time increase.

I do agree that a RAM disk is a valuable feature. I use the RAM-disk feature available in my Trump Card (May and June 1984) for most of my word processing.

Building a low-cost RAM disk would be a good Circuit Cellar project, and I will keep it in mind. However, the problems with this kind of project are twofold. The first is the software. The software would by necessity be specific to a particular operating system, for example, CP/M 3.0, MS-DOS, etc., which would limit the appeal of such a project to some extent. The second problem is that a RAM disk has a lot of RAM on it. With today's prices, 256K bytes of RAM and the associated DIP sockets will cost about $150. Add to that the prices of the other components and a circuit board, and the low-cost RAM disk soon becomes a medium-cost RAM disk.—Steve

Z8 VALVE CONTROL

Dear Steve,

I am attempting to interface a computer to some solenoid switching valves. Would the Z8 System Controller be a good interface? I want to connect the Z8's serial port to the computer and its parallel port to the valves. The Z8 will decide which of 40 valves, up to 7, are to be actuated according to the commands of the computer, so that while the controller is acting upon the valves, the computer can do something else. The controller's program should run about 16K bytes. Does the Z8 have the memory to handle a program this size?

JEFF SCHNEIDER
San Francisco, CA

The Z8 System Controller would be an excellent choice for an application such as you described. A Z8 BASIC System Controller and a Z8 Memory I/O Expansion Board would give you five 8-bit ports that could control the 40 valves that you mention. The two boards would also give you up to 14K bytes of memory space for your program. If you

(continued)

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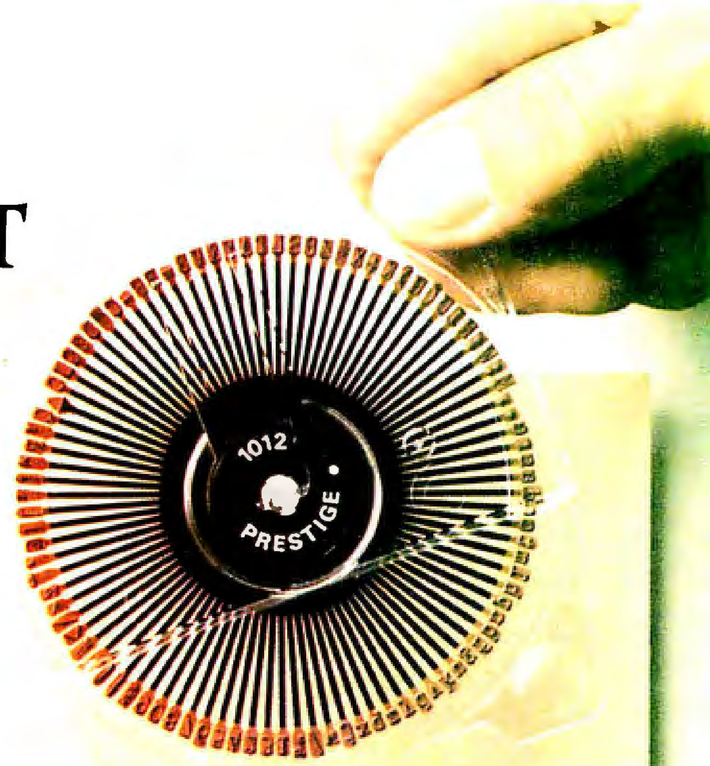

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still need additional capability, more I/O boards could be added to the system by adding them to the motherboard offered for the Z8 system.

You should also read my article in the December 1984 BYTE, "Build the Power I/O System," which describes methods of connecting peripherals in the real world. —Steve

POWER MONITOR

Dear Steve,

In your September 1984 Circuit Cellar project, "Build the AC Power Monitor," you have the differential amplifier IC1a hooked to a current-sensing resistor, Rs, which is connected directly to the hot side of the power line. This results in an input voltage to the IC of more than 100 volts, which exceeds the IC's input-voltage rating. How were you able to keep this IC from self-destructing—or is there something I don't understand? I would think it would be preferable to have the current-sensing resistor on the return or neutral side of the load. Your answer will be appreciated.

LAWRENCE SWANSON
Colorado Springs, CO

The differential amplifier shown in figure 1 of that article measures the voltage difference developed across Rs when current is flowing in the AC line. This voltage difference is the product of the current in the AC line times the value of Rs. The large AC voltage on the line is not detected by the differential amplifier because the ground systems of the AC line and the differential amplifier are isolated from each other by the 120-V-to-12.6-V power-supply transformer.

By using the isolation transformer, the measuring circuit and the AC line don't know electrically that each other exists. All the measuring circuit "knows" is that a voltage is applied between the input terminals of the differential amplifier and only this voltage difference is amplified in the circuit.—Steve

AIDS FOR THE BLIND

Dear Steve,

I have noted with interest your suggestion, mentioned in the October 1984 BYTE, of using acoustic ranging as an aid to the blind. Having had a personal experience with this type of electronic aid, I feel I must comment.

In the middle sixties I had a blind friend. During a trip to England in 1967 I became aware of a commercially available acoustic aid for the blind. A group of us ultimately purchased this for my friend, financed from a bloated laboratory coffee fund that we periodically dumped for good causes. The manufacturer was a British firm, Ultra Electronics, if I remember correctly. The acoustic transmitter/receiver was housed in a flashlight-like case powered by nickel-cadmium batteries, and the output was an audio signal via an earpiece. Frequency varied with distance, enabling the user to "see" with his ears. The experiment with my friend failed for some very practical reasons.

In working with my friend, I learned many surprising things about simple devices that perhaps explains their existence in the blind community. The white cane serves many more functions than I ever imagined. It senses distance from an object. It is useful in following a line, i.e., a hallway, a curb, or the border between a sidewalk and grass. It senses texture. It senses steps and other dangerous forms of surface texture. It warns other people of the blind person's presence.

While the acoustic device could sense distance quite accurately in some situations, the nature of the surface returning the signal tended to muddy the interpretation. Soft things, drapery walls, and people were difficult to interpret. Hard surfaces could be "seen" quite accurately.

Slant-range measurement (perhaps interpretation is a better word) was difficult. The device could be used to follow a line, the demarcation between sidewalk and grass boulevard, for example, but the return was substantially different if this was a concrete/snow demarcation. Patchy snow was exceedingly difficult to deal with.

The device just didn't see steps: another slant-range problem.

It was hard to see people, and they couldn't be aware of his problem since he was only carrying a "flashlight" in the daytime. Embarrassing collisions resulted.

After a diligent learning effort, my friend abandoned the electronic aid for his cane. He did not lack interest or ingenuity. He was in his third year of an electrical engineering education when blinded, and he later developed his own test instrumentation to enable him to advance into better and better jobs with a nationally known instrumentation company. The last I heard of him, he was working in the computer field with a municipal government. I believe it would have been difficult to find a more ideal subject for such an experiment.

In all fairness to the manufacturer, my friend did not take the training course that was required of all purchasers of the device. Because this was a British firm the travel cost was prohibitive, and I managed to twist one of the devices away from them with tears and wringing of the hands. The training course may have made a difference, but I doubt it; the difficulties are quite fundamental when given a bit of thought. My friend thought the device could have been of some assistance if it could have been incorporated into the cane. The cane, however, remained the primary system.

Finally, the blind are not really a big market, and most firms are not interested in helping with these types of products. Any serious development involves a high degree of altruism and must depend on the bright Ciarcias of the world.

RICHARD J. REILLY
St. Paul, MN

ASSEMBLED WHIMSI-BELL

Dear Steve,

I liked your July 1984 article about the Whimsi-Bell. I work in an office that could use such a device, and although I could build your design, I wonder if there isn't another such product on the market that's already built?

ERIC VANDERVEER
Los Alamos, NM

The only unit comparable to my Whimsi-Bell is made by Heath. The company sells a kit that performs a similar function but with only four tunes to choose from. It isn't offered in assembled form either. I haven't seen any assembled units advertised. However, I still believe that other products must be available.

The Whimsi-Bell is an easy-to-assemble kit that represents a low-cost solution to your problem.—Steve ■

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 any of 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.

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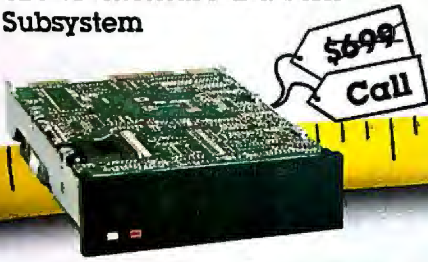

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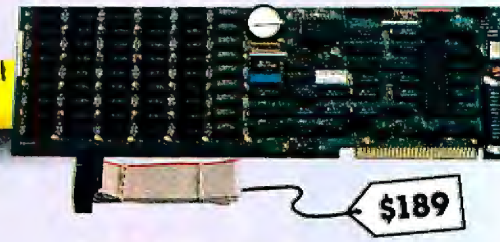

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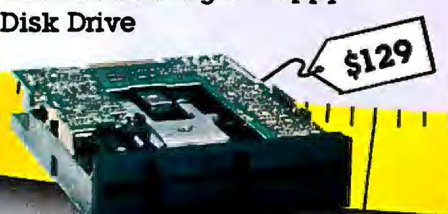

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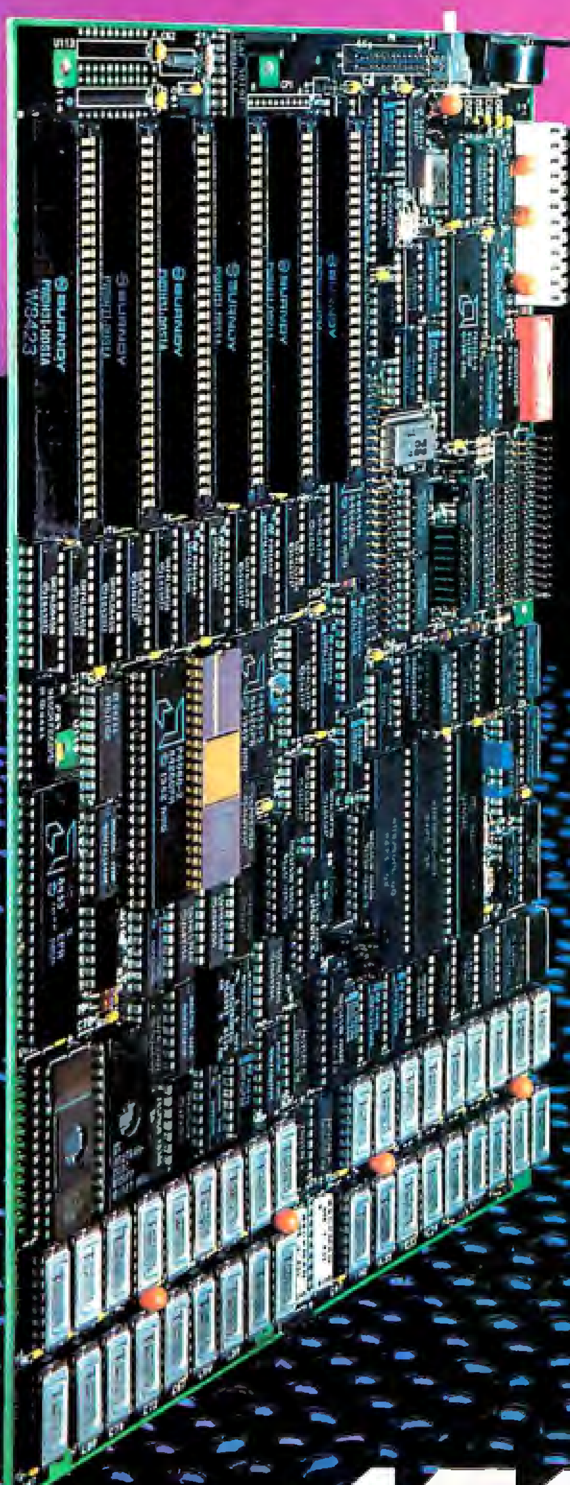

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BY DAN SANDBERG

An algorithm that converts decimals to fractions

IF YOU NEEDED the solution of 11/17 + 13/19 − 139/323 − 37/15 + 47/21 in fractional form, finding the lowest common denominator might be difficult. Instead, you can plug the decimal equivalent, 0.672357364, into the following program and obtain a solution of 7601/11305.

The program can help you factor 133133/1101373 to 11/91 or verify that sin 60° = $\sqrt{3}/2$.

Listing 1, which returns a fraction for every decimal input, uses a short algorithm. First, the program inverts the decimal to obtain a number greater than 1. The routine saves the integer and again inverts the decimal remainder. So it continues, until the algorithm finds a denominator that supports an integer numerator.

To find the denominator, the program uses the algorithm $x_n \times a_{n-1} + a_{n-2} = a_n$, where n equals the number of inversions and x_n equals the saved integers. Figure 1 uses 0.5625 as an example. Using listing 1, you will obtain exact fractions only if the total number of digits in the fraction is less than the number of digits in the computer's precision. For example, if the calculating precision is 12 digits, the computer can construct a fraction like 135791/97531. But if the numerator or denominator contained one more digit, the computer would generate, unless you increased the calculating precision, only an almost exact solution. Try running the program in single and double precision.

If you want fractions printed in mixed form, add

```
35 IF INT(A)>0 THEN PRINT
INT(A);" + ";C*(A - INT(A));"/";C
```

Listing 2 is shorter and faster, but it may require higher calculating precision. It never returns an inexact (even if close) fraction; it returns an error if you input insufficient precision.

Like listing 1, the program inverts the incoming number with a special algorithm until it finds the denominator. If the fraction is too difficult (i.e., requiring greater precision), an overflow error will occur. If you enter too few decimal digits, the program, which does not round A*B to an integer, will warn you by writing a decimal numerator that is close to an integer. With a precision of 12 digits, 0.333333333333 will generate the answer 1/3. However, 0.3333333333 will yield 0.9999999999/3. On the other hand, 0.333 gives the answer 333/1000, a useful feature for those needing precise fractions. Others might round A*B to the nearest integer. The constant, 0.00001, in line 110 is suitable for 12-digit calculating precision. Try constants like 0.0001 and 0.000001 to produce the best possible conversion capability.

For mixed output, you can add

```
130 PRINT INT(A);" + ";(A -
INT(A))*B;"/";B
```

Listing 3 detects constants like π, $\sqrt{2}$, and $\sqrt{3}$; enter the sin 60° (0.8660254) and get $\sqrt{3}/2$. The program divides and multiplies the incoming decimals by the constants, one at a time, and uses a slightly modified version of listing 2 as a subroutine to determine whether the constants form part of the fraction. The decimal equivalent of arctan (−1), −0.7853983, gives the answer $-\pi/4$. arcsin −1 returns $-\pi/2$. You need not struggle with tables.

Note that the program always places the square root in the numerator. Therefore, $1/\sqrt{3}$ will appear as

(continued)

Dan Sandberg (Täppgatan 32, S-151 33 Södertälje, Sweden) is a medical student at the Karolinska Institute in Stockholm.

$0.8660254 \approx \sqrt{3}/2$

N	Decimal	Inversion	Integer(X)	Remainder
1	0.5625	1/0.5625	1	0.7777
2	0.7777	1/0.7777	1	0.2857
3	0.2857	1/0.2857	3	0.5
4	0.5	1/0.5	2	0

The following equation determines the denominator:

	x_n	*	a_{n-1}	+	a_{n-2}	=	a_n
$n=0$	1	*	1	+	0	=	1
$n=1$	1	*	1	+	1	=	2
$n=2$	3	*	2	+	1	=	7
$n=3$	2	*	7	+	2	=	16

Once we know the denominator, the numerator is simple to find, since $N = Q * D$. Here, $N = 0.5625 * 16 = 9$. Therefore, 0.5625 equals 9/16. (Note that, in the first equation, a_{n-1} and a_{n-2} are always set to 1 and 0 respectively.)

Figure 1: *An illustration of the algorithm in listing 1. The entry, 0.5625, is inverted. The routine saves the integer, 1, and inverts the result, 0.7777. Continuing the routine produces four integers: 1, 1, 3, and 2. The expression* C = INT(E)*C + B *in line 30 of listing 1 searches, as in the figure, for a denominator that supports an integer numerator.*

Listing 1: *This short program returns a fraction for every decimal input. Figure 1 helps to explain the algorithm.*

```
10 INPUT A:B=0:C=1:
   D=ABS(A-INT(A))
20 IF D=0 THEN 40
30 E=1/D:F=C:C=INT(E)*C+B:B=F:
   D=E-INT(E):IF A*C< >INT(A*C)
   THEN 30
40 PRINT A*C;"/";C:GOTO 10
```

Listing 2: *A shorter and faster version of listing 1, which returns only exact fractions. You can adjust the constant in line 110 for different conversion capabilities.*

```
100 INPUT A: C=ABS(A):B=1
110 B=B/C:C=(1/C)-INT(1/C):IF
    C>0.00001 THEN 110
120 B=INT(B): PRINT A*B;"/";B:
    GOTO 100
```

Listing 3: *This program uses a slightly modified version of listing 2 as a subroutine to determine whether constants like* π *and* $\sqrt{2}$ *form part of the fraction.*

```
10 K$=" ":L$=" ":INPUT H:A=H:GOSUB 100
20 K$="sqr 2":A=H/SQR(2):GOSUB 100
30 K$="sqr 3":A=H/SQR(3):GOSUB 100
40 K$="sqr 5":A=H/SQR(5):GOSUB 100
45 PI=3.141592653589793#
50 K$="PI": A=H/PI:GOSUB 100
60 K$="PI exp 2":A=H/PI/PI:GOSUB 100
70 K$=" ":L$="PI":A=H*PI:GOSUB 100
80 L$="PI exp 2":A=H*PI*PI:GOSUB 100
100 C=ABS(A):B=1
110 B=B/C:C=(1/C)-INT(1/C):IF B>10000 THEN RETURN
120 IF C>0.00001 THEN 110
130 B=INT(B): PRINT A*B;K$;"/";B;L$:END
```

SQR 3/3. To eliminate this, simply add

```
125 B=INT(B):IF SQR(B)= H/A
THEN L$=K$:K$=" ":A=A*B:B=1
```

I am sure that the third listing will be a useful subroutine for a variety of tasks. You could easily add other constants for the program to search. ■

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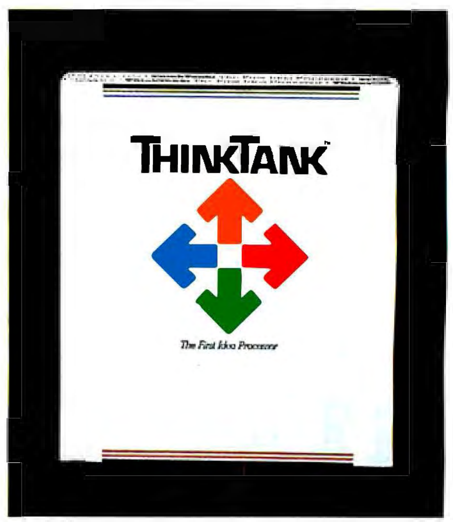

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COMPUTING PI

BY DAVID J. CRAWFORD

Using infinite series to compute mathematical functions

THE ANCIENT GREEKS, who had an almost religious obsession with geometry, were well aware that the ratio of the circumference of a circle to its diameter is a constant. However, they had little success in measuring the value of the constant, which we now symbolize with the lowercase Greek letter "π" (pi). Even Archimedes, regarded as one of the three greatest mathematicians of all time, could do no better than estimate π somewhere between $3\frac{1}{7}$ and $3\frac{10}{71}$. There were two reasons for this.

First, the numbering system of the Greeks did not allow easy arithmetic computations. Second, and most important, they had no algebraic method to compute π; instead, they summed the perimeter of a many-sided polygon.

In fact, mathematicians had no method for approximating the decimal value of π and other irrational numbers until the arrival of calculus in the late seventeenth century. The new tool was the *infinite series*, especially the technique now known as Taylor series expansion.

Like many other calculus operations named after individuals, full credit for discovery of the Taylor series should not belong to one person. In 1712, Brook Taylor (1685–1731), a mathematician at Cambridge, generalized the series and put it on a sound theoretical footing. Even before his birth, however, other mathematicians had discovered the "magical" properties of the infinite series.

By 1671, the Scottish mathematician James Gregory knew that the function arctangent x (meaning "the angle whose tangent is x") equaled the sum of the series

$$x - \frac{1}{3}(x^3) + \frac{1}{5}(x^5) - \frac{1}{7}(x^7) + \ldots$$

for values of x between -1 and $+1$. This series, actually derived using a geometric rather than a Taylor series, provided a method for computing π because arctangent 1 equals $\frac{\pi}{4}$ in the radian measure of angles used in the calculus. Therefore, 4 times arctangent 1 is the exact value of π and is expressed as the series

$$\frac{4}{1} - \frac{4}{3} + \frac{4}{5} - \frac{4}{7} + \frac{4}{9} - \ldots$$

Listing 1 sums the terms in this series. [*Editor's note: The listings for the programs in this article are available for downloading via* BYTEnet Listings. *The telephone number is* (603) 924-9820.]

Line 190 declares the variables as double-precision. Line 210 prints a heading for each set of 10 terms. Lines 220–230 add another term to the sum. Lines 240–270 print a line of formatted output. Lines 280–300 update the variables in preparation for computing the next term in the series. Line 310 jumps back to do the next term. The program will run indefinitely.

Table 1 presents the output of listing 1 for the first 10 terms of the series.

The cumulative sum in the right-hand column is alternately greater than and less than the actual value of π. As more terms are added, the sum will continue to oscillate back and forth, but closer and closer to the true value of π.

Mathematicians have referred to this series as an elegant method for computing π because it is a clear and very simple formulation; however, a mathematician would be the first to admit that in practical terms the

(continued)

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method is virtually useless. To illustrate the impracticality of the series, it is only necessary to let the program run for a few minutes. Table 2 presents the output after 1000 terms.

The total is beginning to look more like π, but we have added 1000 terms without resolving the third decimal place. Considering the amount of number crunching that has been done, this is not a satisfactory result.

John Machin found the answer to the problem in 1706. Another Scotsman and one of Taylor's instructors at Cambridge, Machin was able to show through the use of trigonometric identities that "arctangent 1" is exactly equal to "4 arctangent $\frac{1}{5}$ – arctangent $\frac{1}{239}$." This rather bizarre-looking equality has considerable significance because, when computed as an infinite series, it will converge much more rapidly. The infinite series for computing π raises x to higher and higher powers. In listing 1, $x=1$ and remains equal to 1 when raised to higher powers. If, however, x is a fraction of 1, as it is in Machin's identity, higher powers of x will become smaller and smaller, speeding the convergence.

To use the new identity to compute π, we again multiply by 4 and expand two different series. First, we compute the sum of the series for "16 arctangent $\frac{1}{5}$" as follows:

$$16(\tfrac{1}{5}) - \tfrac{16}{3}(\tfrac{1}{5})^3 + \tfrac{16}{5}(\tfrac{1}{5})^5 - \ldots$$

Then we calculate "4 arctangent $\frac{1}{239}$" with the series

$$4(\tfrac{1}{239}) - \tfrac{4}{3}(\tfrac{1}{239})^3 + \tfrac{4}{5}(\tfrac{1}{239})^5 - \ldots$$

and subtract the second sum from the first. The result will again equal π but will require much less computation.

To see just how quickly these new series converge, we use listing 2, which incorporates the first program as a subroutine for summing a given number of terms of the arctangent series.

Line 190 declares the variables as double-precision. Line 200 sets up the parameters for the first call of the arctangent-series subroutine in line 210. Line 220 temporarily stores the returned sum. Line 230 sets up the second subroutine call in line 240. Lines 250–260 print the final answer. Table 3 is the complete output of the program.

Note how quickly the magnitude of the denominators in the second column increases for both series. The result, given in the lower right-hand corner of the output, is the value of π correct to 15 decimal places. The advantages of this method are obvious; it required only 12 terms of the first series and 4 of the second.

There is no point in adding any more terms to either series because for both the last term has an absolute value less than 10^{-16}; the first 15 decimal places would not subsequently change. In fact, adding only a few more terms to the second series might cause an overflow error because most microcomputer programming languages are not equipped to handle numbers whose base-10 exponents exceed + or −39.

The value of π computed above is the most accurate that Microsoft BASIC can derive in its double-precision mode. More accuracy would require special routines to handle decimal numbers with more than 16 significant figures. Of course, this has already been done. One of the first

(continued)

Listing 1: *Summing the series 4 times arctangent 1.*

```
100 REM *******************************
110 REM *                             *
120 REM *            PI1.BAS          *
130 REM *                             *
140 REM *******************************
150 REM
160 REM  THIS PROGRAM COMPUTES PI USING THE INFINITE-SERIES EXPANSION
170 REM  OF 4 ARCTANGENT 1.
180 REM
190 DEFDBL A-D,P
200 A=4 : B=1 : C=1 : E=1 : PI=0
210 IF RIGHT$(STR$(E),1)="1" THEN PRINT "TERM #","RATIO",
    "DECIMAL",,"PI TOTAL"
220 D=C*A/B
230 PI=PI+D
240 PRINT E,
250 IF SGN(C)=1 THEN PRINT "+ "; ELSE PRINT "- ";
260 PRINT STR$(A);" /";STR$(B),
270 PRINT TAB(29);D;TAB(56);PI
280 C= -C
290 B=B+2
300 E=E+1
310 GOTO 210
```

Table 1: *The first 10 terms derived from listing 1.*

Term #	Ratio	Decimal	Pi Total
1	+ 4 / 1	4	4
2	− 4 / 3	−1.333333333333333	2.666666666666667
3	+ 4 / 5	0.8	3.466666666666667
4	− 4 / 7	−0.5714285714285714	2.895238095238095
5	+ 4 / 9	0.4444444444444444	3.33968253968254
6	− 4 / 11	−0.3636363636363636	2.976046176046176
7	+ 4 / 13	0.3076923076923077	3.283738483738484
8	− 4 / 15	−0.2666666666666667	3.017071817071817
9	+ 4 / 17	0.2352941176470588	3.252365934718876
10	− 4 / 19	−0.2105263157894737	3.041839618929402

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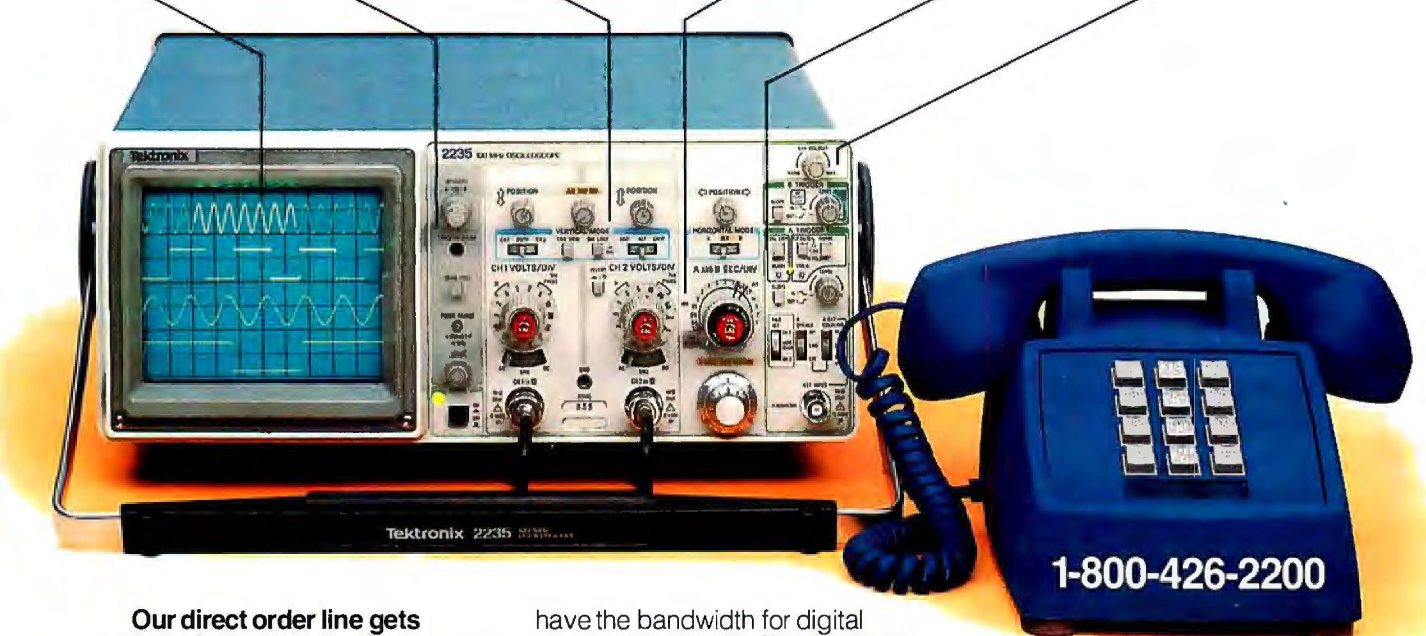

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tasks given to digital computers at the dawn of the computer age was to calculate the value of π to an absurd number of decimal places. In 1949, at the Army Ballistic Research Center in Aberdeen, Maryland, the original ENIAC, a vacuum-tube computer, computed π to 2037 decimal places. Over the next 20 years, the accuracy increased many times, until in Paris in 1967, a Control Data 6600 calculated

(continued)

Table 2: *Later output from listing 1.*

Term #	Ratio	Decimal	Pi Total
1001	+ 4 / 2001	1.999000499750125D-03	3.142591654339554
1002	– 4 / 2003	–1.99700449326011D-03	3.140594649846294
1003	+ 4 / 2005	1.99501246882793D-03	3.142589662315122
1004	– 4 / 2007	–1.993024414549078D-03	3.140596637900573
1005	+ 4 / 2009	1.991040318566451D-03	3.14258767821914
1006	– 4 / 2011	–1.989060169070114D-03	3.14059861805007
1007	+ 4 / 2013	1.987083954297069D-03	3.142585702004367
1008	– 4 / 2015	–1.985111662531017D-03	3.140600590341836
1009	+ 4 / 2017	1.983143282102132D-03	3.142583733623938
1010	– 4 / 2019	–1.981178801386825D-03	3.140602554822551

Listing 2: *Summing Machin's series.*

```
100 REM ********************************
110 REM *                              *
120 REM *           PI2.BAS            *
130 REM *                              *
140 REM ********************************
150 REM
160 REM  THIS PROGRAM COMPUTES PI USING THE INFINITE-SERIES EXPANSION
170 REM  OF "16 ARCTANGENT 1/5 - 4 ARCTANGENT 1/239."
180 REM
190 DEFDBL B-G,P
200 A=12 : B=16 : C=5
210 GOSUB 280
220 P1=P
230 A=4 : B=4 : C=239
240 GOSUB 280
250 PRINT "16 ARCTAN 1/5     -     4 ARCTAN 1/239     =     PI"
260 PRINT P1,P,P1-P
270 STOP
280 REM *** THIS SUBROUTINE SUMS "A" TERMS OF THE INFINITE SERIES
290 REM      FOR "B" TIMES THE ANGLE WHOSE TANGENT IS (1/"C")
300 REM      AND RETURNS THE SUM AS "P."
310 PRINT "INFINITE SERIES FOR";B;"ARCTAN( 1 /";C;")"
320 PRINT "TERM #";TAB(10);"RATIO";TAB(38);"DECIMAL";TAB(61);
    "SUBTOTAL"
330 D=1 : E=1 : F=C : P=0
340 FOR X=1 TO A
350 G=E*F
360 P=P+D*B/G
370 PRINT X;TAB(8)
380 IF SGN(D)=1 THEN PRINT "+"; ELSE PRINT "-";
390 PRINT STR$(B);" /";STR$(G);TAB(37);D*B/G;TAB(60);P
400 F=F*C*C
410 E=E+2
420 D=-D
430 NEXT X
440 PRINT : RETURN
```

Table 3: *The complete output of listing 2.*

Infinite series for 16 arctan(1 / 5)

Term #	Ratio	Decimal	Subtotal
1	+ 16 / 5	3.2	3.2
2	− 16 / 375	− 0.04266666666666667	3.157333333333333
3	+ 16 / 15625	0.001024	3.158357333333333
4	− 16 / 546875	− 2.925714285714286D-05	3.158328076190476
5	+ 16 / 17578125	9.102222222222222D-07	3.158328986412699
6	− 16 / 537109375	− 2.978909090909091D-08	3.158328956623608
7	+ 16 / 15869140625	1.008246153846154D-09	3.158328957631854
8	− 16 / 457763671875	− 3.495253333333333D-11	3.158328957596901
9	+ 16 / 12969970703125	1.233618823529412D-12	3.158328957598135
10	− 16 / 362396240234375	− 4.415056842105263D-14	3.158328957598091
11	+ 16 / 1.001358032226563D + 16	1.597830095238095D-15	3.158328957598092
12	− 16 / 2.741813659667969D + 17	− 5.835553391304348D-17	3.158328957598092

Infinite series for 4 arctan(1 / 239)

Term #	Ratio	Decimal	Subtotal
1	+ 4 / 239	0.01673640167364017	0.01673640167364017
2	− 4 / 40955757	− 9.766636714833522D-08	0.01673630400727302
3	+ 4 / 3899056325995	1.025889257698589D-12	0.01673630400829891
4	− 4 / 3.118051949560246D + 17	− 1.282852263113878D-17	0.0167363040082989

16 arctan 1/5	−	4 arctan 1/239	=	pi
3.158328957598092		0.0167363040082989		3.141592653589793

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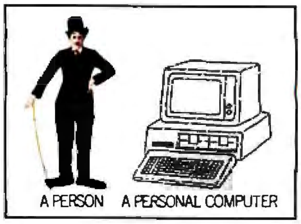

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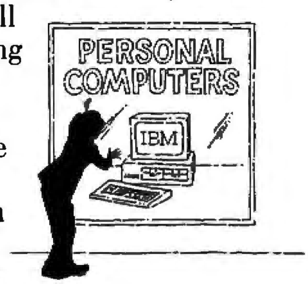

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THE COMMODORE DISK AND PRINTER HANDBOOK, David Bridges and Helen Naylor. North Pomfret, VT: David & Charles Inc., 1984; 212 pages, 15.5 by 23 cm, softcover, ISBN 0-9465-7623-8, $14.95.

COMMODORE LOGO, Harold Bailey, Kathleen Brautigam, and Trudy Doran. Bowie, MD: Brady Communications, 1984; 320 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89303-376-6, $14.95.

COMMODORE 64: TUTOR FOR HOME AND SCHOOL, Julie Knott and Dave Prochnow. Glenview, IL: Scott, Foresman and Co., 1985; 220 pages, 19.5 by 23.5 cm, softcover, ISBN 0-673-18074-3, $15.95.

COMMUNICATING WITH DATABASES IN NATURAL LANGUAGE, Mark Wallace. New York: John Wiley & Sons, 1984; 172 pages, 17 by 24.5 cm, hardcover, ISBN 0-470-20105-3, $29.95

COMPAQ PORTABLE COMPUTER: USE, APPLICATIONS, AND BASIC, William Arnold. New York: Holt, Rinehart and Winston, 1984; 240 pages, 17 by 23 cm, softcover, ISBN 0-03-064119-5, $18.45.

THE COMPLETE GUIDE FOR THE COMMODORE 64, Spencer Bateson. North Pomfret, VT: David & Charles Inc., 1984; 334 pages, 13.5 by 21.5 cm, softcover, ISBN 0-9465-7621-1, $18.95.

THE COMPUTER FREELANCER'S HANDBOOK, Ardy Friedberg. New York: New American Library, 1984; 160 pages, 15 by 22.5 cm, softcover, ISBN 0-452-25562-7, $10.95.

COMPUTER PROGRAMMING FOR THE COMPLEAT IDIOT, Donald McCunn. San Francisco, CA: Design Enterprises of San Francisco, 1984; 208 pages, 21 by 27.5 cm, softcover, ISBN 0-932538-14-2, $10.95.

COMPUTER PROGRAMMING IN FORTRAN THE EASY WAY, Lawrence S. Leff and Arlene Podos. Woodbury, NY: Barron's Educational Series, 1985; 326 pages, 19.5 by 27.5 cm, softcover, ISBN 0-8120-2800-7, $7.95.

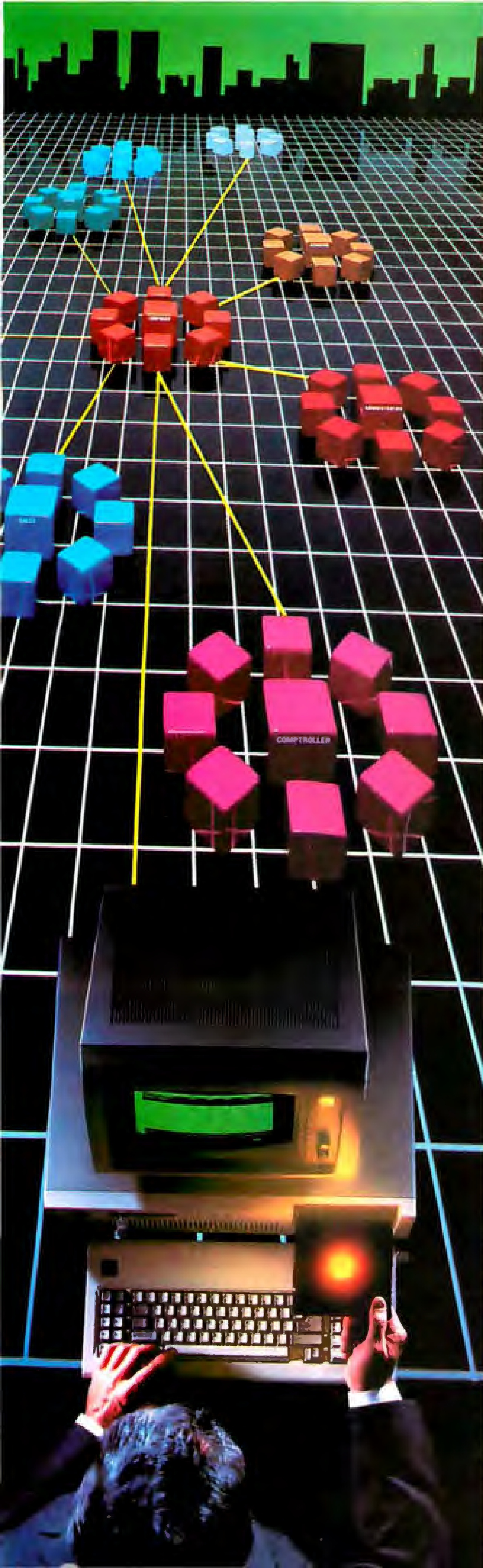
CP/M SOFTWARE DIRECTORY, Xerox Corporation. New York: R. R. Bowker Co., 1984; 768 pages, 21.5 by 28 cm, softcover, ISBN 0-8352-1973-9, $24.95.

CREATIVE COMPUTER GRAPHICS, Annabel Jankel and Rocky Morton. New York: Cambridge University Press, 1984; 150 pages, 30 by 30.5 cm, softcover, ISBN 0-521-26251-8, $29.95.

DATABASE AND FILE MANAGEMENT SYSTEMS FOR THE MICRO-

(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.*



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COMPUTER, Nelson T. Dinerstein. Glenview, IL: Scott, Foresman and Co., 1985; 128 pages, 19 by 23 cm, softcover, ISBN 0-673-18088-3, $15.95.

DATABASES: ROLE AND STRUCTURE, P. M. Stocker, P. M. D. Gray, and M. P. Atkinson, eds. New York: Cambridge University Press, 1984; 416 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-521-25430-2, $39.50.

DBASE II & DBASE III: AN INTRODUCTION FOR INFORMATION SERVICES, Roger C. Palmer. Studio City, CA: Pacific Information, 1984; 102 pages, 21.5 by 28 cm, softcover, ISBN 0-913203-09-2, $25.

DIAGRAMMING TECHNIQUES FOR ANALYSTS AND PROGRAMMERS, James Martin and Carma McClure. Englewood Cliffs, NJ: Prentice-Hall, 1985; 414 pages, 18 by 24.5 cm, hardcover, ISBN 0-13-208794-4, $40.

DIGITAL AND MICROPROCESSOR ENGINEERING, S. J. Cahill. New York: John Wiley & Sons, 1984; 514 pages, 15 by 22.5 cm, softcover, ISBN 0-470-27301-1, $34.95.

ELECTRONICS THE EASY WAY, Rex Miller. Woodbury, NY: Barron's Educational Series, 1984; 336 pages, 19.5 by 27.5 cm, softcover, ISBN 0-8120-2709-4, $8.95.

ELECTRONICS READY REFERENCE MANUAL, E. Pasahow. New York: McGraw-Hill, 1985; 588 pages, 10.5 by 14.5 cm, hardcover, ISBN 0-07-048723-5, $24.50.

THE ENDLESS APPLE, Charles Rubin. Bellevue, WA: Microsoft Press, 1984; 286 pages, 19 by 23.5 cm, softcover, ISBN 0-914845-27-6, $15.95.

EPSON PRINTER USER'S HANDBOOK, the staff of Weber Systems. New York: Ballantine Books, 1984; 310 pages, 14 by 22 cm, softcover, ISBN 0-345-31842-0, $9.95.

THE EVERYONE CAN BUILD A ROBOT BOOK, Kendra Bonnett, Gene Oldfield, and the editors of *DIGIT Magazine*. New York: Simon & Schuster, 1984; 86 pages, 19 by 23.5 cm, softcover, ISBN 0-671-53059-3, $8.95.

EXPANDING YOUR IBM PC, Bil. Alvernaz. Bowie, MD: Brady Communications, 1985; 254 pages, 18 by 23.5 cm, softcover, ISBN 0-89303-445-2, $16.95.

EXPERT SYSTEMS, Richard Forsyth, ed. New York: Chapman and Hall, 1984; 248 pages, 15 by 23.5 pages, softcover, ISBN 0-412-26280-0, $19.95.

EXPLORING CAREERS AS A COMPUTER TECHNICIAN, Jean W. Spencer. New York: Rosen Publishing Group, 1985; 128 pages, 14.5 by 22 cm, hardcover, ISBN 0-8239-0626-4, $8.97.

FANCY PROGRAMMING IN IBM PC BASIC, Gabriel Cuellar. Reston, VA: Reston Publishing, 1984; 278 pages, 15 by 22.5 cm, softcover, ISBN 0-8359-1860-2, $19.95.

THE FIFTH GENERATION, ARTIFICIAL INTELLIGENCE AND JAPAN'S COMPUTER CHALLENGE TO THE WORLD, Edward A. Feigenbaum and Pamela McCorduck. New York: New American Library, 1984; 354 pages, 10.5 by 18 cm, softcover, ISBN 0-451-13153-3, $3.95.

FINANCIAL PLANNING SOFTWARE TOOL KIT, Robert T. LeClair. Glenview, IL: Scott, Foresman and Co., 1985; 80 pages, 19 by 23 cm, spiral-bound, ISBN 0-673-15974-4, $44.95. Includes floppy disk.

FUNDAMENTALS OF HUMAN–COMPUTER INTERACTION, Andrew Monk, ed. Orlando, FL: Academic Press, 1984; 312 pages, 16 by 23.5, hardcover, ISBN 0-12-504580-8, $26.50.

FUNDAMENTALS OF ROBOTICS, Larry Heath. Reston, VA: Reston Publishing, 1985; 432 pages, 18 by 24 cm, hardcover, ISBN 0-8359-2189-1, $32.95.

GETTING WHAT YOU WANT FROM THE TRS-80 MODEL 100, E. Paul Cone. New York: Harper & Row, 1984; 256 pages, 18.5 by 23 cm, softcover, ISBN 0-06-669022-6, $14.95.

THE GRAPHIC MACINTOSH BOOK, Richard Maran. Toronto, Ontario: Holt, Rinehart & Winston of Canada Ltd., 1984;

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48 pages, 21.5 by 28 cm, softcover, ISBN 0-03-928875-7, $9.95.

THE GRAPHIC PC-DOS BOOK, Richard Maran. Toronto, Ontario: Holt, Rinehart & Winston of Canada Ltd., 1984; 30 pages, 21.5 by 28 cm, softcover, ISBN 0-03-928876-5, $9.95.

A GUIDE TO APPLE WRITER II/IIE, John A. Allen and Alex Ayres. Reston, VA: Reston Publishing, 1984; 352 pages, 15 by 23 cm, softcover, ISBN 0-8359-2613-3, $18.95.

HACKERS: HEROES OF THE COMPUTER REVOLUTION, Steven Levy. Garden City, NY: Anchor Press/Doubleday, 1984; 480 pages, 14.5 by 21.5 cm, hardcover, ISBN 0-385-19195-2, $17.95.

HERE COME THE CLONES! Melody Newrock. New York: McGraw-Hill, 1984; 206 pages, 15 by 23 cm, softcover, ISBN 0-07-046458-8, $18.95.

A HOBBYIST'S GUIDE TO COMPUTER EXPERIMENTATION, John D. Lenk. Englewood Cliffs, NJ: Prentice-Hall, 1985; 304 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-13-392473-4, $25.95.

HOME ACCOUNTANT PLUS, Leslie Lauderdale. Reston, VA: Reston Publishing, 1985; 192 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-2846-2, $16.95.

HOW TO BUILD PROGRAMS ON YOUR COMMODORE 64, Lou Goldstein. Bowie, MD: Brady Communications, 1985; 256 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89303-522-X, $13.95.

HOW TO EXCEL ON YOUR ATARI 600XL AND 800XL, Timothy O. Knight. New York: McGraw-Hill, 1985; 144 pages, 14 by 20.5 cm, spiral-bound, ISBN 0-07-035104-X, $9.95.

HOW TO MAKE MONEY WITH YOUR MICRO, Herman Holtz. New York: John Wiley & Sons, 1984; 336 pages, 15 by 22.5 cm, softcover, ISBN 0-471-88455-3, $14.95.

HOW TO MULTIPLY MATRICES FASTER, Victor Pan. Lecture Notes in Computer Science #179. New York: Springer-Verlag, 1984; 224 pages, 16.5 by 24 cm, softcover, ISBN 0-387-13866-8, $11.

HOW TO START AND RUN YOUR OWN WORD-PROCESSING BUSINESS, Gary S. Belkin. New York: John Wiley & Sons, 1984; 216 pages, 13.5 by 21 cm, softcover, ISBN 0-471-88396-4, $9.95.

HUMAN FACTORS AND INTERACTIVE COMPUTER SYSTEMS, Yannis Vassiliou, ed. Norwood, NJ: Ablex Publishing Corp., 1984; 304 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-89391-182-8, $35.

IBM PC GRAPHICS, John Clark Craig and Jeff Bretz. Blue Ridge Summit, PA: Tab Books, 1984; 268 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1860-0, $13.95.

THE IBM PCJR FOR STUDENTS: USER'S HANDBOOK, staff of Weber Systems. Cleveland, OH: Weber Systems, 1984; 564 pages, 15 by 23 cm, softcover, ISBN 0-938862-25-1, $17.95.

THE INDIVIDUAL INVESTOR'S MICROCOMPUTER RESOURCE GUIDE, Norm Nicholson. Chicago, IL: Investment Information Services Press, 1984; 204 pages, 15.5 by 22.5 cm, softcover, ISBN 0-930369-01-7, $11.95.

INFORMATION PAYOFF: THE TRANSFORMATION OF WORK IN THE ELECTRONIC AGE, Paul A. Strassmann. New York: The Free Press, 1985; 320 pages, 16 by 24 cm, hardcover, ISBN 0-02-931720-7, $20.75.

INTERACTIVE FORTRAN 77, Ian Chivers and Malcolm Clark. New York: John Wiley & Sons, 1984; 232 pages, 17 by 24.5 cm, hardcover, ISBN 0-470-20101-0, $29.95.

INTRODUCTION TO INTEGRATED-CIRCUIT LAYOUT, Brian Spinks. Englewood Cliffs, NJ: Prentice-Hall, 1985; 190 pages, 21 by 28 cm, softcover, ISBN 0-13-485400-4, $19.95.

AN INTRODUCTION TO PROGRAMMING THE SINCLAIR QL, R. A. and J. W. Penfold. London: Bernard Babani Ltd., 1984; 112

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pages, 11 by 17.5 cm, softcover, ISBN 0-85934-125-9, £1.95.

An Introduction to 6502 Machine Code, R. A. and J. W. Penfold. London: Bernard Babani Ltd., 1984; 112 pages, 11 by 17.5 cm, softcover, ISBN 0-85934-122-4, £1.95.

An Introduction to Z80 Machine Code, R. A. and J. W. Penfold. London: Bernard Babani Ltd., 1984; 144 pages, 11 by 17.5 cm, softcover, ISBN 0-85934-127-5, £2.25.

Ken Uston's Illustrated Guide to the Apple IIe, Ken Uston. Englewood Cliffs, NJ: Prentice-Hall, 1984; 288 pages, 17.5 by 23 cm, softcover, ISBN 0-13-514688-7, $9.95.

Ken Uston's Illustrated Guide to the Commodore 64, Ken Uston. Englewood Cliffs, NJ: Prentice-Hall, 1984; 272 pages, 17.5 by 23 cm, softcover, ISBN 0-13-514621-6, $9.95.

Keyboard Challenge with Commodore 64, David D. Busch. Bowie, MD: Brady Communications, 1985; 204 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89303-601-3, $12.95.

Local Area Networks, James Harry Green. Glenview, IL: Scott, Foresman and Co., 1985; 288 pages, 16 by 23.5 cm, softcover, ISBN 0-673-18065-4, $17.95.

Magic Writing, John Stratton with Dorothy Stratton. New York: New American Library, 1984; 368 pages, 13.5 by 20 cm, softcover, ISBN 0-452-25563-5, $12.95.

Making Money with Your Home Computer, Dana K. Cassell. New York: Dodd, Mead & Co., 1984; 160 pages, 13.5 by 21 cm, softcover, ISBN 0-396-08448-6, $5.95.

Making Music with Microprocessors, Bonaventura Antony Paturzo. Blue Ridge Summit, PA: Tab Books, 1984; 294 pages, 13 by 21 cm, softcover, ISBN 0-8306-1729-9, $11.95.

Manager's Guide to Small Computers, Charles W. Bradley. New York: Holt, Rinehart and Winston, 1984; 366 pages, 17.5 by 23, softcover, ISBN 0-03-059538-X, $20.45.

The Master Handbook of High-Level Microcomputer Languages, Charles F. Taylor. Blue Ridge Summit, PA: Tab Books, 1984; 366 pages, 18.5 by 23.5 cm, softcover, ISBN 0-8306-1733-7, $15.50.

Mastering the 8088 Microprocessor, L. V. Dao. Blue Ridge Summit, PA: Tab Books, 1984; 336 pages, 13 by 21 cm, softcover, ISBN 0-8306-1888-0, $15.95.

Mastering FORTH, Anita Anderson and Martin Tracy. Bowie, MD: Brady Communications, 1984; 224 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89303-660-9, $19.95.

Mastering Symphony, Douglas Cobb. Berkeley, CA: Sybex, 1984; 800 pages, 17.5 by 23 cm, softcover, ISBN 0-89588-244-2, $24.95.

Micro Interfacing Circuits, Book 2, R. A. Penfold. London: Bernard Babani Ltd., 1984; 96 pages, 11 by 17 cm, softcover, ISBN 0-85934-106-2, £2.25.

Microcomputer Assembly Language Programming, Gary Elfring. New York: Van Nostrand Reinhold, 1984; 314 pages, 15.5 by 22.5 cm, hardcover, ISBN 0-442-22261-0, $29.95.

Microcomputer Buyer's Guide, 3rd ed., Tony Webster. New York: McGraw-Hill, 1984; 360 pages, 21 by 27.5 cm, softcover, ISBN 0-07-068963-6, $19.95.

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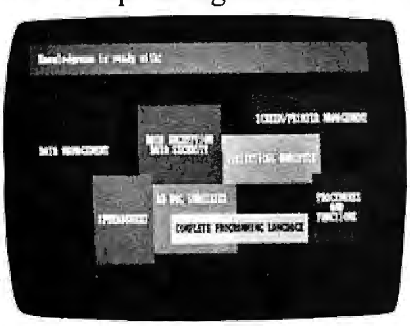

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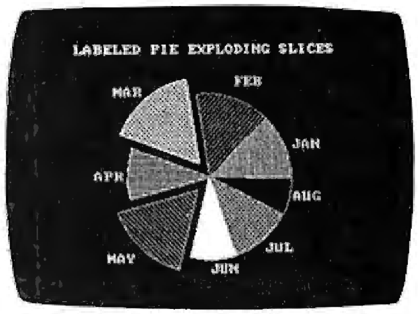

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MACINTOSH, Larry Joel Goldstein and David I. Schneider. Bowie, MD: Brady Communications, 1985; 576 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89303-662-5, $19.95.

MICROSOFT WORD MADE EASY, Paul Hoffman. Berkeley, CA: Osborne/McGraw-Hill, 1985; 258 pages, 18.5 by 23.5 cm, softcover, ISBN 0-88134-144-4, $14.95.

THE MIND AND THE MACHINE, Steve Torrance, ed. New York: John Wiley & Sons, 1984; 220 pages, 17 by 25 cm, hardcover, ISBN 0-470-20104-5, $29.95.

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.

MY PERSONAL COMPUTER AND OTHER FAMILY CRISES, Ben Ross Schneider Jr. New York: Macmillan Publishing, 1985; 254 pages, 14.5 by 22 cm, hardcover, ISBN 0-02-949610-1, $15.95.

1985 COMPUTER BUYING GUIDE, the editors of *Consumer Guide*. New York: New American Library, 1984; 384 pages, 10.5 by 17.5 cm, softcover, ISBN 0-451-13244-0, $4.50.

OFFICE TECHNOLOGY FOR THE NONTECHNICAL MANAGER, Phyllis J. Peck and Gilbert J. Konkel. Stamford, CT: Office Publications, 1984; 226 pages, 15 by 23 cm, softcover, ISBN 0-911054-07-3, $13.95.

100 PROGRAMS FOR THE COMMODORE 64, John Gordon and Ian McLean. Englewood Cliffs, NJ: Prentice-Hall, 1984; 352 pages, 14.5 by 23 cm, softcover, ISBN 0-13-634650-2, $14.95.

OWNING YOUR HOME COMPUTER, Robert L. Perry. New York: Dodd, Mead & Co., 1984; 256 pages, 21.5 by 28 cm, softcover, ISBN 0-396-08250-5, $13.95.

PASCAL PROGRAMMING FOR THE IBM PC AND XT, W. M. Fuori, L. Gioia, S. Gaughran, L. Aufiero, and M. Fuori. Reston, VA: Reston Publishing, 1985; 270 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-54354-8, $19.95.

PC PROGRAMMING TECHNIQUES, A. C. Elliott. Bowie, MD: Brady Communications, 1985; 174 pages, 17.5 by 23.5 cm, softcover, ISBN 0-89303-755-9, $14.95.

PERSONAL COMPUTERS AND THE DISABLED, Peter A. McWilliams. Garden City, NY: Quantum/Doubleday, 1984; 416 pages, 15 by 23 cm, softcover, ISBN 0-385-19685-7, $9.95.

PERSONAL GRAPHICS, Michael P. Barnett and Graham K. Barnett. Boston, MA: Little, Brown and Co., 1984; 332 pages, 21 by 27.5 cm, softcover, ISBN 0-316-08220-1, $14.50.

THE PHYSICS DISK, Sheridan Simon. Englewood Cliffs, NJ: Prentice-Hall, 1985; 82 pages, 17.5 by 23.5 cm, spiral-bound, ISBN 0-13-672387-X, $29.95. Includes floppy disk.

THE POWER OF: PROFESSIONAL TAX PLANNING USING LOTUS 1-2-3, Mitchell H. Jacobs and Robert B. Rice. Englewood Cliffs, NJ: Prentice-Hall, 1984; 224 pages, 21 by 27.5 cm, softcover, ISBN 0-13-688276-5, $29.95.

THE POWER OF: PROFESSIONAL TAX PLANNING USING MULTIPLAN, Mitchell H. Jacobs and Robert B. Rice. Englewood Cliffs, NJ: Prentice-Hall, 1984; 218 pages, 21 by 27.5 cm, softcover, ISBN 0-13-688250-1, $29.95.

A PRACTICAL GUIDE TO COMPUTER COMMUNICATIONS AND NETWORKING, 2nd ed., Richard Deasington. New York: John Wiley & Sons, 1984; 126 pages, 17 by 24 cm, softcover, ISBN 0-470-20078-2, $24.95.

A PRACTICAL GUIDE TO MACHINE LANGUAGE PROGRAMMING ON THE TIMEX/SINCLAIR 1500 AND 1000 (AND ZX81), David B. Wood. Lexington, MA: Sirius-Ware, 1985; 252 pages, 15 by 23 cm, softcover, ISBN 0-926848-00-3, $14.95.

PROCEDURAL ELEMENTS FOR COMPUTER GRAPHICS, David F. Rogers. New York: McGraw-Hill, 1985; 448 pages, 16.5 by 23.5 cm, softcover, ISBN 0-07-053534-5, $24.95.

PRODOS QUICK AND SIMPLE FOR THE APPLE II FAMILY, John G.

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Burdick and Peter B. Weiser. Glenview, IL: Scott, Foresman and Co., 1985; 256 pages, 19 by 23 cm, softcover, ISBN 0-673-18077-8, $19.95.

PROGRAMMER'S GUIDE TO MS-DOS FOR THE IBM PC, Dennis N. Jump. Reston, VA: Reston Publishing, 1984; 266 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-5655-5, $16.95.

PROGRAMMING HALO GRAPHICS IN C, Robert J. Traister. Englewood Cliffs, NJ: Prentice-Hall, 1985; 192 pages, 17.5 by 23 cm, softcover, ISBN 0-13-729310-0, $17.95.

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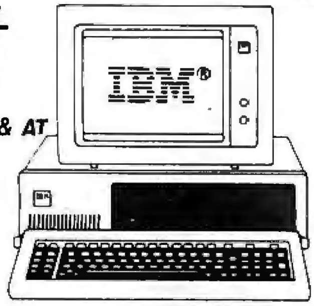

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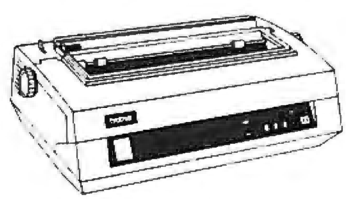

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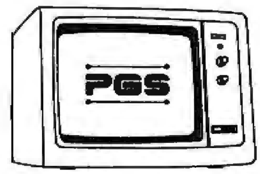

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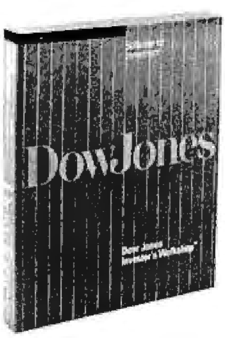

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Inquiry 140

(continued from page 32)
tempt to maintain their prices with more promotion and advertising?

Economic theory says that when excess profits are being made (excess profits being profits higher than would be expected given the risk of the investment), then new competitors will enter the market to grab some of these high profits. This new competition will push prices down. As a hot new market with only a few suppliers changes into one with a much larger number of suppliers and a much wider customer base (a classic free market), the pricing should change to reflect the new realities. Unfortunately, a large number of companies were founded with the idea that these juicy profits would go on forever, that the products' pricing would never have to relate to the costs of production. These companies developed without understanding the organic nature of a free market, that they themselves were the new entrants whose role was to bring prices down to mature market levels.

I don't believe that the software market has approached anything like its potential sales levels, but this won't change until prices come down. The recent integrated packages (Symphony, Framework, Enable) have all aimed themselves at the corporate market. They figure that their products are the perfect productivity packages for a personal computer, except that prices would have to be lowered to appeal to the private owner. Would Borland's SideKick, elegant piece of work that it is, have nearly the impact if it was $199? I'd rather have a car without a radio than a PC without SideKick, but part of its success is its utility-class price.

When we see prices for the full-featured integrated packages come down to the $300 to $400 range, the market will react with the same excitement created by those breakthrough spreadsheets, VisiCalc and Lotus 1-2-3.

ZAVE SHAPIRO
Winnipeg, Manitoba, Canada

SIGN-LANGUAGE SOFTWARE WANTED

I would greatly appreciate the assistance of BYTE readers in my research project. I am attempting to identify public-domain and proprietary microcomputer software packages that teach sign language. I am defining sign language as any system of hand gestures used for communicating with the hearing-impaired. If you have such information, please contact me at POB 19142, Washington, DC 20036, or leave a message at (202) 475-4939 and I will return your call. All responses will be acknowledged.

ELLEN L. BOUWKAMP
Washington, DC

TOWARD A LESS STRUCTURED APPROACH

So much hype has been published about the wonders of structured programming, and so much of the criticism of it has been from petulant programming wizards worried about being accountable to their supervisors, that a more dispassionate voice is called for. Every benefit has its cost, and structuring is no exception.

A key problem of the structured approach is strikingly illustrated by the index in Niklaus Wirth's book, *Programming in Modula-2*, reviewed by David D. Clark in the August 1984 BYTE. Consider for a moment two programs to print an index whose entries are in the array INDEX of dimension N, an even number (I'll use vanilla BASIC here to reach the widest audience; granted, both programs could be improved in many ways by applying structured techniques in another language, but it's the difference between the programs that's important here):

```
10 FOR I = 1 TO N STEP 2: LPRINT
   INDEX(I); TAB(40); INDEX(I + 1) :
   NEXTI
```

and:

```
10 PL = 60: FOR I = 1 TO N STEP 2:
   IF (I + PL < = N) LPRINT INDEX(I);
   TAB(40); INDEX(I + PL):
   ELSE LPRINT INDEX(I)

20 NEXT I
```

By every structured standard, the first program wins: It has fewer lines, fewer statements, fewer variables, it's easier to read and understand at a glance, etc. There's only one problem. The first program produces the sort of index that's in Wirth's book: the second entry opposite the first, the third back under the first, the fourth under the second, and so on. It's a royal pain to use.

Thus one of the costs of structure is insensitivity to the end user. Structured programmers typically take the condescending attitude that users are ill-served by programs that have bugs; therefore, they shouldn't quibble about inconveniences they may have to put up with to get bug-free programs. This attitude may pass in the academic world, but the software market today demands programs (and documentation) that are bug-free AND convenient to use.

The best the structure gurus have to offer here is pious exhortations to keep the user in mind, the equivalent of saying, "Hey! Let's be careful out there!" This is a cop-out. This is like the attitude of the computer pioneers who regard program bugs as character flaws; their approach to debugging it to sniff that, with proper conscientiousness, there would be no bugs. This is just the attitude that structured techniques are touted as rebutting. With so much of the programmer's mind focused on the mechanics of structured programming, concentration on how the final product will look to the user is bound to suffer, and kludges like Wirth's index must be expected.

Don't misunderstand me. Structured programming is a fine thing in a production-type environment, when the programmers thoroughly understand the system they're working with (what it can't do, and how to make it do what it can do) and the programs they're trying to write (because they're writing their zillionth database application, process-control routine, etc.). But when programmers are exploring new systems and developing new kinds of programs, they need the flexibility of a less structured approach. Debugging can come later.

ERWIN S. STRAUSS
Fairfax, VA

BARGAIN COMPUTING IN JAPAN

After living in Japan for over a year, I picked up some recent issues of BYTE and was surprised by the current state of the art in personal computers being sold in the United States. It seems that many advertisers in the U.S. offer systems that just do not come close to what we can get here in Tokyo. I was taken aback by this, because I thought that, if in anything, American technology was leading in the personal computer field.

For example, a few weeks ago I purchased a Fujitsu FM-16 Beta, which is not available in the United States. This computer's standard features include:

Hardware

512K bytes of main RAM (expandable to 1 megabyte), two 5¼-inch 1-megabyte floppies, DMA access, 192K bytes of video RAM, 52K bytes of ROM, 80186 16-/16-bit main microprocessor, MBL68B09E (8-bit) subprocessor (2

(continued)

MHz) (for graphics and I/O support) full 102-key keyboard with everything. 640 by 400 (by 4) graphics (partitionable to different pages). 80 by 25 roman character lines (16 by 16 dots/character). Japanese character ROM. RS-232C (transmission rate. etc.. software-controllable). all cables. connectors. and interfaces for printer. mouse. light pen. and voice synthesizer

Software
Japanese Foreign Language Extension (Japanese writing ability). Graphics Extension (GSX. Digital Research). Terminal software. CP/M-86. FBASIC86 V2.0 (with graphics support: windows. viewports. etc.. mouse. light pen. and voice-synthesizer functions. etc.)

All for only about $1200. which is what I paid at Akihabara. the big electronics neighborhood in Tokyo.

It seems. from looking at recent issues of BYTE. that the current 16-bit American systems usually come with only about 128K bytes or 256K bytes of RAM and that minifloppies are way behind the commonly used dual 1-megabyte floppies that are built in to current computers here in Japan. And the prices! It seems that for these substandard systems you have to pay more than twice what you pay here. $2500 to $3000 or more! Why is that?

Anyway. to complete my system. I bought an RGB high-resolution monitor and a Kanji printer (24 x 24 dot) and the entire system. everything. came to less than $2000! Can they beat that in the U.S. yet?

I am now happily running my system. using the included FBASIC and assembler as well as Optimizing C and the very nice screen editor that comes with Turbo Pascal (it seems to handle the Japanese conversions very nicely).

By the way. I spent the last year here working for the Toyo Links Corporation of Tokyo. a computer-graphics company. We created a computer-graphics movie for the Fujitsu Pavilion at the Science and Technology World's Fair (Expo '85). which opens this March. The film is quite exciting: completely computer-generated and projected on a specially-built Omnimax dome. in stereo.

I hope that many American readers of BYTE can visit the fair. which will run for six months. and drop by the pavilion. If anybody would like more information about the fair or movie. drop me a line and I will be glad to pass your name and address onto the fair committee and you'll get some literature from Japan. I would also welcome hearing from people who just want to write and talk about computers here in Japan and elsewhere.

DOUG LERNER
Ota Ku Nishi Kamata 8-24-6-302
Tokyo. 144. Japan

LANGUAGE CONSIDERATIONS

The entertaining and informative dispute among champions and critics of rival computer programming languages should consider the following:

1. *Language size.* To compare languages without considering their sizes. which may vary by one or two orders of magnitude. is disinformative.

2. *External size constraints.* Today's 8K-byte to 16K-byte BASICs are constrained by the allotted ROM room. not by the nature of the language itself. A 64K BASIC interpreter is the obvious and natural size for a microprocessor. which. like the 6509/6510 or 8088/8086. organizes a memory in 64K pages. Will a language that sounds great compared to an 8K Procrustean BASIC still sound great compared to a 64K full-page BASIC?

3. *Factional interests.* Interpretation vs. compilation represents the real power struggle between do-it-yourself computer users and the caste of professional priests and scribes (systems programmers and applications programmers) attempting to insinuate itself between the computer and its end users. Logo versus BASIC versus Pascal represents the power struggle among elementary. secondary. and higher education. There's always the simple bias of salesmen "pushing" their own wares and "knocking the competition." Important personal. social. economical. and political fortunes ride on the outcomes of language competitions. and it would be hopelessly naive to imagine otherwise.

4. *Personal sentiments.* Some language criticism reveals more of the critic than of the language criticized. Scratch a critic of line numbers. find an unconfessed mathophobe. FORTH's arcane magic attracts a personality radically different from those attracted to Pascal and Modula-2. Sentiments should be addressed explicitly. not glossed over by coats of pseudorational. pseudotechnical varnish.

5. *Language essentials.* Features that can be optionally added to or deleted from a language don't distinguish it from other languages. Logo's supposedly distinctive "turtle graphics" and some of Pascal's supposedly distinctive "powerful structured-programming constructs" have been absorbed by some BASICs. APL's matrix operators could be added to Modula-2. C's advanced assembly-language commands could be added to COBOL. and whitewall tires could be added to any car without effecting any fundamental change. So what are the essential differences among languages that merit discussion? Do any exist? I don't know.

But I do know that some purported feature advantages are mythical. Pascal fans argue that invoking procedures by semi-descriptive names like ERRMSG. for display an error message. and FIXERR. for fix the error condition. enable you to scan a listing and grasp its flow. But to grasp a BASIC line like

```
500 IF X=0 THEN GOSUB 2500:
    GOTO 5720
```

you've go to look up lines 2500 and 5720. Surprise! Microsoft BASIC on the Commodore PCs I recently checked has an undocumented feature that gives the best of both approaches. You can write:

```
500 IF X=0 THEN GOSUB 2500
    ERRMSG: GOTO 5720 FIXERR
```

While scanning the program you can ignore the line numbers and grab the semi-descriptive names. But when you do want to find ERRMSG and FIXERR. the line numbers tell you exactly where to look in a long listing. Will this revelation cause wholesale defections from the Pascal camp? I doubt it. though I'm sure it will provoke some giggling among BASIC fans. More generally. I do hope that future critiques and comparisons of languages will shed more light on the five general issues I've mentioned.

J. G. KROL
Anaheim, CA

FUBAR AGAIN

As one of the 10 million Americans overseas during World War II. I can surely recall FUBAR and its friends ("The Origin of 'FOO.BAR.'" February. page 420).

There were three of them: SNAFU. TARFU. and FUBAR. All fared well because there was a nonvulgar word. "fouled." that could be substituted for the original. SNAFU means Situation Normal—All Fouled Up. TARFU means Things Are Really Fouled Up. and FUBAR means Fouled Up Beyond All Recognition. as you indicated.

These three survived. I believe. partly because they showed a slight ring of culture and restraint. even in the otherwise unbearable military.

NOEL J. THOMPSON
Warren. OR ■

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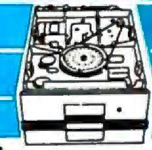

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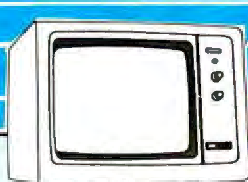

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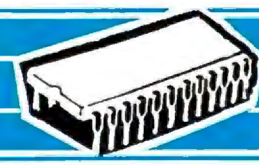

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NEW SYSTEMS

Total Talk PC Aids Visually Impaired

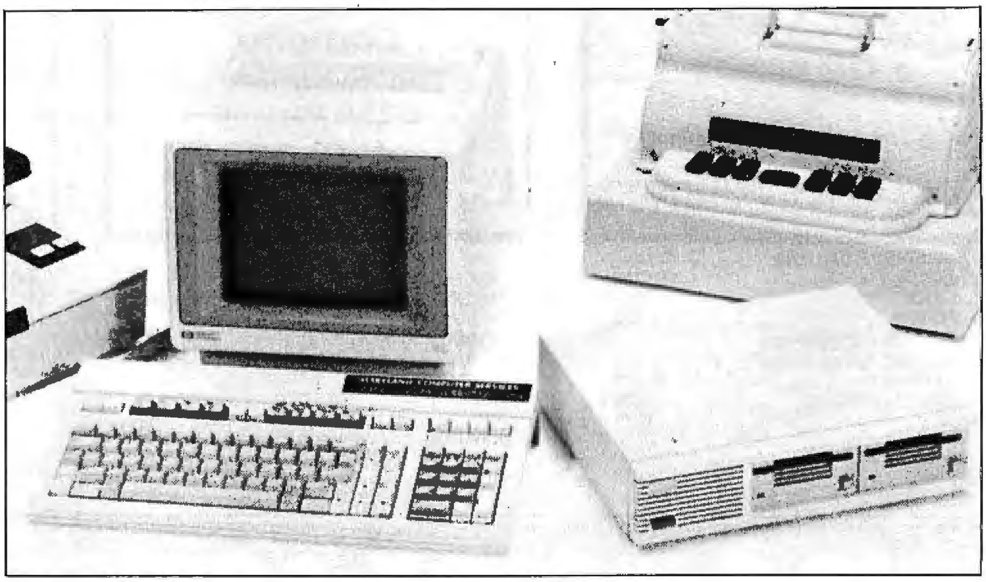
Maryland Computer Services' Total Talk PC is a talking computer based on Hewlett-Packard's HP 150. The system includes a speech-synthesis board, voice-generation firmware, software, and a speech-control pad that turns any group of characters into a spoken word.

With Total Talk PC, a blind or visually impaired user can hear data entered through the keyboard or appearing on the screen. The user can control pitch, volume, and the rate of speech (from 45 to 720 words per minute). The user can also choose to listen to information either a single word, a sentence, or a paragraph at a time. Another feature is user-definition of words that don't follow standard rules of pronunciation, such as abbreviations and mnemonics.

The Search String and Programmable Key functions let the user locate a word or phrase and combine several routinely used keystrokes into one key. The Enunciator Key announces functions before the system performs them.

Also, more than 50 speech functions are built into the Total Talk PC and controlled through its modified numeric keypad. The system connects to most computers from micros to mainframes. It uses MS-DOS and includes a built-in Talking Information Manager for keeping track of addresses, phone numbers, and dates.

Total Talk PC is available in two versions. The standard configuration has dual 3½-inch double-sided double-density disk drives and sells for $7995.95. The second model uses a 15-megabyte Winchester hard-disk drive and costs $10,995.95. Contact Maryland Computer Services, 2010 Rock Spring Rd., Forest Hill, MD 21050, (301) 879-3366.
Inquiry 615.



The Total Talk PC system based on the HP 150, along with some optional peripherals.

The TERI 16-bit Microcomputer

The TERI is an integrated unit that contains a CRT, 80-cps dot-matrix printer, two double-sided double-density disk drives, clock and calendar, modem, and Telex capabilities. The screen collapses into the main unit to form a low profile, and the footprint is slightly larger than that of a typewriter. A remote unit is also available.

The TERI uses Intel's 8086 chip and is IBM software-compatible. The basic system contains those features mentioned above, a case in three color choices, 192K bytes of memory expandable to 768K bytes, an 80-character 12-inch built-in screen, graphics capabilities in color and monochrome, a remote CRT hookup, five expansion slots, an RS-232C port, a security-card activator, and such software as MS-DOS. Some available options are a color monitor, hard-disk drive, and remote monitor with keyboard.

The system's basic unit is selling at $3600. Contact Israel Strategic Computers Ltd., 19 Nachon St., Yemin Moshe, Jerusalem, Israel, tel: 02 247-681/243-368; Telex 35770 COIN IL TER.
Inquiry 616.

Expert 32 Multiprocessor Computer

Elite Computer Systems' Expert 32 is a 32-bit multiprocessor computer that supports four true 32-bit processor card sets. However, the system is designed to support more processors, with quantity dependent on application. The E82/CPU2 processor card is based on the 32032 processor from National Semiconductor. It includes the floating-point processor, memory-management unit, real-time clock/calendar, and 32K bytes of cache memory.

The system has a 16-slot double-width VME bus backplane and comes standard with a processor board set. Other features include 512K bytes of main memory expandable to 16 megabytes; a peripheral-interface card with DMA SCSI disk interface, 4 intelligent RS-232C serial channels expandable to 20; a Centronics-compatible parallel printer interface; a 500-watt power supply; and 5¼-inch cartridge hard-disk drives with 5 megabytes of removable storage and 5 megabytes of fixed storage. You can expand the Expert 32 to accommodate up to 140 megabytes of storage.

The Expert 32 uses ECS PVS, a portable virtual-storage operating system that supports real-time and

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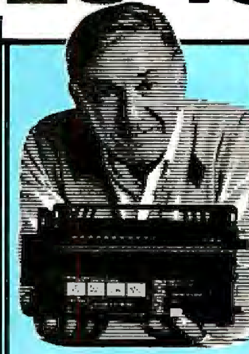

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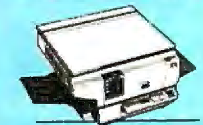

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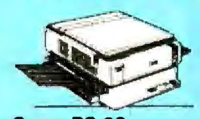

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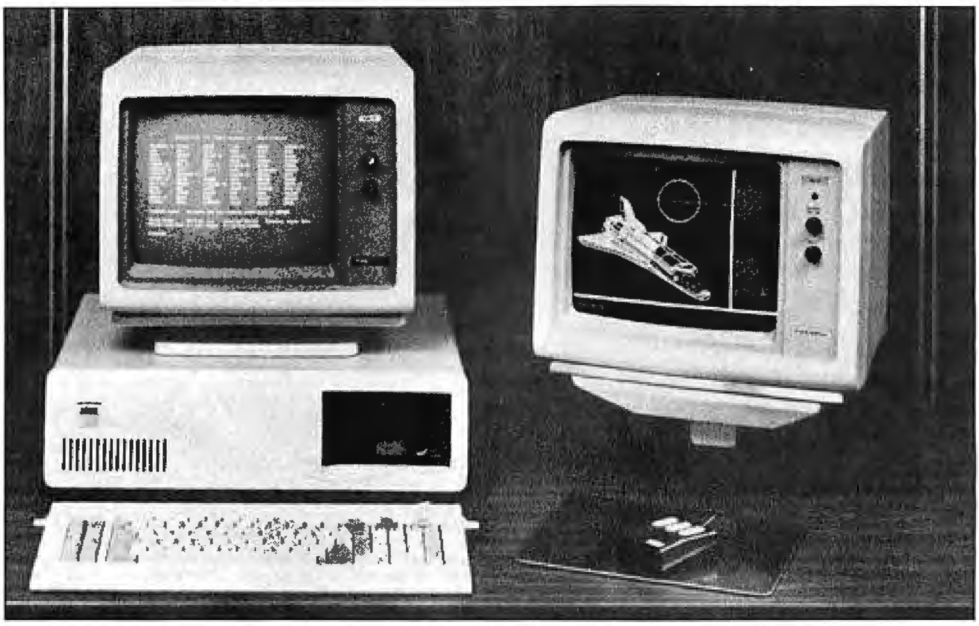

MNC *International's* MCAD *workstations for computer-aided design.*

multiple-processor environments. ECS PVS also supplies demand-paged virtual memory, multiuser and multitasking operation, mountable file systems, and dynamically installed device drivers. UNIX will soon be supported on the Expert 32. Elite provides additional software support with compilers for FORTRAN, Pascal, C, Modula-2, LISP, and SMPL.

Quantity-one prices for the Expert 32 start at $17,700. Additional E82/CPU2 processor sets are $3850. Contact Elite Computer Systems, 4129 May St., Wichita, KS 67209, (316) 942-6619.
Inquiry 617.

Multifunction CAD Workstations

MNC International created the MCAD family of workstations specifically for computer-aided design. The workstations are based on MNC's IBM PC-compatible computers and come complete with hardware and software.

The first three available models, MCAD 1000, MCAD 2000, and MCAD 3000, integrate the AutoCAD 2 software with three levels of hardware. All members of the MCAD family use an IBM PC-compatible processor and an 8087 coprocessor.

MCAD 1000 comes standard with a 10-megabyte hard-disk drive and 256K bytes of RAM. The monochrome graphics adapter provides 720- by 348-dot resolution. AutoCAD 2 basic design software and an integral mouse come with the package.

MCAD 2000 has the same processor configuration as MCAD 1000 but uses two monitors: a monochrome display functions as the system console, and the graphics design console is a medium-resolution color display. This display combined with an Artist II graphics adapter from Control Systems gives you up to 16 simultaneous colors with a 640- by 400-dot resolution. Control is through the keyboard or an optical mouse.

The top-of-the-line MCAD 3000 also uses two monitors, including a high-resolution color-graphics monitor that supplies 1024- by 768-dot resolution with 16 simultaneous colors. MCAD 3000 disk memory is 22 megabytes, half of which is a removable cartridge. It comes standard with 512K bytes of RAM.

Options include plotters, printers, extended memory to 640K bytes, and software extensions. Several Tektronix emulation packages are also available.

Prices for the packages include software. MCAD 1000 is $4850, MCAD 2000 is $6995, and MCAD 3000 is $11,995. IBM PC owners can purchase add-on kits to make their systems equivalent to any MCAD model. Contact MNC International, 2817 Anthony Lane S, Minneapolis, MN 55418, (612) 788-1099.
Inquiry 618.

Spirit 68 32-bit Microcomputer System

Spirit 68 from First Computer Corporation is a 32-bit system that runs with UNIX System V. Spirit 68 can handle up to 12 users and addresses up to 4 megabytes of parity MOS memory while offering full processor functionality. The system also supports local-area networks and remote communications.

The basic Spirit 68 contains 40 megabytes of online disk storage that comprises a 20-megabyte removable disk cartridge and 20 megabytes of fixed storage. It also has a 22-bit addressing capability.

The system is available in two styles: a clamshell, pedestal-type cabinet that opens along the full length of the unit and a standard rack-mount version. Both styles accept three models of field-installable expansion modules that increase disk storage with 40 megabytes of combination fixed/removable storage and either 72 or 142 megabytes of fixed storage.

Basic Spirit 68 system pricing ranges from $16,200 to $19,500. Contact First Computer Corp., 645 Blackhawk Dr., Westmont, IL 60559, (312) 920-1050.
Inquiry 619.

(continued)

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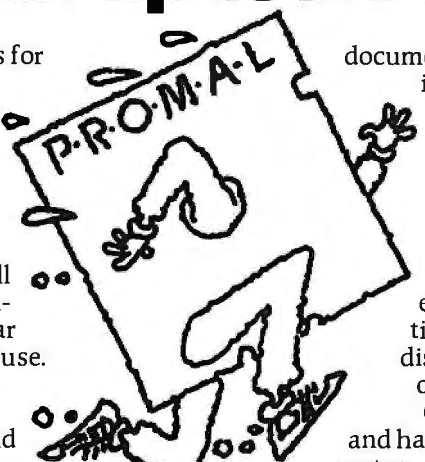

If you've been writing programs for your Commodore 64, Apple IIe or Apple IIc in BASIC you can take a giant step forward in speed of execution and in programming productivity for just $49.95.

You can get program performance that you only thought possible from machine language programs. While still using a powerful, understandable high-level language. A language that's similar to Pascal, but much easier to learn and use.

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COMMODORE 64 BENCHMARK

(Sieve of Eratosthenes)

	PROMAL	BASIC	COMAL	FORTH	PASCAL
Execution Time (secs.)	**30**	630	490	51	55
Object Code Size (bytes)	**128**	255	329	181	415
Program Load Time (secs.)	**3.2**	3.8	6.3	11.2	23.5
Compile Time (secs.)	**8.5**	–	–	3.9	108

PROMAL—a language especially for small systems.

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Or—for only $10.00 plus $2.50 postage and handling you can get the PM-100 demo system. It includes a 32-page manual and all the capabilities of the PM-200 except the ability to print or save files to disk. It's a very inexpensive way to explore the wonders of PROMAL.

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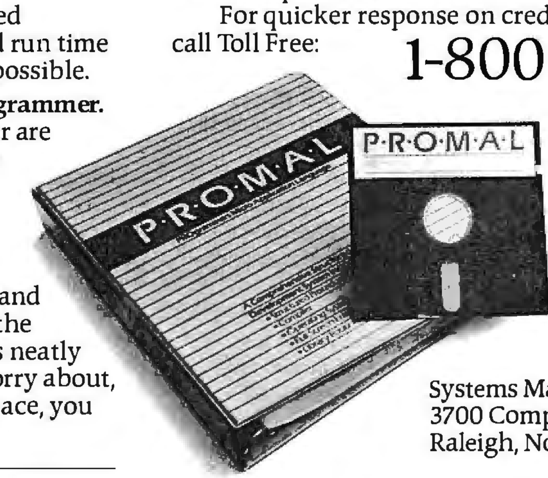

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ADD-INS

Model 256DIS EPROM Programmer

The Model 256DIS is a single EPROM programmer from Softalk, a subsidiary of Dynatec International. It can program any EPROM from a 2716 to a 27512, including "A" version and CMOS EPROMs. This programmer does not require additional modules or adapters.

Softalk's Model 256DIS programs one EPROM at a time. You can enter data from the programmer's own keyboard or from a development system through a standard RS-232C port. The programmer can also load from a master PROM into its 64K bytes of memory for programming a copy. The system uses a two-digit device code to set up the appropriate pin configuration and algorithms for the device being programmed.

The Model 256DIS costs $895. Contact Softalk Inc., 3594 West 1820 S, Salt Lake City, UT 84104, (800) 722-7425; in Utah, (801) 973-9500.

Inquiry 620.

The Apple in Color

An RGB color module for the Apple IIc is available from Telemax. The Peacock Model CM2C is an outboard module that comes with two cables and connectors. One short cable plugs into the 15-pin video output connector at the rear of the IIc. The other 3-foot cable plugs into your RGB monitor.

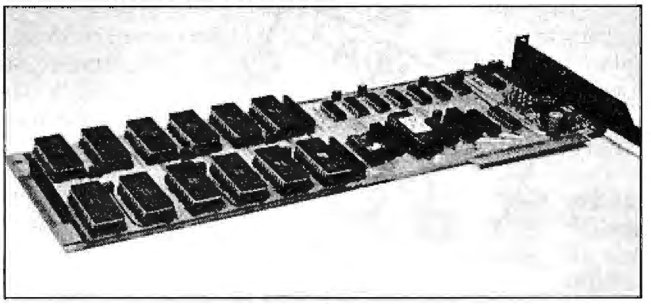
With the Peacock, you can select text and background colors from 14 color combinations. The Peacock Model CM2C sells for $199.

Another Telemax product, the Kaleidoscope II, is an RGB color board for the Apple II, IIe, and II+, and the Franklin ACE 100, 1000, and 1200. The board has a two-page memory operating system for programming both foreground and background colors. You can set each line of text to one of eight foreground and background colors.

The Kaleidoscope II plugs into slot 7. It lets you use your 80-column card or any other card that provides 80 columns and extended memory in slot 0 of the Apple IIe. For the Apple II+ and II and the Franklin series, you can use the Model VSP-80 switchplate option to interface 80-column boards to the Kaleidoscope II.

Apple versions of the Kaleidoscope II sell for $199; Franklin models are $219. The VSP-80 is $30, and the monitor connector is $15. Contact Telemax Inc., 780 Lorraine Dr., POB 339, Warrington, PA 18976, (215) 343-3000.

Inquiry 621.



ROMDISK PC *card for the* IBM PC.

Universal Programmer

Logical Devices' PROMPRO-XP is a 16-bit MOS EPROM programmer that will support software for the IBM PC as well as for other systems. This unit can program MOS EEPROMs, MOS EPROMs, CMOS EPROMs, bipolar PROMs, programmable logic devices, and microprocessors with on-board EPROMs.

PROMPRO-XP has a base system that handles I/O, internal memory, control, and power functions. It can program MOS or CMOS EEPROMs and EPROMs without the aid of plug-in adapters. Adapters are available to handle devices with widely different technologies, such as bipolar PROMS and programmable logic devices.

This universal programmer directs I/O communications through a serial RS-232C port or a detachable keypad with an alphanumeric display. It can send data to a printer or be remotely operated.

You can organize a 512K-byte internal RAM buffer in 64K-byte by 8 or 32K-byte by 16 arrays so that two EPROMs with different data can be programmed simultaneously. An In-Circuit-Emulation option lets you download a 16-bit file in memory and run a 68000 or 8086 program from the PROMPRO-XP's memory. Other features include a built-in eraser, range command, and complete self-diagnosis.

The PROMPRO-XP base unit is $1995; bipolar and PAL adapters are $495 each. Contact Logical Devices Inc., 1321 Northwest 65th Place, Fort Lauderdale, FL 33309, (800) 331-7766; in Florida, (305) 974-0975.

Inquiry 622.

ROMDISK PC Accessory Card

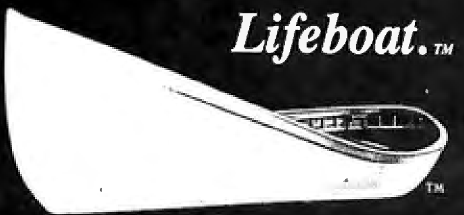
ROMDISK PC for the IBM PC and compatibles consists of a ROM and circuitry that emulates a write-protected disk and disk-drive controller. This full-size card fits into an accessory slot inside the microcomputer case.

ROMDISK PC works with PC-DOS, MS-DOS, and equivalent DOSes. A utility program copies a user-selected DOS, programs, or program files from disk into the ROM, thus converting the software to firmware. You can use DOS commands to auto-boot or selectively load software into RAM from ROMDISK PC.

The microcomputer's power supply supports ROMDISK PC. You can erase the EPROMs with an ultraviolet eraser without removing them from the printed-circuit board, then load new programs into ROM. Data-access time is 100 microseconds; program characteristics and the DOS determine overall speed improvements.

ROMDISK PC-0, a half-size board with 180K bytes of storage, sells for $599. ROMDISK PC-1, a full-size board with 180K bytes of storage upgradable to 360K bytes, is also $599. ROMDISK PC-2 is a full-size

(continued)



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The Lattice® C Compiler

The cornerstone of a program is its compiler; it can make the difference between a good program and a great one. The Lattice C compiler features:

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"Lattice C produces remarkable code...the documentation sets such a high standard that others don't even come close...in the top category for its quick compilation and execution time and consistent reliability."

Ralph A. Phraner, *Byte* Magazine

Lattice Library source code also available.

Language Utilities

Pfix 86/Pfix 86 Plus — dynamic and symbolic debuggers respectively, these provide multiple-window debugging with breakpointing capability.
Plink 86 — a two-pass overlay linkage editor that helps solve memory problems.
Text Management Utilities — includes GREP (searches files for patterns), DIFF (differential text file comparator), and more.
LMK (UNIX "make") — automates the construction of large multi-module products.
Curses — lets you write programs with full screen output transportable among all UNIX, XENIX and PC-DOS systems without changing your source code.
BASTOC — translates MBASIC or CBASIC source code directly to Lattice C source code.
C Cross Reference Generator — examines your C source modules and produces a listing of each symbol and where it is referenced.

Editors

Pmate — a customizable full screen text editor featuring its own powerful macro command language.
ES/P for C — C program entry with automatic syntax checking and formatting.
VEDIT — an easy-to-use word processor for use with V-PRINT.
V-PRINT — a print formatting companion for VEDIT.
CVUE — a full-screen editor that offers an easy way to use command structure.
EMACS — a full screen multi window text editor.
Fast/C — speeds up the cycle of edit-compile-debug-edit-recompile.

Graphics and Screen Design

HALO — one of the industry's standard graphics development packages. Over 150 graphics commands including line, arc, box, circle and ellipse primitives. The **10 Fontpack** is also available.
Panel — a screen formatter and data entry aid.
Lattice Window — a library of subroutines allowing design of windows.

Functions

C-Food Smorgasbord — a tasty selection of utility functions for Lattice C programmers; includes a binary coded decimal arithmetic package, level 0 I/O functions, a Terminal Independence Package, and more.
Float-87 — supports the 8087 math chip to boost the speed of floating-point calculations.
The Greenleaf Functions — a comprehensive library of over 200 routines.
The Greenleaf Comm Library — an easy-to-use asynchronous communications library.
C Power Packs — sets of functions useful for a wide variety of applications.
BASIC C — This library is a simple bridge from IBM BASIC to C.

Database Record Managers

Phact — a database record manager library of C language functions, used in the creation and manipulation of large and small databases.
Btrieve — a sophisticated file management system designed for developing applications under PC-DOS. Data can be instantly retrieved by key value.
FABS — a Fast Access Btree Structure function library designed for rapid, keyed access to data files using multipath structures.
Autosort — a fast sort/merge utility.
Lattice dB-C ISAM — a library of C functions that enables you to create and access dBase format database files.

Cross-Compilers

For programmers active in both micro and mini environments we provide advanced cross-compilers which product Intel 8086 object modules. All were developed to be as functional — and reliable — as the native compilers. They are available for the following systems:

VAX/VMS, VAX/UNIX, 68K/UNIX-S, 68K/UNIX-L

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Z80 Cross-Compiler for MS- and PC-DOS — produces Z80 object modules in the Microsoft relocatable format.

New Products

Run/C — finally, a C interpreter for all levels of C Programmers.
C Sprite — a symbolic debugger with breakpoint capability.

Inquiry 241

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BY

ADD-INS

board with 360K bytes of storage and costs $999. Contact Curtis Inc., 22 Red Fox Rd., St. Paul, MN 55110, (612) 484-5064.
Inquiry **623**.

512K-byte Memory Upgrade for the Mac

Micro Conversions has developed an upgrade kit for converting a 128K-byte Macintosh to 512K bytes. Installation does not require adding wires or drilling holes—only basic soldering.

The kit includes a tool to open the Macintosh's case, miniature flush cutters, an integrated-circuit insertion tool, stainless steel electronic-assembly tweezers, an X-Acto knife, and three rolls of desoldering braid. Parts for the upgrade include a multiplexer chip, seventeen 256K-byte RAM chips, 16-pin low-profile sockets for all chips to be installed, a miniature printed-circuit board assembly, and resistors and capacitor required for the new multiplexer chip.

The price of the 512K-byte upgrade kit is $350. You can also have the kit installed by Micro Conversions for a total cost of $399. Contact Micro Conversions, 3606 Knoll Crest Dr., Arlington, TX 76014, (817) 465-5758.
Inquiry **624**.

The Macintosh 512Kit

Three versions of the 512Kit from Levco Enterprises let you upgrade your 128K-byte Macintosh to 512K bytes. Kit I contains complete installation instructions, a printed-circuit board, a pair of 2.2k-ohm resistors, a single 0.1-microfarad capacitor, a seven-position pin strip, and a 74AS253 integrated circuit. Kit II also has sixteen 16-pin gold-plated sockets for the memory chips. Kit III includes all of the above plus seventeen 256K-bit DRAMs.

The 512Kit prices are $49.95 for Kit I, $59.95 for Kit II, and $298.95 for Kit III. A fully installed upgrade costs $399.95. Contact Levco Enterprises, 4954 Sun Valley Rd., Del Mar, CA 92014, (619) 755-7827.
Inquiry **625**.

PERIPHERALS

Hard-Disk Storage for the PC AT

PS20 Plus is a plug-in 20-megabyte hard-disk drive for the IBM PC AT. It works directly with the AT's controller board to provide the same capabilities as the extended AT.

If you need more storage, you can add a Perstor Expansion System for up to four additional hard-disk drives.

PS20 Plus sells for $1295; Perstor Expansion Systems start at $2000. Contact Systems and Software Inc., 7825 East Redfield Rd., Scottsdale, AZ 85260, (602) 948-7313.
Inquiry **626**.

PS20 *Plus for the* IBM PC AT.

Commodore Modem Disk Drive

Commodore recently announced a 1200-bps modem and a disk drive.

The 1670 Modem/1200, a compact modem, uses many of the same commands as the Hayes Smartmodem and has an internal speaker that lets you follow the progress of a call.

Included in its $200 list price are communications software for the Commodore 64 and one hour on CompuServe. A 300-bps version is offered for about $70. Commodore plans a version of the 1200-bps modem with an RS-232C interface.

The Commodore 1571 disk drive works with the Commodore 128 as well as Commodore's 64, Plus/4, and LCD computers. It features compatibility with the older 1541 drive and enhanced disk capacity and speed. In its CP/M mode, it stores 410K bytes of data and transfers data at 3500 cps. Data-transfer rates under C64 and C128 control are 300 and 1500 cps, respectively. It will also read and write other CP/M-formatted disks.

The Commodore 1571 disk drive will cost approximately $300. Contact Commodore International Ltd., 1200 Wilson Dr., West Chester, PA 19380, (215) 431-9100.
Inquiry **627**.

IBM PC AT Line of Hard Disks

Genoa Systems has a line of hard-disk products for the IBM PC AT that includes 20- and 32-megabyte drives. These drives work with the existing PC AT controller and power supply. Both systems are compatible with all PC AT operating systems.

You can install one or two of the drives in your computer. They function with any network that works with the PC AT.

The drives cost $1795 for 20 megabytes and $2295 for 32 megabytes. Contact Genoa Systems Corp., 73 East Trimble Rd., San Jose, CA 95131, (408) 945-9720.
Inquiry **628**.

Removable-Cartridge Winchester for IBM PC AT

Interface's removable-cartridge Winchester disk subsystem provides data storage, data security, and multiuse of a single PC AT. You can remove the disk

(continued)

SOME FLOPPY DISKS WILL GIVE YOU A BYTE YOU'LL NEVER FORGET.

You'll find them lurking in stores wherever floppy disks are sold. Those evil denizens of computer drives that are eagerly waiting to devour your valuable information, bit by bit. What they can do to you and your business is too painful to print.

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Whether you choose our 8-inch, 5.25-inch standard, 5.25-inch High Density or 3.5-inch No-Risk Disks, you'll be assured of consistent error-free performance, through years of extended usage. And although you'll probably never need it, it's nice to know that all our disks are covered by a lifetime replacement warranty.

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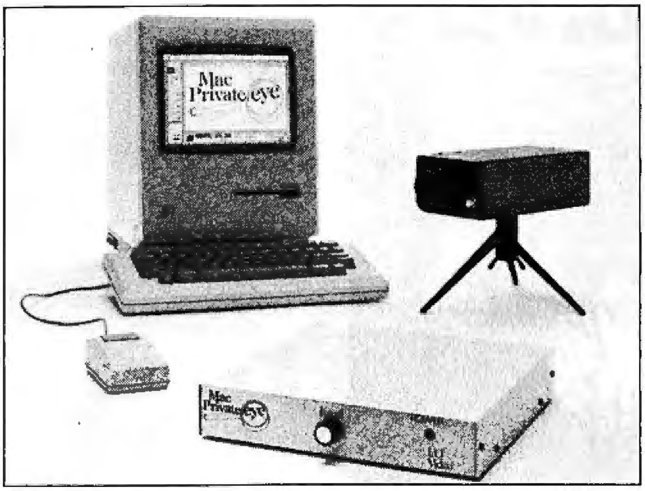


Mac Private Eye video digitizer.

cartridge when you finish working to help decrease the incidence of damaged or erased data.

The cartridge drive fits into the B slot on the IBM PC AT. It has 10½ megabytes of formatted storage per cartridge. Track-to-track access time is 22.5 milliseconds and an average access time, including head-settling time, is 98 milliseconds. The drive has a 5-megabit-per-second data-transfer rate.

The removable cartridge for the PC AT, model I²ATDMA10, sells for $1695. A PC version, model I²DMA10, is $2295. Contact Interface Inc., 21101 Osborne St., Canoga Park, CA 91304, (818) 341-7914.
Inquiry 629.

Mac Private Eye Video Digitizer

Mac Private Eye is a video digitizer that converts video signals into images on an Apple Macintosh. Reproduction quality is reportedly good enough for professional use. The system accepts images from any standard NTSC video source, such as a black-and-white or color television camera, television monitor, or videocassette recorder.

The subject does not have to be stationary because Mac Private Eye works with moving video images. It captures a complete video frame in real time. Each video frame is converted into a 512- by 512-pixel image that you can see on the Macintosh with a movable window.

You can also manipulate images with MacPaint and store them in MacPaint files. The digitizer uses a random dot-pattern generator that creates images with continuous shades of gray.

You can make television camera adjustments by viewing the image on the Mac, so you do not need a television monitor. Also, you can transfer the image using a modem to the user's Mac, another Mac Private Eye user, and directly from Mac to Mac.

Suggested retail price for Mac Private Eye is $595. Also available is a black-and-white television camera for $225 or both units for $799. Contact I/O Video Inc., 222 Third St., Cambridge, MA 02142, (617) 547-4141.
Inquiry 630.

SOFTWARE • APPLE

Speed Up the 512K Macintosh

TurboCharger quickens floppy-disk access on the 512K-byte Macintosh by keeping critical areas of disk in RAM. According to Nevins Microsystems, disk performance is often doubled or tripled, with reported peak performance more than 500 percent faster. (The company cited a test using pfs:File to search a database of 1325 forms. With TurboCharger, the test took 11 seconds; without TurboCharger, it took 60.5 seconds.)

Once installed on a Mac start-up disk, TurboCharger works automatically. The program analyzes disk usage, buffering critical areas of disk in RAM. As little as 32K bytes of RAM can be used for buffering.

TurboCharger works with copy-protected software and can be used with almost every package written for the Mac, including MacWrite and MacPaint, Multiplan, Word, and Jazz. The price is $95. Contact Nevins Microsystems Inc., 210 Fifth Ave., New York, NY 10010, (212) 563-1910.
Inquiry 631.

Ensemble: Integrated Software for the Macintosh

Hayden Software's Ensemble is an integrated software package that runs on Apple's Macintosh. This package contains word-processing, spreadsheet, graphics, and list-management applications, and it will work on either a 128K- or a 512K-byte Macintosh.

Ensemble lets you use the Macintosh's mouse and pull-down menus when using the word processor or when entering data into the spreadsheet. The word processor is said to be functionally similar to MacWrite. You can generate 10 types of graphs, including bar, pie, and line charts, from spreadsheet data, and you can use the list manager to merge addresses and letters.

Ensemble is available for $299.95. Contact Hayden Software Co. Inc., 600 Suffolk St., Lowell, MA 01854, (617) 937-0200.
Inquiry 632.

Applesoft Screen Routines

Magic Screen, a set of Applesoft screen-handling routines, consists of a screen-generator program for designing screens and a screen processor that contains a set of input and output routines. These routines can be called with ampersand (&) statements in an Applesoft BASIC program to handle full-screen data entry, reports, menus, and help screens.

With the screen generator, you can specify the protected and unprotected fields along with the attributes for data-entry fields. A data field can be defined as numeric, alphanumeric, or as a question field.

The screen processor, which becomes part of the Applesoft program, contains 18 screen routines, including & WINDOW, & MOVE, and & WAIT.

Magic Screen retails for $30 and can be copied. Contact Graphware Inc., POB 373, Middletown, OH 45042, (513) 424-6733.
Inquiry 633.

(continued)

SOFTWARE • APPLE

Graphic Communications

A communications package for the Macintosh, Telescape features an integrated communications directory, intelligent macros, universal terminal emulation, error-checking file transfer, and unattended message service. But according to the vendor, the package's most innovative feature is its graphics capability.

Telescape uses character-coded messages to produce graphics shapes as well as text of various sizes and styles. You can send messages by electronic mail or place them on any information utility. Business uses include transmission of charts and graphs. You can also create and send simple animated messages.

The program can be set to emulate any terminal. Definitions for TTY, VT52, VT100/VT102, Teleray, and TeleVideo are provided. Protocol selections include ASCII and XMODEM at 300, 1200, or 2400 bps.

Telescape works with any Mac or Lisa running under MacWorks. Suggested retail price is $125. Contact Mainstay, 28611B Canwood St., Agoura Hills, CA 91301, (818) 991-6540.
Inquiry 634.

SOFTWARE • CP/M/MS-DOS

Program Analyzer for C

A superset of the UNIX LINT utility, Pre-C is designed to increase programmer productivity by quickly identifying program statement errors, including interface inconsistencies that require cross-file checking. The developer claims that a single execution of Pre-C spots many errors difficult to isolate when tracing a program with a debugger.

Producing a collection of diagnostic messages, the analyzer is said to identify incorrect subroutine calls and other problems up to 100 times faster than a programmer using a debugger. Pre-C can complement a debugging tool, because debuggers find dynamic errors (such as incorrect data values) that Pre-C cannot find. Pre-C makes approximately 1000 instruction checks per minute.

Pre-C is neither machine- nor screen-dependent. It will run on any MS-DOS or PC-DOS machine running versions 2.0, 2.1, or 3.0 and supports many popular C compilers, including Mark Williams' C, Computer Innovations' C86, and Lattice C. The price is $395. Contact Phoenix Computer Products Corp., 1416 Providence Highway, Norwood, MA 02062, (617) 762-5030.
Inquiry 635.

UNIX-like Tools for MS-DOS

A collection of 19 tools adapted from UNIX, QTools is intended to provide a concise way to specify complex file manipulations, formats, and views. The toolbox operates under MS-DOS or PC-DOS on IBM PCs and compatibles.

QTools supports I/O redirection and pipes, wild cards, environment variables, command-line options (all parameters are passed to the utilities on the command line so that they can be used in automated batch processing), and on-line help.

The utilities fall into three general classes: file listing; file maintenance; and pattern search, substitution, and translation.

QTools costs $49.95. Contact QCAD Systems Inc., 1164 Hyde Ave., San Jose, CA 95129, (800) 538-9787; in California, (408) 255-5574.
Inquiry 636.

Electronic-Circuit Analysis

ACNAP is a general-purpose, AC network analysis program for active and passive electronic circuits consisting of resistors, capacitors, inductors, transistors, and operational amplifiers. You can examine circuits with up to 200 components and 30 nodes in a single pass.

The program has a circuit editor that supports addition, deletion, and changes of components, tolerances, and node connections. ACNAP automatically computes the magnitude and phase at any node in the circuit and includes Monte Carlo, worst-case, noise equivalent bandwidth, and sensitivity analyses. Logarithmic or linear frequency sweeps may be specified.

ACNAP costs $72.95 and is available for systems running MS-DOS, PC-DOS, or CP/M-80. Contact BV Engineering, Suite 207, 2200 Business Way, Riverside, CA 92501, (714) 781-0252.
Inquiry 637.

Ensure Unreadability of Deleted Data

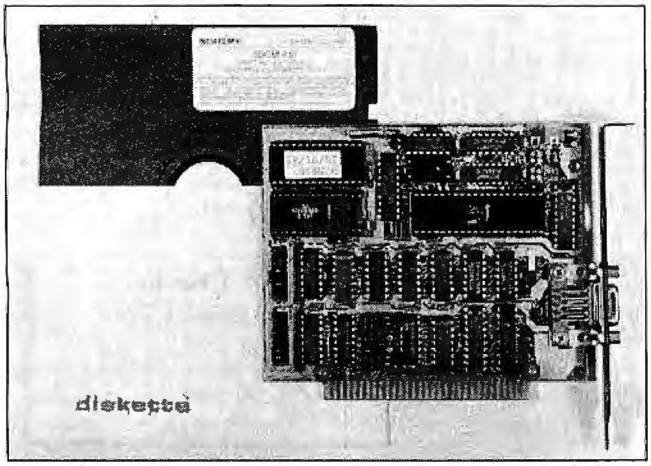
Erasesure is an MS-DOS/PC-DOS utility that reportedly makes erased or deleted files completely unreadable. The utility's developer noted that files thought to be deleted are often left on disk until DOS needs the space; only then is the data overwritten. That data can still be read, using a disk-reading utility or the DOS utility Debug.

Erasesure first prepares the data for removal and then deletes it according to DOS conventions. Instead of Delete or Erase, you use the program's Sure command and the filename. The software is not copy-protected, so it can be transferred to hard-disk systems. Erasesure costs $30 and is available from MPPi Ltd., 2200 Lehigh Ave., Glenview, IL 60025, (312) 998-8401.
Inquiry 638.

WordStar from Any Directory

Hard-disk WordStar users can run from any directory or subdirectory, including the floppy-disk drive, with a utility called SmartPath. Until now, the vendor said, hard-disk users had to keep multiple copies of the

SOFTWARE • CP/M/MS-DOS



*Datem's d*DCM810 *Bitbus support package.*

word processor on disk because WordStar didn't recognize directories or subdirectories.

With SmartPath, you can run any program that uses overlays from any directory. With only one copy of WordStar on the hard disk, you can group letters, documents, and programs into separate directories.

SmartPath is priced at $29.95 and runs under PC-DOS 2.0, 2.1, 3.0, and 3.1. Contact Software Research Technologies Inc., Suite 211, 3757 Wilshire Blvd., Los Angeles, CA 90010, (213) 384-4120.

Inquiry **639**.

Support for the Bitbus

Datem's dDCM810 package provides applications programmers with a high-level interface between MS-DOS computers and the Bitbus distributed control network. The software runs on any IBM PC-compatible machine equipped with a Datem dDCM800 Bitbus interface adapter.

Facilities within the support package include message packet management, named device interfaces, full message protocol, and user-specified flow control. Datem offers utilities to let you manipulate the RAM-resident dDCM810 operating environment. The software provides an interface for users who want to develop real-time, hierarchical distributed control systems for data acquisition, process control, and robotics.

In addition to user-specified flow control, dDCM810 manages the routing of sporadic response messages. The software also provides automatic response-connection generation when operating the host PC as a slave node.

The application support package costs $415 (U.S. currency). Contact Datem Ltd., 148 Colonnade Rd., Nepean, Ontario K2E 7R4, Canada, (613) 225-5919

Inquiry **640**.

SOFTWARE • IBM PC

Volkswriter for Scientists

A word-processing package for scientists and academics, Volkswriter Scientific features more than 400 bit-mapped science and math characters, Roman and Greek alphabets, and multiple type styles and sizes. According to Lifetree Software, the package heightens the quality of dot-matrix output because it drives each pin rather than using the native character set of the printer.

The program offers user-definable and recallable composite symbols and macros, five text levels for each line, on-screen tutorials, and nine help menus. It's a page-oriented word processor with hyphenation and underlining as you edit.

Lifetree stresses that Volkswriter Scientific, priced at $495, is not an upgrade of Volkswriter Deluxe. The program runs on the IBM PC and close compatibles, including the Compaq, Corona, Chameleon, and Hyperion, and requires 256K bytes, two disk drives, a color monitor, and color-graphics adapter. Contact Lifetree Software, 411 Pacific St., Monterey, CA 93940, (408) 373-4718.

Inquiry **642**.

FORTH for XENIX and UNIX

Ubiquitous Systems has introduced a FORTH-language software-development system tailored specifically for XENIX and UNIX. u4th is a portable, standard FORTH that is source-transportable to any other environment that has a standard C compiler with a UNIX-compatible library.

u4th's features include access to UNIX system calls, the capability to incorporate new primitives written in C, the capability to compile high-level FORTH words into the load image, a direct-threaded interpreter, and an object-oriented extension word set. The system is largely compliant, the vendor said, with the FORTH-83 standard (word size of 32 bits may be used where applicable, and lowercase characters are standard).

The object-oriented FORTH extensions provide a set of system-building tools suitable for AI research and other complex tasks, yet they can drop into "normal" FORTH when necessary. u4th has several object classes, including memory managers, lists, and tagged data objects.

The price of u4th for the IBM PC XT and PC AT is $395. Contact Ubiquitous Systems Inc., 13333 Bel-Red Rd. NE, Bellevue, WA 98005, (206) 641-8030.

Inquiry **641**.

TelePaint Includes Paint Software, Can Enhance Any Graph

LCS/Telegraphics' TelePaint software lets you capture, edit, enlarge, and enhance graphs generated by such programs as Lotus 1-2-3. With TelePaint, you can reposition charts, add new text or graphics, and change, add, or highlight colors and patterns. Added text can use any of 16 fonts and can range from simple labels and captions to full Paragraphs. Entire graphs or parts of graphs can be stored to disk or printed in color or black and white.

(continued)

SOFTWARE • IBM PC

You can use TelePaint as a standard paint program, similar to Apple's MacPaint for the Macintosh. It's fully mouse-driven and uses pull-down and pop-up menus. TelePaint runs on the IBM PC, XT, AT, and compatibles. It requires 256K bytes of RAM, one double-sided disk drive, an IBM color-display adapter, and a Microsoft-compatible mouse.

TelePaint is available for $149. Contact LCS/Telegraphics, 261 Vassar St., Cambridge, MA 02139, (617) 547-4738.
Inquiry **646**.

Program Development from Mainframe to Microcomputer

You can off-load program-development work done on a mainframe computer to an IBM PC with VS COBOL Workbench. Designed to provide uninterrupted development, testing, and maintenance of programs downloaded to a PC, the Workbench supports many features of COBOL as implemented in IBM's OS/VS COBOL and VS COBOL II. OS/VS COBOL and VS COBOL II syntax can be used separately or coexist in a single program. You can convert OS/VS COBOL programs to VS COBOL II using flags that report errors in code compiled from one syntax to the other.

Support of CALLs and EXEC statements enables you to edit, debug, and test applications that use IBM host interfaces such as IMS/VS, CICS/VS, DL/1, and SQL/DS. A Session Controller facility records keystrokes of testing and debugging sessions.

The syntax-check component examines the COBOL source code and generates executable intermediate code. It also flags code that is not ANSI-74 standard.

VS COBOL Workbench, which costs $4000, supports the IBM PC, PC XT, PC AT, and Portable PC. Contact Micro Focus Inc., 2465 East Bayshore Rd., Palo Alto, CA 94303, (415) 856-4161.
Inquiry **643**.

STATA *statistical program for the* IBM PC.

Statistics and Data Analysis

STATA, a program designed to help you manage, display, and analyze data, has features in common with spreadsheet, database-management, and statistical packages. The program lets you ask "what if" questions. Like a database manager, STATA enables you to create complex data sets, transform them, and locate pieces of information. The package can calculate the standard univariate statistics, correlations and covariances, and chi-square tests for independence in two-way tables.

STATA runs on an IBM PC, PC XT, or PC AT with at least 256K bytes of RAM and one double-sided disk drive. The package will use, but does not require, the 8087 math coprocessor. The Professional System costs $395; the Student Version, sold only to college bookstores, costs $30. Contact Computing Resource Center, 10801 National Blvd., Los Angeles, CA 90064, (213) 470-4341.
Inquiry **644**.

Error Checker for Lotus 1-2-3

A tool for validating Lotus 1-2-3 models, the Cambridge Spreadsheet Analyst permits automatic location of all circular reference errors. This CIRC feature reportedly eliminates hours spent tracking down interlocking formulas.

A complete package for spotting errors and scrutinizing a model's logic, the Analyst will scan a worksheet for more than a dozen conditions likely to indicate problems. Two interactive features let you examine the assumptions behind a 1-2-3 model. The cross-reference function shows where and how a given cell, range, or 1-2-3 function is used. The interactive probe capability lets you explore the cells that affect a formula.

The Analyst works directly with 1-2-3 spreadsheet files and, where possible, reflects the command conventions of the Lotus software. A help screen is available at every decision point.

The Cambridge Spreadsheet Analyst costs $95, runs on the PC family, and requires at least 192K bytes of RAM, two disk drives, and PC-DOS 1.1 or higher. Contact The Cambridge Software Collaborative, 56 Garden St., Cambridge, MA 02138, (800) 343-0663 ext. 4200; in Massachusetts, (800) 322-1238 ext. 4200.
Inquiry **645**.

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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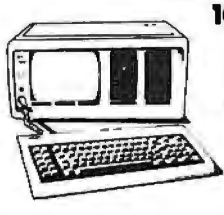

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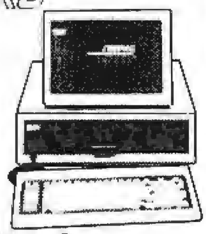

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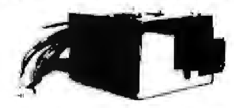

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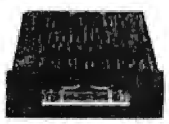

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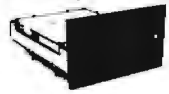

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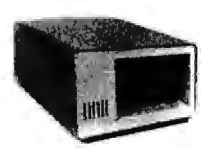

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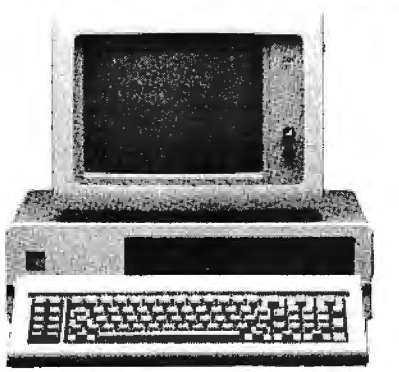

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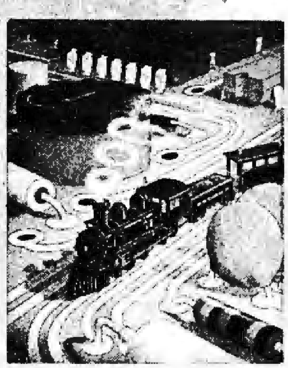

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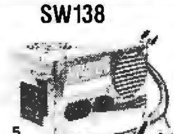

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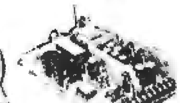
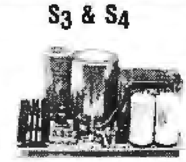


S_3 & S_4



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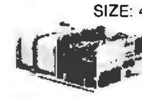

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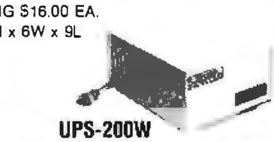

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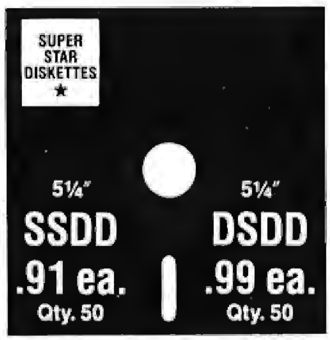

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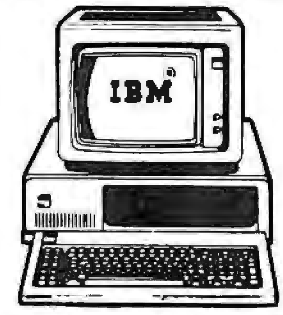

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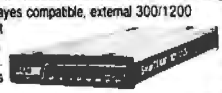

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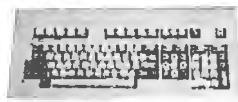

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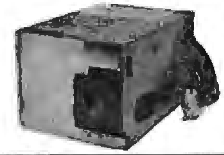

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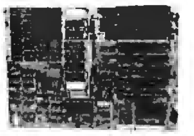

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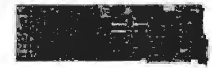

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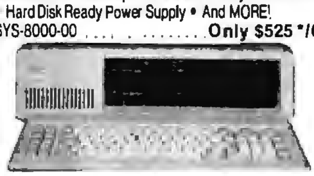

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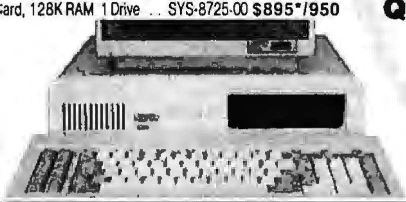

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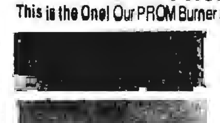

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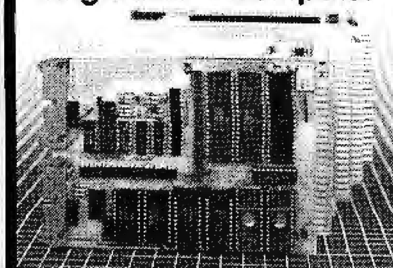

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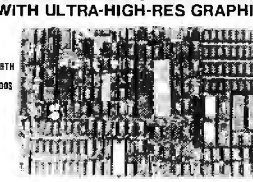

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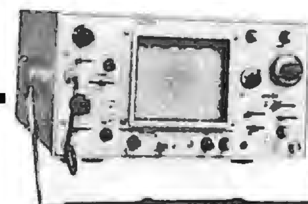

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HM6264LP-15	8192 x 8 (150ns) (cmos)(LP)	22.95
HM6264LP-12	8192 x 8 (120ns) (cmos)(LP)	24.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.45
UPD411	4096 x 1 (300ns)	1.95
MM5280	4096 x 1 (300ns)	1.95
MK4108	8192 x 1 (200ns)	.49
MM5298	8192 x 1 (250ns)	.49
4116-20	16384 x 1 (200ns)	.79
4116-15	16384 x 1 (150ns)	.99
4116-12	16384 x 1 (120ns)	1.49
2118	16384 x 1 (150ns) (5v)	3.95
4164-25	65536 x 1 (250ns) (5v)	2.00
4164-20	65536 x 1 (200ns) (5v)	2.22
4164-15	65536 x 1 (150ns) (5v)	2.50
41256-20	262144 x 1 (200ns)	12.95
41256-15	262144 x 1 (150ns)	15.95

5V = Single 5 Volt Supply

EPROMS

1702	256 x 8 (1us)	3.95
2708	1024 x 8 (450ns)	2.49
2758	1024 x 8 (450ns)	5.90
2716	2048 x 8 (450ns) (5v)	2.95
2716-1	2048 x 8 (350ns) (5v)	3.95
TMS2516	2048 x 8 (450ns) (5v)	3.95
TMS2716	2048 x 8 (450ns)	6.95
TMS2532	4096 x 8 (450ns) (5v)	3.95
2732	4096 x 8 (450ns) (5v)	3.95
2732 A-4	4096 x 8 (450ns) (21v)	3.95
2732 A-35	4096 x 8 (350ns) (21v)	3.95
2732 A	4096 x 8 (250ns) (21v)	5.95
2732 A-2	4096 x 8 (200ns) (21v)	8.95
2764	8192 x 8 (450ns) (5v)	4.95
2764-25	8192 x 8 (250ns) (5v)	5.95
2764-20	8192 x 8 (200ns) (5v)	9.95
TMS2564	8192 x 8 (450ns) (5v)	9.95
MCM68764	8192 x 8 (450ns) (5v) (24-pin)	17.95
MCM68766	8192 x 8 (350ns) (5v) (24-pin)	19.95
27128-45	16384 x 8 (250ns) (5v)	14.95
27128-30	16384 x 8 (300ns) (5v)	16.95
27128-25	16384 x 8 (250ns) (5v)	18.95
27256-25	32768 x 8 (250ns) (14v)	79.95

5v = Single 5 Volt Supply

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	1.65	74LS324	1.70
74LS20	.24	74LS155	.68	74LS352	1.25
74LS21	.28	74LS156	.88	74LS353	1.25
74LS22	.24	74LS157	.84	74LS363	1.30
74LS26	.28	74LS158	.58	74LS364	1.90
74LS27	.28	74LS160	.68	74LS365	.48
74LS28	.34	74LS161	.84	74LS366	.48
74LS30	.24	74LS162	.88	74LS367	.44
74LS32	.28	74LS163	.84	74LS368	.44
74LS33	.54	74LS164	.88	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	74LS379	1.30
74LS47	.74	74LS170	1.45	74LS385	1.85
74LS48	.74	74LS173	.88	74LS386	.44
74LS49	.74	74LS174	.64	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	.38
74LS74	.34	74LS192	.78	74LS490	1.90
74LS75	.38	74LS193	.78	74LS624	3.95
74LS76	.38	74LS194	.68	74LS640	2.15
74LS78	.48	74LS195	.88	74LS645	2.15
74LS83	.58	74LS196	.78	74LS668	1.65
74LS85	.88	74LS197	.78	74LS669	1.65
74LS86	.38	74LS221	.88	74LS670	1.45
74LS90	.54	74LS240	.94	74LS674	9.80
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	26LS2521	2.75
74LS124	2.85	74LS259	2.70	25LS2569	4.20

CRT CONTROLLERS

6845	11.95	8275	28.95
68B45	16.95	7220	38.95
HD46505sp	11.95	CRT5027	18.95
6847	10.95	CRT5037	28.95
MC1372	6.90	TMS9918A	38.95
68047	23.95	DP8350	48.95

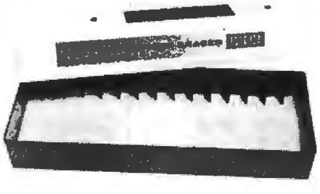
DISC CONTROLLERS

1771	14.95	2797	54.95
1791	21.95	6843	33.95
1793	25.95	8272	18.95
1795	21.95	UPD765	18.95
1797	21.95	MB8876	23.95
2791	49.95	MB8877	25.95
2793	49.95	1691	6.95
2795	54.95	2143	6.95

UV ERASERS

QUV-T8/1 $49.95

ECONOMY Model



- Erases 15 EPROMS in 20 minutes
- Plastic Enclosure

6500

1 MHZ		2 MHz	
65022	4.90	6502A	5.90
6504	6.90	6520A	5.90
6505	8.90	6522A	8.90
6507	9.90	6532A	10.90
6520	4.30	6545A	12.90
6522	4.90	6551A	10.90
6532	8.90	**3 MHz**	
6545	9.90		
6551	9.90	6502B	7.90

6800

1 MHz		68B00 2 MHz	
6800	2.90		
6802	7.90	68B00	9.90
6803	17.90	68B02	11.90
6808	12.90	68B09	11.90
6809E	8.90	68B09E	11.90
6809	8.90	68B10	5.90
6810	2.90	68B21	5.90
6820	4.30	68B40	19.90
6821	2.90	68B45	19.90
6828	13.90	68B50	5.90
6840	11.90		
6843	33.90		
6844	24.90	**68000**	
6845	11.90		
6847	10.90	68000-8	34.90
6850	2.90	68047	23.90
6852	5.90	68488	18.90
6860	7.90	68652	14.90
6862	10.90	68661	8.90
6875	6.90	68764	17.95
6880	1.90	68766	19.95
6883	21.90		

8000

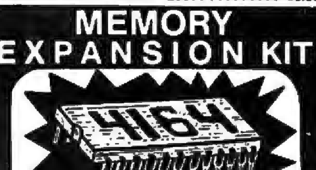
8031	14.90	8253	6.90
8035	5.90	8253-5	7.90
8039	5.90	8255	4.45
INS-8060	16.90	8255-5	4.90
INS-8073	29.90	8257	7.90
8080A	3.90	8257-5	8.90
8085	4.90	8259	5.90
8085A-2	11.90	8259-5	8.90
8086	24.90	8271	69.90
8087-3 (5 MHz)	159.90	8272	19.90
8087-2 (8MHz)	279.90	8274	28.90
8088	19.90	8275	28.90
8089	59.90	8279	6.90
		8279-5	7.90
8100		8282	6.45
		8283	6.45
8131	2.90	8284	4.90
8155	6.90	8286	6.45
8155-2	7.90	8287	6.45
8156	5.90	8288	12.90
8185	28.90	8289	44.90
8185-2	38.90	8292	12.90

8200		8300	
8202	23.90	8303	2.90
8203	38.90	8304	1.90
8205	2.90	8307	2.90
8212	1.75	8308	2.90
8214	3.75	8310	9.90
8216	1.75	8311	3.90
8224	2.20	**8700**	
8226	1.75	8741	28.90
8228	3.45	8748	19.90
8237	12.90	8749	28.90
8237-5	14.90	8755	23.90
8238	4.45		
8243	4.45	**80000**	
8250	8.90	80186-6	99.90
8251	3.90	80188	89.90
8251A	4.45		

Z-80

2 MHz			
Z80-CPU	1.95	Z80A-SIO/0	9.95
Z80-CTC	1.95	Z80A-SIO/1	9.95
Z80-DART	6.95	Z80A-SIO/2	9.95
Z80-DMA	7.95	Z80A-SIO/9	9.95
Z80-PIO	1.95	**6 MHz**	
Z80-SIO/0	9.95		
Z80-SIO/1	8.95	Z80B-CPU	7.95
Z80-SIO/2	8.95	Z80B-CTC	8.95
Z80-SIO/9	8.95	Z80B-PIO	8.95
4 MHz		Z80B-DART	18.95
		Z80B SIO/0	28.95
Z80A-CPU	2.45	Z80 SIO/2	29.95
Z80A-CTC	2.45	**ZILOG**	
Z80A-DART	7.95		
Z80A-DMA	8.95	Z6132	29.95
Z80A-PIO	2.45	Z8671	38.95

MEMORY EXPANSION KIT



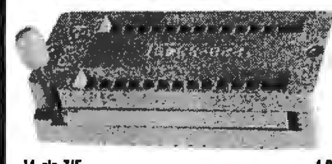
4164 200ns

9 for $19.98

DIP SWITCHES

4 POSITION	.79
5 POSITION	.85
6 POSITION	.85
7 POSITION	.89
8 POSITION	.89

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 = TEXTOOL (Zero Insertion Force

IC SOCKETS

(1 to 99)

8 pin ST.	.12	8 pin WW.	.58
14 pin ST.	.14	14 pin WW.	.68
16 pin ST.	.15	16 pin WW.	.68
18 pin ST.	.19	18 pin WW.	.95
20 pin ST.	.28	20 pin WW.	1.04
22 pin ST.	.29	22 pin WW.	1.34
24 pin ST.	.29	24 pin WW.	1.44
28 pin ST.	.39	28 pin WW.	1.54
40 pin ST.	.48	40 pin WW.	1.94

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
4.9150 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
6.0000 MHz	1.95	48.0000 MHz	1.9
6.1440 MHz	1.95	49.4350 MHz	1.9
6.4000 MHz	1.95	49.8900 MHz	1.9
6.5536 MHz	1.95		

32.768 KHz. .99

VOLTAGE REGULATORS

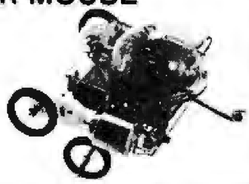
7805T	.74	7905T	.8
78M05C	.34	7908T	.8
7808T	.74	7912T	.8
7812T	.74	7915T	.8
7815T	.74	7924T	.8
7824T	.74	7905K	1.4
7805K	1.34	7912K	1.4
7812K	1.34	7915K	1.4
7815K	1.34	7924K	1.4
7824K	1.34	79L05	.7
78L05	.68	79L12	.7
78L12	.68	79L15	.7
78L15	.68	LM323K	4.9
78H05K	9.90	UA78S40	1.9
78H12K	9.90		

C,T = TO-220   K = TO-3
L = TO-92

Inquiry 139

ROBOT KITS!

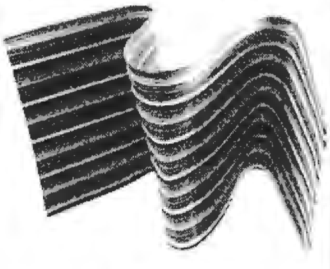
PIPER-MOUSE



Controlled by sound sensor and 1-channel electronic circuit. Use the whistle in this kit and Piper-Mouse follows your commands, turning left or right, stopping and starting. Uses 2 AA and 1 9V battery (not included).

MV-915 $44.95

RIBBON CABLE



	SINGLE COLOR		COLOR CODED	
CONTACTS	1'	10'	1'	10"
10	.45	4.30	.76	7.20
16	.50	4.70	.65	6.70
20	.60	5.60	1.15	10.90
25	.70	6.50	1.22	11.50
26	.70	6.50	1.27	11.50
34	.93	8.60	1.55	14.40
40	1.27	11.50	1.62	16.70
50	1.26	12.00	2.40	21.90

RESISTORS

¼ WATT 5% CARBON FILM
ALL STANDARD VALUES
FROM 1 OHM - 10 MEG OHM

50 PCS 1.25
100 PCS 2.00
1,000 PCS 15.00

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Extended 80-Col. VIDEO CARD

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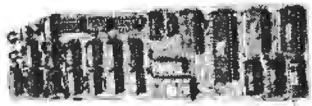
★ 64K to 128K ★

MULTIVIEW 80/160 249.00

80-160 columns with any monitor!

- Screens: 80x24, 80x32, 80x48, 98x24, 132x24, 132x30, 160x24
- On-screen BOLD and Underline
- Reverse scrolling
- Easy-to-read *Wide-angle* mode
- Apple II and IIe compatible
- Prompt lines
- Upper & lowercase letters



APPLE & IBM ACCESSORIES

80 Column Apple II+ ... 149.95
80 Column Apple IIE ... 119.95
Z80 Apple II+ 89.00
Z80 Apple IIE 89.00
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VIEWMAX-80 149.95

80-Column card for Apple II series

- Video Soft Switch
- Inverse Video
- VIDEX's Videoterm compatible

VIEWMAX-80e 119.95

80-Column extended video card for Apple IIe

- 64K RAM, expandable to 128K
- Double High-resolution circuit
- Compatible with Pascal & CP/M

PRINTMAX 59.95

Parallel printer card, Apple II series

- Centronics compatible
- Variable print widths
- Up to 5000 characters/second

APPLE & IBM Compatible DISK DRIVES

169.95

- Shugart mechanism, made in U.S.A.
- Directly replaces Apple Disk II
- Fully compatible with Apple Controller or other Apple compatible controllers.
- One Year Warranty

FULL or ½-Height

16K RAM Card - Apple II+

- 2-Year Warranty

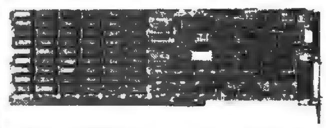
Assembled & Tested 39.95

APPLE or IBM JOYSTICK

$29.95

Compatible for either:
APPLE II and APPLE IIe
OR
IBM-PC, JR., & IBM-XT

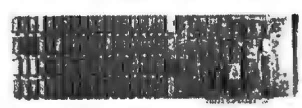
MULTIFUNCTION CARD



- 64K to 384K RAM
- Parallel Port
- Serial Port
- Clock Calendar
- Software Included
- 1-Year Warranty

$249.95

MEMORY CARD



- Expandable to 512K
- Fully compatible with IBM software
- Fully compatible w/IBM diagnostic utilities
- Serial Port Available
- 1-Year Warranty

$199.95

MEMORY EXPANSION KIT

4164 200ns
9 for $19.98

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.

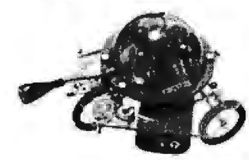
LIFETIME WARRANTY ON ALL ATHANA DISKETTES

NO LABEL: (SOFT SECTOR w/HUB RING)
25 per package
SS/DD ...... 24.75 or .99 ea.
DS/DD ...... 29.75 or 1.19 ea.

2-YEAR WARRANTY ON ALL BULK DISKETTES

ROBOT KITS!

PEPPY



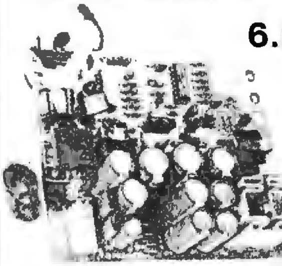
2-way sensor detects noise or solid objects in its path. When front sensor contacts an obstacle or hears a loud noise (hand-clap), Peppy automatically turns to the left.
Uses 2 AA and 1 9V battery (not included).

MV-916 $24.95

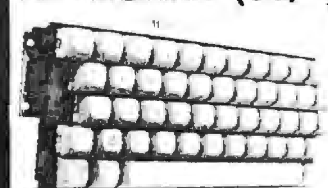
Reg. Power Supply

Model 4A/PS (99/4)
3 DC Outputs:
12V @ .4A, +5V @ 1.1A
−5V @ .2A Highly Filtered

6.95



KEYBOARD (99/4)



48 keys 4"x10" 6.95

TERMS: Minimum order $10.00. For shipping and handling, include $2.50 for UPS ground or $3.50 for UPS Blue (air). For each additional air pound, add $1 for UPS Blue shipping and handling. California residents must include 6% sales tax. Bay area and LA residents include 6½% sales tax. Prices are subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturers. All merchandise subject to prior sale.

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Apple Professional System incl: Apple IIE, 128K, Tilt Monitor, DuoDisk, 80 col. card	$1375
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Fat Mac512K, same as above	2995
Apple IIc	989
Apple IIc w/Monitor & Stand	1059

IBM

IBM PC Bare w/Cont. & 64K	$1345*
IBM PC64K, 1 Drive	1475*
IBM PC64K, 2 Drives	1575*
IBM PC 128K, 1 Drive	1495*
IBM 256K, 2 Drives	1599*
IBM XT, 10 Meg. Floppy & 128K	3295*
IBM AT Base	Call
IBM AT Enhanced	Call

*Call For Current IBM Prices

KAYPRO

Kaypro II	Call
Kaypro IIX	For
Kaypro 4	Current
Kaypro 4/88	Price
Kaypro 10	And
Kaypro 16	Stock

SANYO

MBC 550-2 w/1 320K Drive & sftwr.	$ 895
MBC 555-2 w/2 320K Drives & more software	1065
Serial Port for Sanyo	79
Sanyo Video Board	165

TAVA

TAVA PC1 Par. & 1 Ser. Ports, 128K, 2-320K Drives, Color Card & Monitor	$1499
TAVA XT same as above incl. 10 meg Hd Disk	$2495

COMPAQ

256K, w/2 - 320K Drives	$1945
DeskTop Model 1	1650
Desk Top Model 2	1999
Desk Top Model 3	3795
DeskTop Model 4	4995

SOFTWARE

LOTUS DEVELOPMENT CORP.

Lotus 1-2-3	$ 289
Symphony	434

ASHTON TATE

D Base II	$ 329
D Base III	389

PRINTER SWITCHBOX

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SRS-4 Serial	89
SCN-2 Parallel	79
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PRINTERS

OKIDATA

ML182A, Replaces 82A "New"	$ 279
ML83A, 15" Para. & Ser.	539
ML92P, 160cps, Corr. Quality	349
ML92 IBM Graphics Comp.	349
ML92S, 160 cps, Corr. Quality	465
ML92Apple Mac. 2K Graphics	475
ML93P, 160 cps, Corr. Quality	579
ML93 IBM Graphics Comp.	579
ML93S, 160 cps, Corr. Quality	659
ML84P, 200 cps	679
ML84 IBM Graphics Comp.	679
ML84S, 200 cps	779
Okimate 20	139
Interface Module for OKI20	79

RITEMAN

Riteman Plus 120 cps w/Tractor	$ 257
Riteman Blue Plus 140 cps IBM	342
Riteman II 160 cps, 8K mem. w/Trac	369
Riteman 15, 160cps, 15" carr.	549

QUME

Letterpro 20P Prop. Spc. Enh Prnt	$ 399
Sprint 1140+, 2K, 40 cps, 132 col. width	1229

STAR MICRONICS

SG10Ft, 120 cps, corr. qual.	$ 239
SG15Ft, 120 cps, corr.qual.	399
SD10Ft, 160 cps, corr. qual.	359
SD15Ft, 160cps, corr. qual.	475
SR10Ft, 200 cps, corr. qual.	499
SR15Ft, 200cps, corr. qual.	629
SB10 Draft, 144 cps, NLQ 60 cps	795
Powertype, 18 cps Bi-Di	359

C. ITOH

Prowriter 8510 AP, 120 cps, Parallel	$ 299
Prowriter 8510 BC2, 120 cps, Serial	399
Prowriter 8510 SP, 180cps, Parallel	399
8510 BPI (IBM Compatible), 120 cps	335
Prowriter II 1550 P, 15" 120 cps, Parallel	445
Prowriter II 1550BCD, 15" 120 cps, Serial	499
1550 EP (IBM Compatible), 120 cps	445
1550SP, 180cps	549
Starwriter F10-40PU, 40 cps	869
Starwriter A10, 205P, 29 cps	499
Printmaster F10-55PU, 55 cps	1069

BROTHER

HR25, 25cps	$ 629
HR35, 36 cps	839

DYNAX

DX15XL By Brother, 20cps	$ 379

JUKI

6100, L.Q. 18 cps w/proportional spc.	$ 389
6300, 40 cps	689

TOSHIBA

P1351 Dot Matrix, 192 cps, letter quality 100 cps, does graphics. 3 in 1 printer	$1195
P1340 same as above but 10" carr.	585

PANASONIC

1091 w/Tractor, 120 cps, 1 yr. war.	$ 269
1092, 10" car., 180cps	439
1093, 15" car. 160cps	669

LEGEND

880, 80 cps, FT & Graphics	$ 229
1080, 120 cps, FT & Graphics	275

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Grappler +
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PARADISE 5 PACK
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INTEL 8087
$115

PRINTER ACCESSORIES

ORANGE MICRO

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Buffered Grappler +, 16K exp. 64K	159

TOSHIBA

Bi-Directional Tractor	$ 149
Font Disk for Down loading P1351	48

MICROTEK

Dumpling GX (same as Grappler +)	$ 69
Dumpling GX w/16K buffer	145
Dumpling GX w/32K buffer	12
Additional Buffering 16K	16

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Par. Card & Cable for Apple	$ 45

OKIDATA

Plug and Play for IBM	$ 49
Okigraph I for 82A	49
Okigraph I for 83A	49
Tractor for 82A & 92	49

JUKI

Bi-Directional Tractor, 6100/6300	$ 145
Serial Interface	65

BROTHER

Tractor for DX-15	$ 99
Tractor for HR25	129
Tractor for HR35	129
Cut Sheet Feeder for DX15	175
Cut Sheet Feeder for HR25/35	199
Keyboard for DX15	165

STAR MICRONICS

Graphstar, Apple Interface	$ 69
Universal Atari	79
Universal Commadore	59
Serial Interface Card	59

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IBM PC to Parallel Printer	$ 18
Serial Cable	18
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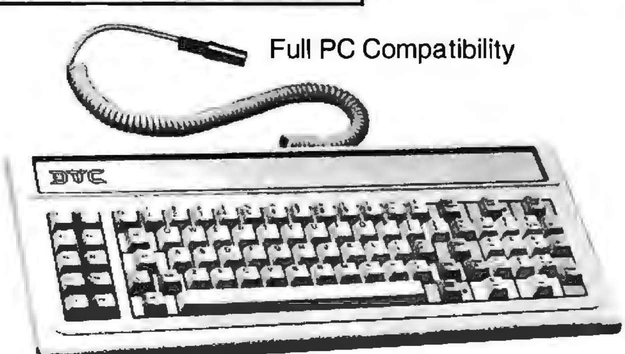

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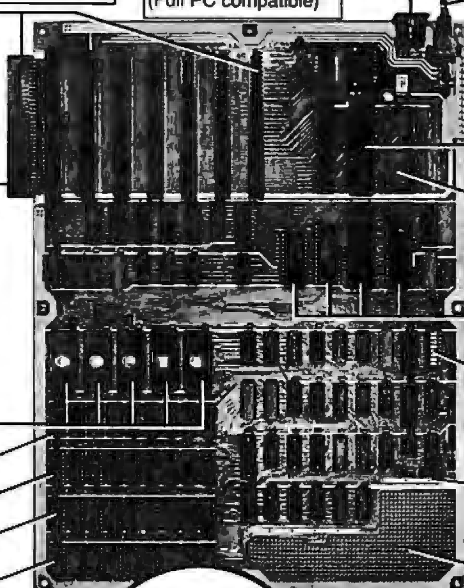

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California Digital

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NEC RGB COLOR MONITOR $259

The NEC JC-1401D is a 13" medium/high resolution RGB monitor suitable for use with the Sanyo MBC-550/555 or the IBM/PC. The monitor features a resolution of 400 dots by 240 lines. Colors available are Red, Green, Blue, Yellow, Cyan, Magenta, Black and White. These monitors are currently being used in applications far more critical than microcomputers.
The NEC monitor carries the Litton-Monroe label and was originally scheduled for use in their "Office of the Future" equipment. A change in Monroe's marketing strategy has made these units excess inventory which were sold to California Digital. We are offering these prime "new" RGB monitors at a fraction of their original cost. Sanyo compatible NEC-1401/S: IBM/P/C Computer compatible NEC-1401/PC

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	128 95
Amdek 300A 12" amber phos., hi-resolution	AMK-300A	138 95
Amdek 310A designed for IBM/PC, amber	AMK-310A	158.95
Zenith ZVM122 Amber Phosphor 12" 40/80 column switch.	ZTH-122	89.95
Zenith ZVM 123 green phosphor 12" 40/80 column switch.	ZTH-Z123	89.95
NEC JB1201 green phosphor 18 MHz composit video	NEC-JB1201	159.00
NEC JB1260 commercial grade composit	NEC-JB1260	119.00
Conrac 9" open frame requires horz sync. & 12v. supply.	CON-BW9	59.00

COLOR

NEC JC1401D Medium/High 13" RGB	NEC-1401/X	259 00
BMC AU9191U Color composit video with sound	BMC-9191	238.95
BMC 9191M RGB designed for use with the IBM computer	BMC-9191M	379.00
NEC JC1203DM, RGB color monitor	NEC-1203	699.00
NEC JC1215 color composit.	NEC-JC1215	339 00
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	419.95
Amdek Color III +, 13" RGB, medium resolution	AMK-300	359.95
Princeton HX-12 RGB IBM/PC compatible	PRN-HX12	478.95

PRINTERS

MATRIX PRINTERS

Star Gemini-10X 120 char/sec.	STR-G10X	249 00
Star Gemini-15X, 100char./sec 15" paper	STR-G15X	365 00
Star Gemini Delta 10, 160 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	549 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" corespondence 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" pa er, 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 ultra high speed 600 lines per minute	PTX-P600	5795 00

WORD PROCESSING PRINTERS

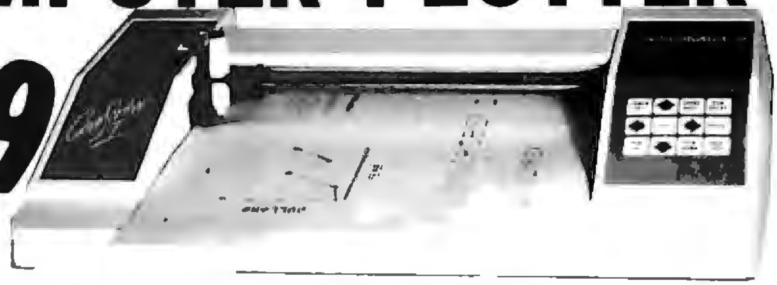
Starwriter F10 parallel, 40 char/sec	PRO-F10P	49900
NEC8810 55 char/second, serial interface	NEC-8810	165900
NEC8830 55 char/sec. par'l interface	NEC-8830	165900
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1599.00
NEC2050 designed for IBM/PC 20 char/sec par'l.	NEC-2050	689.00
Silver Reed 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/s c. 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

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, s lit screen.	WYS-300	1159 00
Zenith 29 terminal, VT52 compatible detatchble 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

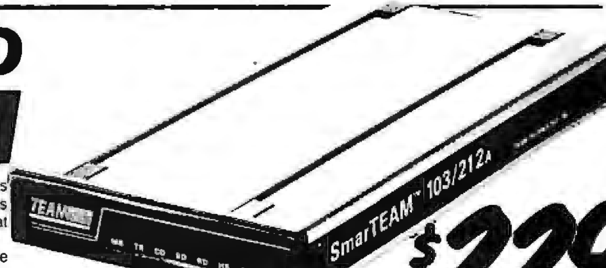
COMPUTER PLOTTER

$219



The Comrex Comscriber I is the ideal solution to make short work of translating financial and numeric data into a graphic presentation.
Many ready to run programs such as Lotus 1-2-3, Visi-on and Apple business graphics already support this plotter.
The Comscriber I features programmable paper sizes up to 8½ by 120 inches, 6 inch per second plot speed and 0.004" step size.
Easy to implement Centronics interface allows the Comscriber I immediate use with the printer port of most personal computers.
The Comscriber I is manufactured for Comrex by the Enter Computer Corporation. The plotter is marketed by Heath Kit and also sold under Enters own "Sweet P" Label. This is your opportunity to purchase a graphic plotter which was originally priced at $795 for only $219.
Also available is a support package which includes demonstration software, interface cable, amulticolor pen assortment and a variety of paper and transparency material.

1200 BAUD MODEM



$229

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

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.

MODEMS

Team 1200 HayesCompatible	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, Hayes compatible	SGL-MK12	239 00
Signalman Mark 1, direct connect with terminal cable	SGL-MK1	75 00
Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	429 00
Hayes 1200B for use with the IBM/PC, 1200 baud	HYS-1200B	399 00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279 00
Hayes Chronograph, time & date	HYS-CHR232	199 00
U S Robotics 212A 300/1200 baud, auto dial/answer	USR-212A	439 00
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

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 spread sheet, 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.

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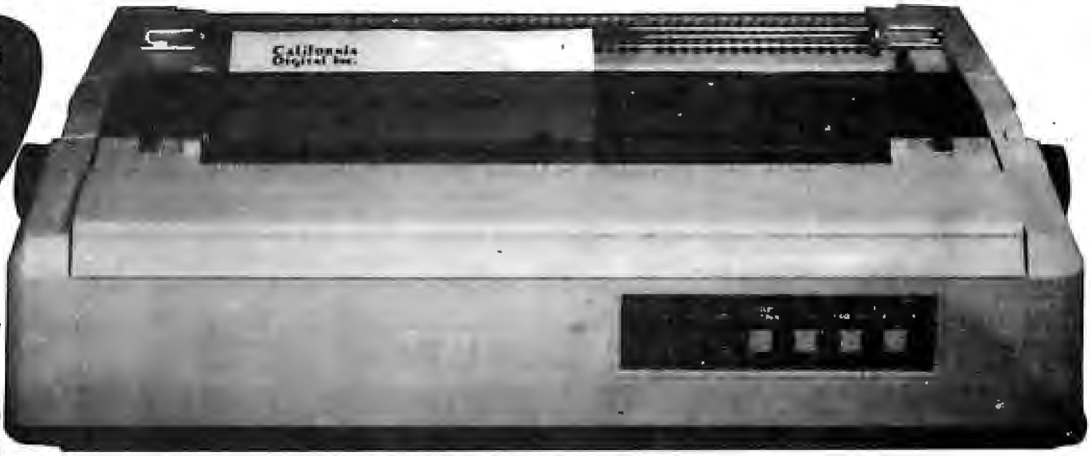
C.ITOH F10 STARWRITER



$499

LETTER QUALITY PRINTER

C. Itoh's STARWRITER F-10 is the answer for the perfect daisy wheel printer. The F-10 produces letter quality printing at 40 characters per second. Auto installs with Wordstar and Perfect Writter. 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 Starwriter 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.

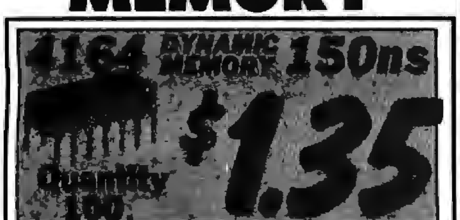
Options available include tractor feed, buffered memory and an assortment of printer cables for a variety of computers.

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

MEMORY



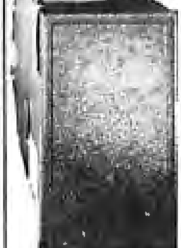
DYNAMIC MEMORY

		1-31	32 +	100 +
4164 150ns. 64K 128 refresh	ICM-4164150	2.29	1.99	1.35
41256 150ns. 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
21L02 450ns. 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
5257 300ns. 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	7.65	7.25
2732 450ns. 4K x 8	ICE-2732	4.50	3.75	3.55
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

$119

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	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 HalfHeight	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

VISA

Shipping: First five pounds $3.00, each additional pound $.50.
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California Digital

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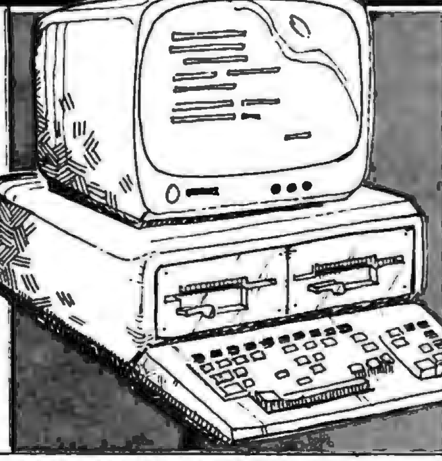


IBM COMPATIBLE $995

OPERATES MS/DOS & CPM86

Monitor and Disk Drives included.

The Olympia Computer is a current technology, IBM/PC compatible computer complete with two quad density disk drives, 128K/byte of user memory (expandable to 512K) and a 12 inch high resolution monitor. This unit features a 8086 CPU, a true 16 bit microprocessor, built in RS-232 serial port and a Centronics parallel printer port.

The Olympia includes a dual operating system and both MS/DOS 2.1 and CP/M 86 are provided. The computer will also support Concurrent CP/M. And will operate Lotus 1-2-3 as well as Flight Simulator. The Olympia uses Digital Research's GSX/86 graphics extension system which allows application programs to use the full capabilities of screen graphics.

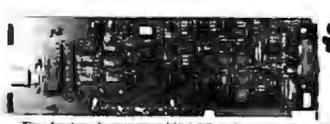
The original suggested list price on the Olympia Computer was $3,595 but California Digital offering these units, while supplies last, at only $995.

WINCHESTER SUBSYSTEM For IBM/PC $519

The California Digital Winchester subsystem provides over 10 megabytes of memory for only $519. This low cost external hard disk systems is supplied with controller card and operating software.

Everything you need to install this Winchester on your IBM/PC is included with the subsystem kit. And at only $519, this is by far the best value that has ever been offered in a hard disk system.

ANCHOR AUTOMATION MODEM $89



The Anchor Automation Mark VI is direct connect modem that plus into any slot of your IBM/PC. This modem supports auto answer and auto dial capabilities. Other features include telephone number storage, send / receive text files, single key-stroke dialing along with many other functions provided on disk. The Mark VI was originally priced at over $300.

FREE

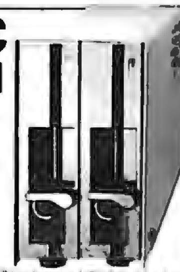
Plastic library case supplied with all diskettes purchased from California Digital.

FIVE INCH DOUBLE SIDED DOUBLE DENSITY

		Each box	10 Boxes	100 Boxes
CAL DIGITAL	CAL-551 CAL-561 N/A	19.95	18.75	17.85
SCOTCH	MMM-745/0 MMM-745/10 MMM-745/16	29.95	27.95	24.75
VERBATIM	VRB-550/01 VRB-550/10 VRB-550/16	29.95	27.95	23.75
MAXELL / HD	MXL-MD2/96 N/A N/A	CALL		
DYSAN	DYS-104/2D DYS-107/2D DYS-105/2D	42.50	40.50	35.50
DYSAN / 96	DYS-204/2D N/A N/A	49.95	47.95	45.75

Other diskettes available include 3½" and all 8" formats. Please phone for prices.

DUAL TEAC SUBSYSTEM $289



The dual Teac 55F subsystem features two 96 track per inch 5¼" double sided disk drives. Also supplied within the subsystem is 50 watt power supply and a four foot shielded signal cable.

TELETYPE MODEL 40 $595

The Teletype Model 40 printer is continuous heavy duty communication equipment that have recently come off lease from a Cado Computer customer. It is seldom that California Digital becomes involved in the marketing of reconditioned equipment but we felt that this printer represented such an exceptional value that we had to offer this equipment to our customers.

The full character chain printer is capable of printing text in excess of 300 lines per minute. This printer, long used in high speed mini-computer applications, will provide the small business user with good quality multi-part printouts at speeds that can not be attained by dot matrix printers.

This unit also has a four channel vertical forms feed controller that allows for quick change of various form lenghts. The Teletype Model 40 printer has a proprietary serial Teletype SSI interface and DIP switches are provided for setting baud rates to 9600. An optional RS-232 serial interface is available please phone for details.

western union EasyLink

EasyLink gives any personal computer access to over 1.5 million Western Unions World Wide terminals. With EasyLink service you can send Telexs, Telegrams and Mailgrams from your computer. Through the use of the "Mailbox" messages can be received even when your computer is turned off, and "picked up" at your convenience.

Joining the World of Western Union's EasyLink is FREE of charge and there is no monthly service fee. Sending a domestic Telex is about $1.75 and a Mailgram has an adverage cost of $2.50. Western Union does require a minimum usage of $25 per month. Call California Digital to receive your EasyLink subscriber number.

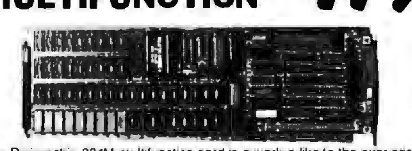
BAR CODE READER For IBM/PC $589

The DataLogic bar code reader plugs directly between the keyboard and the mainframe of your IBM/PC. All instructions are supplied in firmware built into the reader device. By the flip of a dip switch this bar code reader is capable of reading eight different formats of code including UPC, 2/5 and many more.

Bar code is suitable for inventory control, freight and invoice records, personal records and other application limited only by imagination.

Other DataLogic bar code readers are designed for the Apple II and RS-232 serial terminals. Please phone for list of other bar code products available.

DIGIGRAPHICS MULTIFUNCTION $179



The Digigraphic 384M multifunction card is a work-a-like to the over priced AST Sixpack Plus but at a much more attractive price.

Memory is expandible to 384K/byte, battery backed up clock/calendar, fully programmable RS-232 communication port, centronics parallel port, and game port as standard equipment making this card an outstanding value.

Software is also provided for clock/calendar functions, RAM-Disk up to 360K, print spooler for up to 3 printers, as well as diagnostic memory tests.

$179.00 no memory DGC-384/0, $219.00 64K/byte memory DGC-384/64

CONNECTORS

RIBBON CONNECTORS

DB25P male	CND-r25P	5 85	5 25	4 15
DB25S female	CND-r25S	5 95	5 50	4 50
57 30360 male	CNC-r36P	7 95	6 75	6 90
57 30360f male	CNC-r36S	7 95	6 75	5 90
20 pin edge	CNI DE20	4 35	3 30	2 50
20 pin socket	CNI-DS20	2 75	1 85	1 60
26 pin edge	CNI-DE26	4 95	3 50	2 70
26 pin socket	CNI-DS26	3 50	2 40	2 15
34 pin edge	CNI DE34	4 95	4 50	3 50
34 pin socket	CNI-DS34	4 50	3 95	3 15
50 pin edge	CNI-DE50	5 95	5 60	4 80
50 pin socket	CNI-DS50	4 95	4 60	3 80

AMPHENOL / CENTRONICS TYPE

57-30360 36/P	CNC-36P	7 95	6 35	3 97
IEEE488 C dor	CND-24P	7 95	6 35	5 35

"D" TYPE	catalog	each	10-99	100+
DE9P male	CND-9P	1.60	1.40	1 30
DE9S female	CND-9S	2.25	2 00	1 30
DE hood	CND-9H	1.50	1 35	1 20
DA15P male	CND-15P	2 35	2 10	1 90
DA15S female	CND-15S	3.25	3 10	2 90
DA15 hood	CND-15H	1.60	1 35	1.30
DB25P male	CND-25P	1.95	1.75	1.35
DB25S female	CND-25S	2.95	2 55	1 65
DB25 hood	CND25H	1 35	1 15	77
DC37P male	CND-37P	420	3 95	3.65
DC37S female	CND-37S	5 95	5 75	5 50
DC37 hood	CND-37H	2 25	1 95	165
DD50P male	CND-50P	5 50	5 10	4 75
DD50 hood	CND-50H	2.60	2.40	2 10
Hardware 2/set	CND-2HS	.89	.69	42

VISA

master charge

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Foreign orders: 10% shipping, excess will be refunded.
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45 Megabyte Streaming Tape System

Includes 45 MB half-high streaming tape drive, 45 MB tape cartridge, controller, cables, and software. Just plug-in and run!

- IBM PC, XT, AT compatible
- Fast 2.2 minutes per 10 MB
- Unique flexible software allows choice of file-by-file or complete mirror-image back-up & retrieval
- 6 different file selection parameters
- Automatic error checking & correction
- Full one year factory warranty

	LIST	JADE
Internal 45 MB for XT	$1395	$1095.95
Internal 45 MB for PC	$1495	$1145.95
External 45 MB system	$1595	$1195.95
Extra 45 MB tape cartridge	$50	$45.95

GET YOUR IBM PC-AT THE

AST Advantage

- Up to 3 Megabytes of RAM
- Uses standard 64K or 256K chips
- Has PAL for split-addressing
- Low power, IBM-AT high speed bus
- One parallel & one serial port
- 2nd serial or game port optional

	LIST	JADE
128K, 1 serial, 1 parallel	$595	$479.95
512K, 1 serial, 1 parallel	$1395	$679.95
1.5 MB, 1 serial, 1 parallel	$2195	$989.95
3.0 MB, 1 serial, 1 parallel	$4145	$1689.95

New Products to Expand Your PCjr.

	LIST	JADE
AST 512K jrCombo w/128K	$395	$299.95
512K Multifunc. Card w/0K	$295	$229.95
External 360KB Disk Drive	$499	$369.95
Parallel Printer Port	$120	$94.95
8087 Co-Processor Card	$199	$149.95
Light Pen System	$299	$229.95
Simultaneous Disk/Keyboard	$59	$44.95
AST-PCnet IIjr LAN	$495	$399.95
TECMAR CAPTAINjr. w/128K	$499	$349.95
TECMAR GRAPHICS MASTER	$699	$499.95

Hayes Smartmodem 2400 BAUD IN STOCK!

(At press time we had 100 Smartmodem 2400's in stock and more on their way to us.)

SAVE $210.00

List Price $895 **Sale Price $679.95**

New! from JADE IBM Multifunction Card

Up to 384K, parallel printer port, RS-232 serial port, serial cable, clock/calendar, RAM disk/spooler and diagnostic software package.

	LIST	JADE
0K	$349	$198.95
64K	$449	$229.95
256K	$549	$329.95
384K	$649	$399.95

AST for IBM PC

	LIST	JADE
Six Pak Plus 64K	$395	269.95
Six Pak Plus 256K	$695	$399.95
Six Pak Plus 384K	$945	$469.95
Mega Plus 64K	$395	$269.95
Mega Plus 256K	$665	$379.95
Mega Plus 512K	$1095	$699.95
I/O Plus	$165	$119.95
Preview	$399	$309.95

64K RAM Upgrade Kits for Your IBM PC $17.95

High speed RAM upgrade kit with FREE! parity (error detection) and one year warranty. We ship thousands of these kits to satisfied customers every week.

	LIST	JADE
128K RAM Chip Kit for AT	$359	$129.95
256K RAM Chip Kit	$495	$88.95

Expansion Boards for Your IBM-AT

	LIST	JADE
JADE AT-Expando Plus	$495	$395.95
AT-Memory Master plus	$495	$429.95
AST Advantage-AT	$595	$479.95
STB Rio Grande 128K to 1.5M	$495	$359.95
STB Grande Byte 128K to 2.5M	$395	$299.95
Quadport-AT 1S, 1P	$154	$139.95
4 Serial port kit	$195	$179.95
Quadmeg-AT 1 MEG	$2465	$1995.95
Quadmeg-AT 2 MEG	$3495	$2995.95
Quadmeg-AT 4 MEG	$7490	CALL
128K Upgrade Kit	$395	$129.95
20 Megabyte Hard Disk	$1790	$895.95

IBM Video Boards

	LIST	JADE
Hercules Color	$245	$189.95
Hercules Graphic	$499	$339.95
Plantronics Color Plus	$549	$379.95
AST Preview	$399	$309.95
AST Monograph Plus	$595	$449.95
Tecmar Graphics Master	$699	$499.95
Quadcolor I	$295	$209.95
Quadcolor II	$275	$209.95
PC Peacock	$299	$239.95
Paradise Graphics Card	$395	$319.95
Paradise Module A	$95	$87.95
Paradise Module B	$275	$239.95
Everex Graphics Edge	$599	$349.95

JADE 1200 BAUD MODEM

Hayes Smartmodem compatible, 1200 BAUD modem at a fraction of the price. FCC approved.

	LIST	JADE
JADE 1200 BAUD MODEM	$399	$229.95

10 Megabyte Hard Disk for Your IBM PC $689.95

Plug-n-run, ready to go, complete with controller card, data cable, and mounting hardware, totally PC/XT compatible, faster than XT, handles 4 different operating systems, streamer tape back-up available. External model includes cabinet & power supply. Full one year manufacturers warranty.

	LIST	JADE
10 MEGABYTE Internal	$1350	$689.95
10 MEGABYTE External	$1585	$849.95
15 MEGABYTE Internal	$1765	$879.95
15 MEGABYTE External	$1897	$1049.95
20 MEGABYTE Internal	$1800	$999.95
20 MEGABYTE External	$2060	$1249.95
33 MEGABYTE Internal	$3298	$1569.95
33 MEGABYTE External	$3388	$1999.95
10 MEGABYTE Half-High Tape	$1000	$579.95
20 MB Disk with 10 MB Tape	$2980	$1799.95

KEYTRONICS Keyboards

	LIST	JADE
5150	$209	$159.95
5151	$299	$199.95

HAYES Smartmodems

Sophisticated direct-connect auto-answer/auto dial modem, touch tone or pulse dialing RS232 interface programmable

	LIST	JADE
HAYES Smartmodem 2400	$899	$679.95
HAYES Smartmodem 1200	$699	$469.95
HAYES 1200B w/o Smartcom II	$539	$369.95
HAYES 1200B for IBM PC	$599	$399.95
HAYES Smartmodem 300	$289	$199.95
HAYES Chronograph	$249	$199.95
HAYES Micromodem 100	$399	$299.95
HAYES Micromodem IIe	$299	$239.95
HAYES Smartmodem IIc	$399	$249.95
HAYES PLEASE Software	$395	$299.95
HAYES Smartcom II	$149	$99.95

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	LIST	JADE
1200B ProModem for IBM PC	$399	$289.95
1200 RS-232 ProModem	$495	$349.95
1200A ProModem for Apple	$449	$349.95
1200 ProModem for Macintosh	$495	$399.95
Alpha/num Display Option	$99	$79.95
Options Processor	$99	$79.95
64K Mem Expansion for Above	$99	$59.95

Mouse by MOUSE SYSTEMS

	LIST	JADE
PC MOUSE with Pop-ups	$195	$139.95
PC MOUSE with Paint	$220	$159.95
FIELD MOUSE (male or female)	$175	$129.95
PC PAINT Software	$99	$69.95
MOUSE WINDOW Software	$150	$109.95
POP-UP MENU Software	$50	$39.95

QUADRAM for IBM PC

	LIST	JADE
Quadboard *No RAM*	$269	$234.95
Quadboard 64K	$395	$275.95
Quadboard 128K	$495	$319.95
Quadboard 256K	$595	$399.95
Quadboard 384K	$795	$469.95
Quadlink	$680	$449.95
Quad 512 Plus 64K	$325	$239.95
Quad 512 Plus 256K	$550	$359.95
Quad 512 Plus 512K	$895	$549.95
Quadcolor I	$295	$209.95
Quadcolor II	$275	$209.95
Quad 2 MEG w/512K	$1195	$995.95
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Low power, half-height tape drive that uses standard audio/data cassettes. Unique flexable software choice of file-by-file or complete mirror-image back-up and retrieval. IBM PC, XT, AT compatible.

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Double-sided, double density

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CDC 1/2 Height	$279	$139.95
CDC Full Height	$299	$149.95

SHUGART 8" Disk Drives

SHUGART SA 801A SS/DD *(Limited Supply)*
LIST $502 .... $399.95 ea. 2 for $389.95 ea.
SHUGART SA-851R DS/DD
LIST $605 .... $459.95 ea. 2 for $454.95 ea.

MICROSOFT for IBM PC

	LIST	JADE
Mouse with Word	$495	$319.95
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5, 10, or 20 Megabyte removeable cartridge mass storage system with flexability not available with hard disks and speed unmatched by floppy disk drives.

	LIST	JADE
5 Mbyte system *Macintosh*	$1895	$1695.95
10 Mbyte system *IBM PC*	$2695	$2289.95
20 Mbyte system *IBM PC*	$3895	$2989.95
Extra 10 Mbyte Cartridge	$100	$79.95

High-Resolution Monitors

	LIST	JADE
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Amdek 300A	$199	$149.95
Amdek 310A	$230	$179.95
Amdek Color 300	$349	$269.95
Amdek Color 500	$525	$399.95
Amdek Color 600	$650	$449.95
Amdek Color 710	$799	$589.95
PGS MAX-12	$269	$189.95
PGS HX-12 640x240	$699	$469.95
PGS SR-12 720x480	$799	$629.95
PGS Scan-Doubler	$299	$199.95
14 inch Quadchrome II	$599	$499.95
Taxan 440 Ultra Hi-res RGB	$799	$599.95
Taxan 210 RGB/Composite	$349	$289.95
Taxan TV Tuner for RGB Monitor	$99	$89.95

PERSYST Boards

	LIST	JADE
Mono display adapter	$225	$189.95
Mono display adapter w/parallel	$250	$199.95
BoB Hi-res display adapter	$595	$469.95
Time Spectrum SB 384 w/64K	$395	$299.95

High Speed 8087 APU

LIST PRICE $293 .... SALE PRICE $179.95

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These industrial quality ISO-BARs look like a standard multi-outlet power strip but contain surge suppression circuitry and built-in noise filters plus a 15 amp circuit breaker.

	LIST	JADE
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UNINTERRUPTABLE POWER SUPPLY

Emergency back-up power to save your computer system and your valuable data. A must for every computer system

	LIST	JADE
200 Watt UPS	$359	$279.95
425 Watt UPS	$539	$459.95
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APPLE Accessories

	LIST	JADE
Full Height Disk Drive	$299	$139.95
Half Height Disk Drive	$249	$149.95
Disk Drive for Apple IIc	$249	$159.95
Dual Disk Controller	$100	$79.95
CP/M 3.0 Card with 64K	$399	$269.95
ALS Z Engine	$299	$145.95
16K RAM Card	$99	$39.95
Best 80 Column Card	$219	$139.95
Printer Card & Cable	$109	$49.95
Fan with Surge Protection	$99	$59.95
Koala Pad	$125	$89.95
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10 Megabyte Hard Disk	$1495	$995.95

IBM PC $1695
JADE XPC $1295

256K of RAM, Two 360K Disk Drives, & Disk Controller

JADE XPC

- 256K of RAM Expands to 640K on Main Board
- 140 Watt Power Supply
- 4.77 or 7 MHz Clock
- 8 Expansion Slots
- Deluxe Keyboard
- 90 Day Warranty

IBM PC

- 256K of RAM Maximum on Main Board
- 63 Watt Power Supply
- 4.77 MHz Clock
- 5 Expansion Slots
- IBM Keyboard
- 90 Day Warranty

OPTION #1

256K of RAM
Two 360K Drives
Hercules Card
Amdek 300

IBM PC ____ $1995
JADE XPC _ $1695

OPTION #2

256K of RAM
Two 360K Drives
Hercules Card
PGS HX-12 Monitor

IBM PC ____ $2395
JADE XPC _ $2095

OPTION #3

256K Expands to 640K
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One 360K Drive
130 Watts of Power
Multifunction Card
Hercules Card
Amdek 300

IBM PC ____ $2995
JADE XPC _ $2695

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EPSON LQ-1500 *200 cps, NLQ*		
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NLQ Board *for RX/FX*	$219	$179.95
LetterWriter *NLQ Kit for FX*	$75	$59.95
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$499.95

NEW! OKIDATA PRINTER MICROLINE 192 $389.95

160 CPS, Near Letter Quality, & Graphics

	LIST	JADE
OKIMATE 20 *Color printer*	$150	$139.95
PLUG-N-PRINT *for OKI 20*	$75	$69.95
OKI 182 *120 cps, graphics*	$299	$259.95
OKI 192 *160 cps, graphics*	$499	$389.95
OKI 193 *160 cps, 15" paper*	$699	$549.95
OKI 92 *160 cps, graphics*	$599	$359.95
OKI 93 *160 cps, 15" paper*	$995	$599.95
OKI 84 *200 cps, parallel*	$1399	$799.95
OKI 84 *200 cps, serial*	$1499	$949.95
Tractor *for OKI 192*	$50	$44.95
Tractor *for OKI 92*	$89	$54.95
2K Serial Board *for 192/193*	$99	$69.95
2K serial Board *for 92/93*	$120	$99.95
Extra Ribbon	$9	$4.95

Ultra-Violet EPROM Erasers

	LIST	JADE
Spectronics with out Timer	$99	$69.95
Spectronics with Timer	$139	$94.95

A-B Printer Switch

Fully bi-directional switch allows your computer to run either of two printers, or allows two computers to share one printer, standard parallel switch box.

	LIST	JADE
Printer Switch	$149	$89.95
Extra Cable	$40	$29.95

CITIZEN Printers

Best Near-Letter-Quality printers for under $1000!!!

	LIST	JADE
CITIZEN MSP-10 FT *160 cps*	$499	$349.95
CITIZEN MSP-15 FT *160 cps*	$749	$529.95
CITIZEN MSP-20 FT *200 cps*	$699	$489.95
CITIZEN MSP-25 FT *200 cps*	$949	$669.95
CITIZEN Serial Option	$60	$49.95

Printer Accessories

	LIST	JADE
IBM PC style cable	$54	$19.95
Standard parallel cable	$40	$19.95
Dual Printer Switch Box	$149	$89.95
Apple Card & cable	$109	$49.95
RS-232C serial cable	$30	$24.95
Ribbons		as low as $4.99
Apple IIc cable	$39	$19.95

SUPER DISKETTE SPECIAL Perfect for IBM, Apple, Kaypro, etc.

Ultra-high quality diskettes from a premium U.S. manufacturer, certified to be absolutely error free for one full year. Buy a box of ten this month and we will include a plastic storage/library box FREE!

	LIST	JADE
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Double-sided, double-density	$42	$19.50
Double-sided, 1.2 MB for AT	$69	$49.50
3½" Single-sided for Mac	$69	$39.50
3½" Double-sided for DG/1	$89	$49.50
Bulk Diskettes as low as		90¢

C. ITOH Printers

C. Itoh's best-selling ProWriter and StarWriter printers are now available with parallel interfaces for Apple & IBM, or a serial interface for Apple IIc, MacIntosh, Data General, etc. Full one year manufacturers warranty.

	LIST	JADE
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ProWriter 8510 FT *120 cps*	$429	$299.95
ProWriter II 1550 FT *120 cps*	$619	$439.95
StarWriter Y10-20 *20 cps*	$489	$359.95
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StarWriter F10-40 *40 cps*	$1199	$899.95
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StarWriter F10 Tractor	$249	$159.95
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Comrex CR-IIe *20 CPS*	$599	$399.95
Tractor *for CR-IIe*	$120	$99.95
Keyboard *for CR-IIe*	$199	$179.95
Sheet Feeder *for CR-IIe*	$259	$199.95
Juki 6100 *18 CPS*	$599	$399.95
Juki 6300 *40 CPS*	$995	$849.95
Tractor *for 6100*	$149	$124.95
NEC 3550 *33 CPS*	$2250	$1399.95
Tractor *for 3550*	$265	$229.95
Toshiba P1340 *180 CPS, par.*	$995	$649.95
Toshiba P1340 *180 CPS, serial*	$995	$649.95
Toshiba P1351 *196 CPS*	$1895	$1289.95
Tractor *for P1351*	$195	$174.95
Sheet Feeder *for P1351*	$1095	$899.95

The LITTLE BOARD with FREE! CP/M 2.2

Miniature single board CP/M computer designed to mount directly on top of a 5¼" floppy disk drive (7.75" x 5.75"). Contains Z80A, CPU, 64K RAM, Boot EPROM, terminal port, modem port, parallel printer port, floppy disk controller, and CP/M 2.2 included FREE!

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Support Package	$59	$48.95
Serial Cable	$13	$11.95
Diskless Monitor Eprom	$30	$24.95
SCSI/Plus I/O Adapter	$99	$89.95

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128K	*Parallel in/Parallel out*	$445	$269.95
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32K *Parallel in/Parallel out*	$299	$229.95
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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
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4116-120	16384x1	(120ns)	8/12.95
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MK4332	32768x1	(200ns)	9.95
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4164-150	65536x1	(150ns)(5v)	9/21.95
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TMS4164-20	65536x1	(200ns)(5V)	4.25
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TMS4416-20	16384x4	(200ns)(5V)	8.95
TMS4416-15	16384x4	(150ns)(5v)	9.95
41256-200	262144x1	(200ns)(5v)	8.95
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5v=Single 5 Volt Supply   REFRESH=Pin 1 Refresh

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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)	9.95
27128-30	16384x8	(300ns)(5V)	10.95
27128	16384x8	(250ns)(5V)	11.95
27256	32768x8	(250ns)(5V)	29.95

5V=Single 5 Volt Supply   21V PGM=Program at 21 Volts

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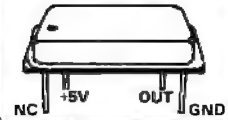

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74LS09	.29	74LS196	.79
74LS10	.25	74LS197	.79
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74LS13	.45	74LS241	.99
74LS14	.59	74LS242	.99
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74LS20	.25	74LS244	1.29
74LS21	.29	74LS245	1.49
74LS22	.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
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74LS91	.89	74LS363	1.35
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74LS93	.55	74LS365	.49
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74LS96	.89	74LS367	.45
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74LS112	.39	74LS374	1.39
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74LS122	.45	74LS378	1.18
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74LS160	.69	74LS682	3.20
74LS161	.65	74LS683	3.20
74LS162	.69	74LS684	3.20
74LS163	.65	74LS685	3.20
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74LS166	1.95	81LS95	1.49
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74LS169	1.75	25LS2518	4.13
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8243	4.45
8250	10.95
8251	3.95
8251A	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	79.95
8272	19.95
8274	39.95
8275	29.95
8279	6.95
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74S37	.88	74S175	.95	74S299	7.35
74S38	.85	74S180	11.95	74S301	6.95
74S40	.35	74S181	3.95	74S373	2.45
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74S112	.50	74S196	1.49	74S471	4.95
74S113	.50	74S197	1.49	74S472	4.95
74S114	.55	74S201	6.95	74S474	4.95
74S124	2.75	74S225	7.95	74S570	2.95
74S132	1.24	74S226	3.99	74S571	2.95
74S133	.45	74S240	2.20	74S573	9.95
74S134	.50	74S241	2.20	87S181	16.25
				87S185	16.95

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

CMOS

4000	.29	4531	.95
4001	.25	4532	1.95
4002	.25	4538	1.95
4006	.89	4539	1.95
4007	.29	4541	2.64
4008	.95	4543	1.19
4009	.39	4553	5.79
4010	.45	4555	.95
4011	.25	4556	.95
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
14411	11.95	74C906	.95
14412	12.95	74C907	1.00
14419	7.95	74C908	2.00
14433	14.95	74C909	2.75
14490	4.95	74C910	9.95
4502	.95	74C911	8.95
4503	.65	74C912	8.95
4507	1.25	74C914	1.95
4508	1.95	74C915	1.19
4510	.85	74C918	2.75
4511	.85	74C920	17.95
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
4522	1.25	74C930	4.95
4526	1.25	80C95	.85
4527	1.95	80C96	.95
4528	1.19	80C97	.95
4529	2.95	80C98	1.20

HIGH SPEED CMOS

A new family of high speed CMOS logic featuring the speed of low power Schottky (8ns typical gate propagation delay), combined with the advantages of CMOS: very low power consumption, superior noise immunity, and improved output drive.

74HC00

74HC: Operate at CMOS logic levels and are ideal for new, all-CMOS designs.

74HC00	.59	74HC175	.99
74HC02	.59	74HC193	1.25
74HC04	.59	74HC194	1.04
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
74HC151	.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.

74HCT00	.69	74HCT175	1.09
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

SPECTRONICS CORPORATION

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	$83.00
PE-14T	x	9	8,000	$119.00
PE-24T	x	12	9,600	$175.00
PL-265T	x	30	9,600	$255.00
PR-125T	x	25	17,000	$349.00
PR-320T	x	42	17,000	$595.00

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

LINEAR

LM301	.34	NE570	3.95
LM301H	.79	NE571	2.95
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	.39
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
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

DATA ACQ

ADC0800	15.55
ADC0804	3.49
ADC0809	4.49
ADC0816	14.95
ADC0817	9.95
ADC0831	8.95
DAC0800	4.49
DAC0806	1.95
DAC0808	2.95
DAC1020	8.25
DAC1021	7.95
DAC1022	5.95
MC1408L6	1.95
MC1408L8	2.95

EXAR

XR2206	3.75
XR2207	3.75
XR2208	3.75
XR2211	5.25
XR2240	3.25

9000

9304	.95
9316	1.00
9328	1.49
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
9637	2.95
96S02	1.95

SOUND CHIPS

76477	3.95
76488	5.95
76489	8.95
SSI-263	39.95
AY3-8910	12.95
AY3-8912	12.95
MC3340	1.49
SP1000	39.00

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

I have had nothing but good experiences with JDR and look foward to more of the same. It's not often a company is willing to help customers to the extent JDR has.

— *Stephen L. Vajo*

VISA   MasterCard

Inquiry 219

U·N·C·L·A·S·S·I·F·I·E·D A·D·S

WANTED: United Cerebral Palsy seeks tax-deductible donation of six IBM PCs with printers for vocational training program. UCP. Suite 204. 1904 Franklin St., Oakland, CA 94612. (415) 832-7430.

WANTED: Nonprofit agency needs donation of microcomputer and printer to help low-income veterans, youth, handicapped individuals, ex-offenders, and unemployment recipients attain training and employment. Will pay shipping. Bill Slovick, Project I.O.V.E. Inc., Suite 2K. 2725 Congress St., San Diego, CA 92110. (619) 238-3826.

WANTED: Small nonprofit YMCA seeks tax-deductible donation of computer system with disk drives and printer. Need word-processing capabilities, network-information management, inventory, and office management. Will pay shipping. Joy Jackson, Kosciusko Community YMCA. 1401 East Smith St., Warsaw, IN 45680. (219) 269-9622.

WANTED: Private educational organization seeks tax-deductible donation of any disk-based microcomputer with printer for educational and administrative purposes. Will pay shipping. Duane D. Hartman, Lord's Mission, POB 1005, Whitefish, MT 59937. (406) 721-2347.

WANTED: Nonprofit educational institution welcomes tax-deductible contributions of computer equipment for classroom instruction, especially Apple, TRS-80, and IBM-compatible. R. M. Edwards, California Lutheran University, 60 West Olsen Rd., Thousand Oaks, CA 91360. (805) 492-2411, ext. 464.

WANTED: Missionary seeks donation of IBM PC or Compaq with word-processing capabilities for aid to Bible translators. Will issue tax-deductible receipt. Reverend Steve Hopkins, Evangel Bible Translators, 39 Maple St., Centerville, OH 45459.

WANTED: Psychology lab needs a reliable terminal and S-100 bus interface cards. Instructor will pay shipping and provide letter for tax purposes. Barry W. Godolphin, PhD, Psychology Department, Sonoma State University, Rohnert Park, CA 94928.

WANTED: Nonprofit club needs microcomputers, even used, such as C-64, Apple, TRS-80, or IBM PC, plus peripherals and public-domain programs. M. Peleg, Mofet-Club, POB 3252, Haifa 31032, Israel.

WANTED: Contact with Altair user group or individuals for mutual support. Walter Gordon, 10 Bonnie Brook Dr., Shelton, CT 06484.

WANTED: Contacts worldwide for exchange of ideas and individual or public-domain software for Apple IIe. J. Paulino Ferreira, Apartado 37, Cortegaça, 3882 Ovar Codex, Portugal.

TRADE: Want to trade a copy of Tannenbaum & Augenstein's *Data Structures Using Pascal* for the PL/I version of the same book. R. C. Pierce, 404 Summit Dr., Corte Madera, CA 94925.

FOR SALE: Victor 9000 hard-disk system with quad-density floppy drive, monitor, 18 months old: $2200 or best offer. American Philosophical Association, University of Delaware, Newark, DE 19716. (302) 451-1112.

FOR SALE: HP CRT, model 1332A hi-res 7-inch flat-face electrostatic XYZ CRT. HP 1984 price $2730; clean and working with manual: $200 plus shipping. Mating camera with Polaroid back: $60 plus shipping. Mark Goldstein, POB 825, Tempe, AZ 85281. (602) 437-1767.

FOR SALE: Apple I, number 37 of the first 175 manufactured. Historical value, excellent condition, runs. Keyboard, cassette interface, power supply. Full 8K memory. Make an offer. John Victor, 24 Sawmill Lane, Greenwich, CT 06830. (203) 869-4479.

FOR SALE: NEC APC H03 computer reset button: $15. Howard D. Roney, 4840 Andrea Dr. NW, Salem, OR 97304.

FOR SALE: Commodore color monitor, model 1702: $160 or trade for hi-res amber monitor plus $60. MPI 5¼-inch DS/DD 40-track drive, model B-52 with case and power supply: $160 or trade for bare half-height 5¼-inch DS/DD 40-track drive. Evan Arnerich, 1366 Marie Court, Santa Maria, CA 93454. (805) 922-0102.

FOR SALE: IBM PC XT 768K, 20 megabytes, AST Six-Pack, Tecmar 1st Mate, Hercules, Plantronics, 8087, Z80, 1200B, second hard disk and floppy, IBM mono and color monitors, game I/O, mouse, Okidata 93, HP 7475A, Oume 11/40, 64K buffer, and more: $6750. Bert Baker, 724W 1720N #109, Provo, UT 84604. (801) 377-7343.

WANTED: Public-domain software for IBM PC on astrology and cosmogram construction. Hanspeter Gräub, POB 141, 4125 Riehen, Switzerland.

FOR TRADE: IBM PC public-domain software. Send name and address. Marc David Seidel, 149 Carol St., Danbury, CT 06810. (203) 798-1375.

FOR SALE: Commodore 64, modem, datasette recorder, phone. All about one year old, original packages, reasonable. David Haaland, POB 1704, Minot, ND 58702. (701) 852-5463.

FOR SALE: Hayes Smartmodem 1200B, like new. Does not conform to Spanish standards; asking $325. F. Tusell, Avenida Tolosa, 95, 2B, 20009 San Sebastian, Spain.

FOR SALE: Morrow S-100 system: MPZ-80, 64K static RAM, DJ2D/B, two DS/DD 8-inch drives, 5-megabyte Winchester, HDCDMA, Multi I/O board, ADM-20 terminal, and more. Best offer. May part out. Dave Edick, 15938 Gramercy, San Leandro, CA 94578.

FOR SALE: Complete BYTE issues in excellent condition: 1975 (4 issues): $15; 1976 to 1978 for $30/year; 1979 for $35. Complete *Kilobaud*, 1977 to 1978: $25/year; 1979 for $30. Postage included. Sold in annual blocks only. Ricky Peterson, 206 Pine Valley Dr., Warner Robins, GA 31093. (912) 922-1196.

FOR SALE: S-100 boards with documentation. 8080 CPU: $35; Vector Graphic 16K static RAM: $60; Ithaca Audio 8K static RAM: $30; Micro Applications 4K static RAM: $15; Ithaca Audio 16K ROM: $75; solid-state music video interface VB1-B: $30; and others. Neil Schmidt, 2201 San Miguel Dr., Walnut Creek, CA 94596. (415) 939-5342.

FOR SALE: IBM PC with 128K, 360K disk, IBM 10-megabyte hard disk, 130-watt power supply, monochrome and printer adapter, Key Tronic 5150 keyboard. Asking 60 percent of current IBM price. Will sell hard disk and adapter card separately. Joe Gunter, RR2, Box 823, Lot 125, Pompano Beach, FL 33067. (305) 421-6301, days 7-11 p.m.

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WANTED: BYTE issue volume 5, number 11, November 1980. Will pay top dollar. Call collect. James Baldwin, (812) 422-3348.

FOR SALE: Lear Siegler ADM 3A+ monitor, hardly used: $250 firm for quick sale; you pay shipping. Patrick Gleeson, 3470 19th St., San Francisco, CA 94110. (415) 864-1967.

FOR SALE: Hewlett-Packard 86B, 12-inch monitor, dual 3½-inch drives, RS-232C interface, two 128K memory modules, modem, ROMs, cables, and more. Retail $6598; asking $3300. Also printer (82906A) and plotter (7475A). Retail $2890; asking $1450. Shannon W. Davis, POB 813, Corvallis, OR 97339. (503) 758-1432.

FOR SALE: Two Radio Shack Modem IIs, 300 bps, auto-dial/auto-answer, direct connect, programmable, good condition, complete with manual. $125 each (retail $200). Gary Turkel, 141 Lafayette Ave., Suffern, NY 10901. (914) 357-5183.

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FOR SALE: Shugart SA460, SA800-2, 5¼-inch power supply and case, and Atari 850 interface. Excellent condition or new. Best offer. Lee Fischman, 1332 East 100th St., Brooklyn, NY 11236. (718) 251-2321.

FOR SALE: S-100 complete board set from Vector Graphic including CPU, disk controller, I/O board, 64K RAM, PROM/RAM board, Flashwriter 80-column board, and two extra boards: $1199. A. Tan, 5749 South Nepal Way, Aurora, CO 80015.

WANTED: Architecture student seeks used graphics computer terminal (at least 1024 by 1024 addressable points) with memory, light pen, manuals, and RS-232C or RS-422 interface. Massimo Stefani, via Lazzaretto II, 20124 Milano, Italy.

WANTED: I would like to know how to convert educational programs from C-64 to IBM PC. G. Sawabini Jr., POB 524, Dearborn, MI 48121.

FOR SALE: Remex 8-inch DS/DD drives, two units: $150 each or trade for S-50 bus equipment. I. W. Wilson, 400 North Pierce St., Lansdale, PA 19446. (215) 855-0102.

WANTED: *Nibble* Magazine, volume 3, number 2 and volume 3, number 1. Also volume 2, number 7 and earlier issues if the price is right. Send prices to Michael Ching, 2118 Kula St., Honolulu, HI 96817.

WANTED: Inexpensive, bare S-100 mainframe and 8-inch floppy-disk enclosures. Dale Kashuba, S.-7 C-10 RR#1, Vernon, British Columbia V1T 6L4 Canada.

FOR SALE: Two Tandon TM 100-1 SS/DD IBM PC disk drives. Excellent condition. $175 each new; will sell for $125 each, $200 for both. Will pay shipping. Mike Molohon, 305 Judy Lane 186, Copperas Cove, TX 76522. (817) 547-5579.

FOR SALE: 64K North Star Horizon-2, FPB-A board, extra 16K IMS static RAM board, Matrox ALT-256 video board, full documentation plus books on CP/M and Z80 assembly language. Make an offer. R. A. Jacobson, 9 Shadewood Lane, Hilton Head Island, SC 29928.

TRADE: Computer Learning Center public-domain software for the Apple II for your CLC disks. Send SASE for list. Dale Flatow, 7684 South Logan Ave., Oak Creek, WI 53154.

WANTED: Hardware, parts, accessories, information for the Exidy Sorcerer computer. Particularly need disk controller, BASIC compiler, EPROM burner, utilities, cassette-to-disk converter, etc. Gary Pewitt, 3039 West 4375 S, Roy, UT 84067.

WANTED: IBM PC, two floppy drives, graphics paper plotter, 256K, etc., to design double-sided layout PC boards, CAD system. Steven Abraiti, M.O.S. Inc., 90 East 212th St., Cleveland, OH 44123.

FOR SALE: Texas Instruments 99/4A technical reference manual: $20. Two Teac SS/DD half-height disk drives from Sanyo MBC 555: $75 each. All in excellent condition. Michael J. Vargo, 2999 Lutheran Rd., Gilbertsville, PA 19525.

FOR SALE: VT-100 terminal with AVO, Sierra Data Sciences Z80 single-board computer, two Oume DS/DD DataTrak 8-inch disk drives, OT. 12-slot S-100 mainframe with power has room for drives. Any reasonable offer accepted. Mark Fowler, 2740 San Carlos Lane, Costa Mesa, CA 92626. (714) 754-1708.

FOR SALE: IBM-compatible board for TRS-80 Model III/4 with 128K RAM, RS-232C serial I/O port, Centronics parallel port, power supply, and enclosure: $500. 8088 microprocessor: $20. 8031 microprocessor: $40. Tandon TM 100-1, 160K disk drive: $100. Other equipment available. Dave Engelbert, 1625 Lake Dr., Haslett, MI 48840. (517) 339-1771.

WANTED: Correspondence with other computerists in English or Italian. Magnaterra Alessandro, Via Tomba 1, 47040 Santarcangelo di Romagna, Forlì, Italy.

FOR SALE: Apple Lisa 2/10, 10 megabytes: $4500. IBM PC Portable, two disk drives: $1950. Apple IIc: $800. Apple IIe, one drive, and monitor: $900. Osborne I single density: $350. Atari 800XL, disk drive, and printer: $600. Apple II+: $800. Betty Weber, POB 413, Gates Mills, OH 44040. (216) 729-2808.

WANTED: Used EPROM eraser for 2716s, etc. Andrew F. Siska, 331 South Grant, Westmont, IL 60559. (312) 960-2176, evenings.

WANTED: Engineering student needs Xerox 820 CPU board or Heath H-8, any condition. Curtis L. Martin, POB 341, Fayette City, PA 15438. (412) 326-8759.

B·O·M·B

BYTE's Ongoing Monitor Box

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THE FEBRUARY SEVEN

"Build a Serial EPROM Programmer," an essential hacker's tool designed in Ciarcia's Circuit Cellar, won the blue ribbon in February. In second place is Phillip Robinson's Product Preview on "The HP Integral Personal Computer," a system that makes UNIX portable. And "Troubles" didn't prevent Jerry Pournelle's column, Computing at Chaos Manor, from placing third. "Copying Mass-Marketed Software," the subject and debut of Computers and Law, won fourth place. Robert Greene Sterne and Perry J. Saidman will coauthor this new column scheduled to appear quarterly. The discussion with James H. Wilkinson on the design process of Turing's Universal machine placed fifth. That interview, entitled "The Birth of a Computer," was conducted by John C. Nash.

Because the first five articles are written by BYTE technical or contributing editors, the articles that placed next in line are eligible for the prize money. Eric Aubanel and Keith Oldham's "Fourier Smoothing Without the Fast Fourier Transform" won sixth place; these coauthors will split the $100 bonus. In seventh place and the winner of the $50 bonus is Jeffrey Star for his "Introduction to Image Processing." Hearty congratulations to all.

R·E·A·D·E·R S·E·R·V·I·C·E

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