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Exclusive! Apple *Lisa* and *IIe* Reviewed

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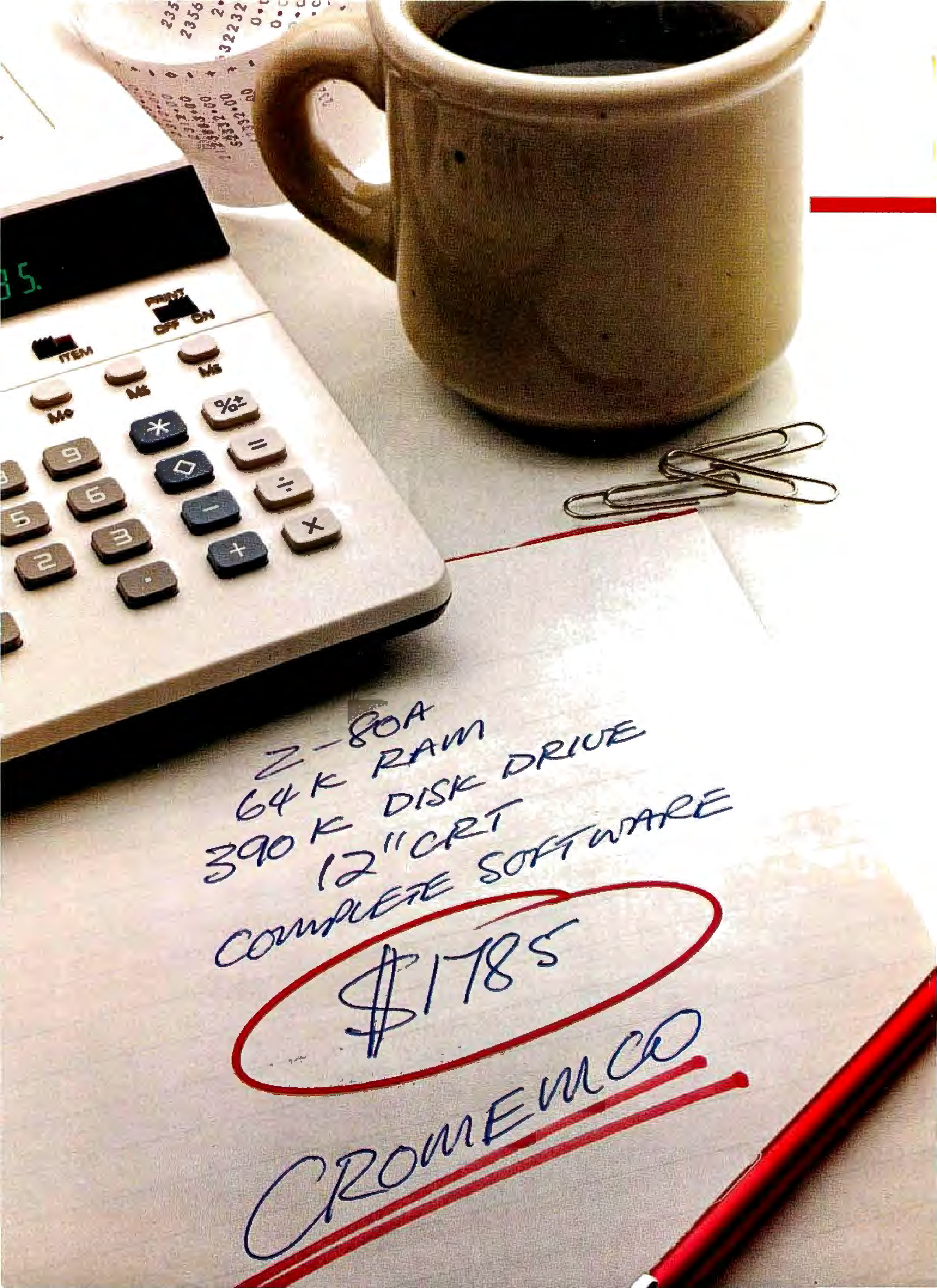
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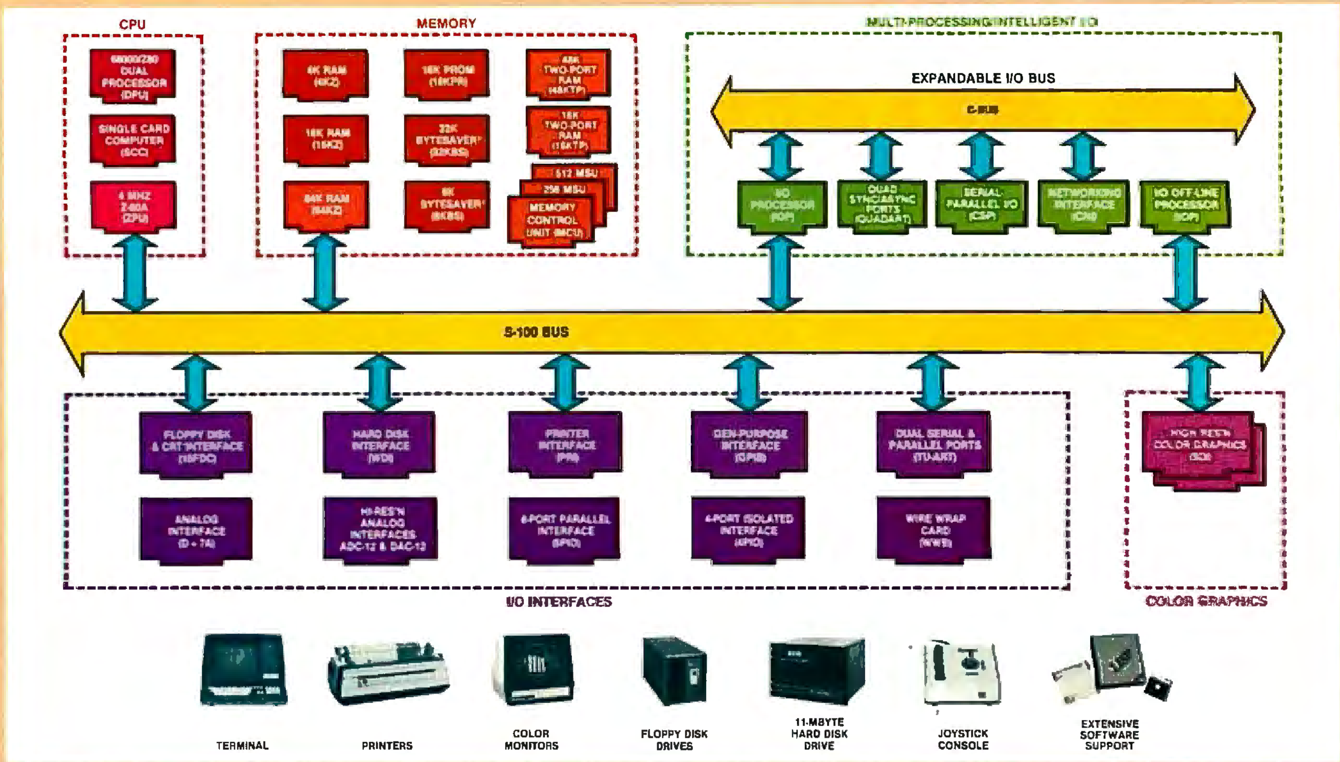

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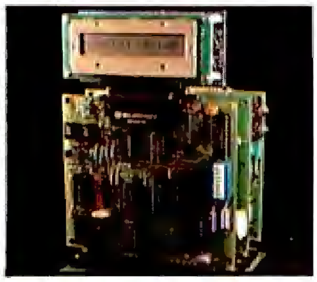

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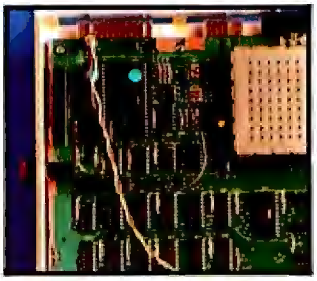

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In This Issue

Microcomputer enthusiasts have been eagerly awaiting the release of Apple's new machines, the Lisa and the IIe (featured in our cover photo by Mike Blake). Officially announced on January 19, these computers, especially the Lisa, are big news. Rumors have been rife about Apple's new products for quite a while, but now the speculation has come to an end and BYTE features three exclusive articles about them. Gregg Williams writes an in-depth description of "The Lisa Computer System," Robin Moore reviews "Apple's Enhanced Computer: The Apple IIe," and Chris Morgan, Gregg Williams, and Phil Lemmons interview three key members of the Lisa design team.

A boon to microcomputer users and a bane to many manufacturers, standards are a current hot topic within the computer industry. This month we feature several articles on the topic of standards, including "The IEEE Standard for the S-100 Bus" by Mark Garetz, "Realizing Graphics Standards for Microcomputers" by Fred E. Langhorst and Thomas B. Clarkson III, "A Proposed Floppy-Disk Format Standard" by Chuck Card, and part 1 of "NAPLPS: A New Standard for Text and Graphics" by Jim Fleming and William Frezza. Also featured this month: Steve Ciarcia tells how to "Build a Handheld LCD Terminal," Jerry Pournelle writes about "Confessions, Pascal Prime, Wescon, and Perfect Writer," and Joel Swank starts our new series on the Commodore VIC-20.

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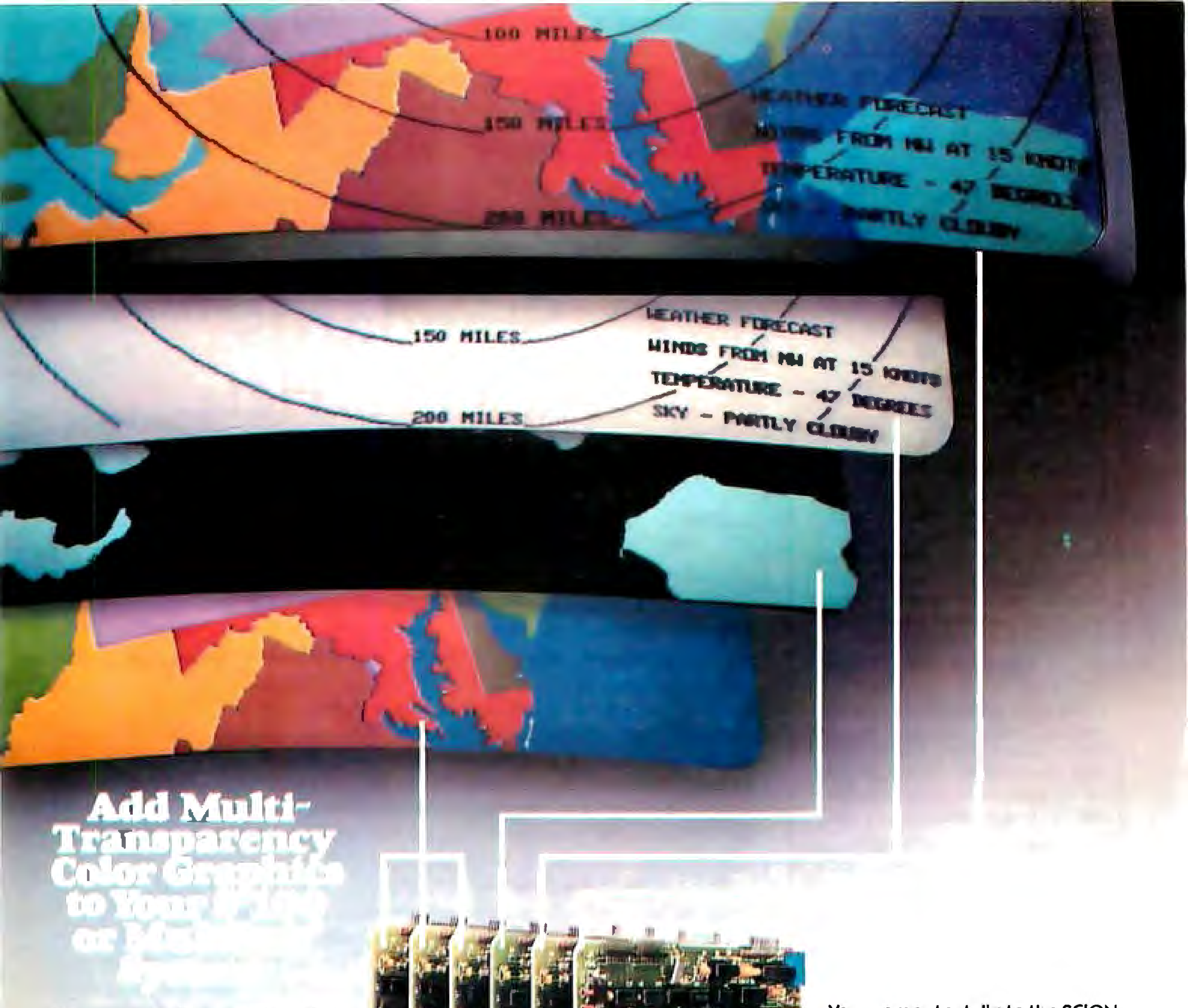

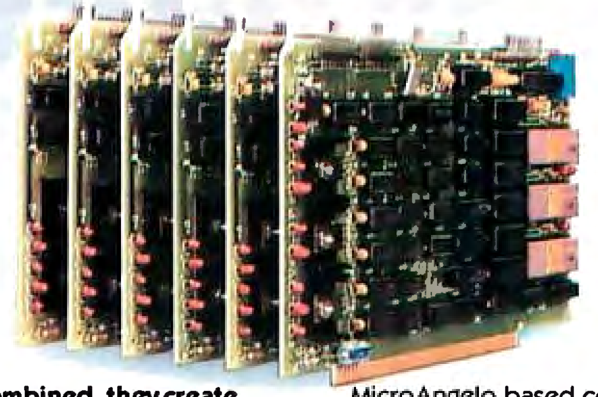

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Editorial

Standards The Love/Hate Relationship

Richard S. Shuford, Special Projects Editor

When you begin to study the history of technology, you learn about Eli Whitney's famous demonstration in 1801 of his mechanized process for making interchangeable firearms parts: the first successful attempt at industrial standardization.

Or so he claimed. According to Edwin Battison, director of the American Precision Museum in Windsor, Vermont, Whitney's demonstration was faked. To be sure, some gun parts were interchanged under the watchful eyes of United States War Department officials, but the parts had been specially made for the event by hand. Whitney couldn't deliver on the promises he made, and the 10,000 badly assembled muskets his company delivered (several years later) turned out to be the bane of the infantry.

The essence of this story may sound sadly familiar to computer users. Too often we see a computer product advertised as possessing a feature that incorporates some industry standard, but when it comes time to use the feature, we find annoying restrictions. Sometimes we have to pay more to get another feature that supports the standard feature, or the feature does not really work at all in the standard way. Disgruntled souls may conclude that the computer industry follows no standards at all.

Those of us who work with computers have a love/hate relationship with standards. According to Robert Rountree of the National Bureau of Standards, "Computer users love standards; computer manufacturers hate them."

How Standards Emerge

A standard, in theory, represents a consensus of expert opinion on how to perform a given technological function. The standards process, in the words of Dr. John A. N. Lee, vice-chairman of the Standards Committee of the ACM (Association for Computing Machinery), is "putting current technology into systematized form, available to everybody, and it's also developing a consensus in a peer-review process."

Some standards are born casually; others come into being after lengthy, formal give-and-take in carefully appointed committees. Many standards in the computer industry are de facto, that is, they emerged because one person or company invented a way of performing some function that has been near-universally imitated by everyone else in the industry. Other computer standards are devised formally by an accredited standards-making organization or by the government; many of these latter standards are compromises worked out among representatives of parties that originally invented incompatible methods of performing the same function.

The most tempting approach to standardization is that of the "Lone Ranger." And it works, sometimes. In this approach, one individual, group, or company develops a method for performing a technological function, presents it to the world, and says, "Please do this my way." Occasionally a proposed standard graduates from Lone-Ranger status to general approval and use, but most such attempts languish in obscurity, unless the proposing person or organization has lots of clout, regardless of the technical merits of the proposal.

We find that technical merit often has nothing to do with whether one of several competing technological developments becomes an accepted standard. In standards work, to mix metaphors a bit, a bird in the hand is usually worth the whole ball game. The first product of a given type to achieve widest commercial distribution usually sets the standards. Thus, we have the S-100 bus (now the IEEE 696 bus) derived from the first successful microcomputer, and we have many de facto standards: the IBM 3740 disk format, Digital Research's CP/M-80 operating system, and Microsoft BASIC.

Pure political and financial muscle also helps establish a standard. AT&T will probably overwhelm all competition in videotex encoding with its NAPLPS (North American Presentation-Level-Protocol Syntax), which was presented to ANSI (American National Standards Institute) on a silver platter for formal acceptance. Even for corporate giants having a bird in the hand helps. IBM will probably have no chance of getting its own graphics/videotex system adopted, simply because NAPLPS got there first.

Forces Hindering Standardization

It's fairly obvious why computer users like standards. Standards make their life easier in thousands of ways. But the reasons standards may be disliked by the people who make computers or peripherals are more obscure.

A creative engineer designing a new computer may feel that following a standard specification is too restrictive. And some companies fear that manufacturing standardized products makes for humdrum marketing and lack of attention from potential customers. They want to differentiate their products from what has gone before. Then, too, there are the costs involved in finding out what standards exist and are appropriate for a certain product, in obtaining the technical specifications and enforcing their use during the design phase, and in testing for compliance. Products designed before the standard was developed may prove difficult or prohibitively expensive to adapt. Furthermore, some existing standards were poorly thought out or froze technology before it matured. These and other reasons can discourage manufacturers from complying with standards.

As well, the making of standards themselves has its own problems and costs. Most American National Standards ultimately cost tens or even hundreds of thousands of dollars, either as direct or indirect expenses, to develop and distribute. Standards work is largely done by volunteers, and sometimes obviously useful efforts to develop standards are delayed or abandoned because of manpower shortages.

In addition to economic problems, the politics of decision making by committee and legal obstacles sometimes muddy the waters of standardization. The most dramatic example is the Supreme Court's ruling last year against the American Society of Mechanical Engineers (*Hydrolevel* v. *ASME*) that the Society was liable under antitrust law for abuses by its representative of its own standards-interpretation process. Although the *Hydrolevel* decision hung on the intentional abuse that occurred (it seems unlikely that a standards-making organization would have the same liability if its representatives acted in good faith), the case has caused some review of procedures in other organizations.

Another obstacle is time. The standards-making process is lengthy and slow. The amount of time required by ANSI for public comment and peer review is intended to prevent any abuse of ANSI's standard-making procedures, but it also drags out the process. Some individuals and organizations have tried, with varying degrees of success, different means of avoiding the slow ANSI procedures. One way to avoid having to make an

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ANSI standard is to go through the IEEE (Institute of Electrical and Electronics Engineers). Although a member of ANSI, the IEEE has been developing standards on its own authority using its own committee process (sometimes a joint ANSI/IEEE standard emerges). IEEE standards have been well received by the industry, but even these typically take years to gel.

Contributions Are Needed

Are you now asking, "Can something be done to improve the standards process?" Yes, within limits.

Although the computer-standards community at first seems like an intimidating monolith, it is composed, for the most part, of men and women who are sincerely doing what they can to systematize the rapidly changing technology of computing. They possibly could use your help.

You can get involved in several ways. The simplest is to use existing standards in your current work and promote their use among your associates. When buying computer products, favor those that employ industry standards.

If you have expertise in a field where standards are being developed, you should obtain copies of the proposed standards documents during the public-comment period and send your written comments to the appropriate bodies (for a list of addresses, see page 142). If you are a member of a professional society, such as the IEEE or the ACM, you can work though your society, informing members of its standards committees about your preferences and telling them if you think certain new standards need to be made or old ones changed. This is especially important for those of us who work with microcomputers, because many of the members of formal standards committees have experience only with larger computers.

Better yet, inquire about becoming a member of an appropriate committee. You can join the thousands of people working in the standards process and share their pride in helping to make advanced technology more available to everyone. ■

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From the Publishers

These are exciting times for the microcomputer industry and for BYTE in particular. During 1982 the industry once again exceeded even the most optimistic predictions of economists, and the performance of BYTE exceeded even the most optimistic predictions of its management. Our audited paid circulation was 324,000 by year-end and we know that at least twice as many readers see each issue. The tremendous results that advertisers have obtained by placing their messages in BYTE magazine led to the first ever (according to some publishing industry commentators) 1000-page increase in a single year.

Fortunately, even if we were somewhat conservative in our predictions of BYTE's performance in 1982, we were aggressive in our efforts in maintaining the strength and quality of the BYTE staff. Nowhere is this more evident than in the BYTE editorial department which, of course, is solely responsible for the indisputable fact that BYTE has become the most respected and trusted voice in computer publishing.

It is because of our strong staff that we can calmly wish Editor in Chief Chris Morgan the best of luck as he begins to devote the lion's share of his time to a new software company. Because Chris has planned out a year's worth of theme issues in advance, has guided the selection of specific articles for many months in advance, and has developed an editorial staff that for more than a year has produced editorial content up to the high standards for which BYTE has become famous (all this with Chris on the road much of the time), we can guarantee the continued unstinting editorial excellence you have come to expect in BYTE.

We remain guided by the thought expressed on the occasion of our fifth anniversary in September 1980: "Although the trappings of success are pleasant for us to contemplate, we would be foolish to forget the philosophy that has produced them: giving both readers and advertisers good value for their dollar."

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Letters

For the Record

Peter Callamaras's review of our Executive Briefing System (November 1982 BYTE, page 164) was greatly appreciated here at Lotus. However, the article was incorrect in the At a Glance section, which listed Mitchell Kapor as the author of EBS.

While Mitchell designed the program and supervised its implementation, EBS was coded by Todd Agulnick, a 15-year-old resident of Newton, Massachusetts. Todd was first employed by Mitchell at the age of 12, and he continues to be a source of inspiration for all of us here at Lotus. His great skill and intellect are appreciated almost as much as his fine sense of humor.

Mary Lynn Davis, Graphics Project Manager
Lotus Development Corp.
55 Wheeler St.
Cambridge, MA 02139

More on BASIC Standards

I read with interest Howard G. Drake's letter dealing with the current and proposed standards for BASIC (October 1982 BYTE, page 18) and wish to comment on two points raised in the letter.

First, the requirement to have DIM statements preceding their use in line-numbered sequence is not new. It has been in the ANSI (American National Standards Institute) Minimal BASIC Standard since the approval of that standard in January of 1978.

The requirement to recognize the existence of DIM statements in line-numbered sequence (rather than in logical sequence) stems from the desire to have the one BASIC program give the same result when that program is run under two implementations, one of which is an interpreter and the other a compiler.

Another point raised by Mr. Drake concerned the need for the interpreter to do a pre-scan in order to recognize the presence of DIM statements.

The X3J2 BASIC Committee was very careful to assure that a pre-scan was *not* required. The suggested technique when a forward transfer-of-control is indicated (as in Mr. Drake's example) is to examine the statements passed over "at the time that they are passed over," to see if they include any of the statements that must appear in line-numbered sequence prior to their use. These statements include the DIM statement, as well as any OPTION statements (OPTION BASE, OPTION ARITHMETIC, etc.), and any function-definitions.

By taking this approach, BASIC processors need only look at those statements up to and including the one being referenced and need not do a pre-scan of the entire program.

I heartily agree that any interested parties should obtain a copy of the Proposed ANSI BASIC Standard, read it, and comment on it, if they find anything that they believe should be changed.

M. O. Duke
IBM
Santa Teresa Laboratory
555 Bailey Ave.
San Jose, CA 95150

Credit Where It's Due

I recently saw the October 1982 BYTE editorial in which Chris Morgan described videotex and teletext. I'd like to correct one statement regarding closed-captioning. The three networks broadcasting closed-captioned programs are PBS, NBC, and ABC; not CBS. CBS has steadfastly refused to provide captions on its programs for the benefit of hearing-impaired people.

Your omission of ABC is most unfortunate because that network was instrumental in the development of the closed-captioning technology. It leads the way in providing closed-captioning services. For example, ABC recently added closed captions to all broadcasts of ABC's "World News Tonight."

Jane Edmondson, Director
Products Promotion and Public Relations
National Captioning Institute
5203 Leesburg Pike, Suite 1500
Falls Church, VA 22041

This Thing Called NAPLPS

With regard to Chris Morgan's editorial discussing "This Thing Called Videotex" ("Some Answers to Frequently Asked Questions," October 1982 BYTE, page 10), let me respond with one definition of what videotex is today.

The North American Presentation Level Protocol Syntax (NAPLPS) allows text and graphics to be encoded in a manner independent of the display apparatus on which it will be presented. Virtually any micro-, mini-, or mainframe computer can be configured to generate NAPLPS pages, and any communications medium—whether it be telephone, broadcast, cable television, microwave, or satellite transmission—can be used.

What does this mean to microcomputer users today? Throughout North America microcomputers from virtually any manufacturer have a common format for text and color graphics that can be communicated universally. NAPLPS is a simple, highly efficient and economical color graphics generator in combination with a decoder. Here are some examples of what is being accomplished today:

- Users of Hewlett-Packard 80 Series, Commodore PET, and other microcomputers are now being offered a color-graphics program for Visicalc. The software digests raw Visicalc data files and automatically draws color charts and graphs including exploded pie charts.
- IBM Personal Computer users can obtain an electronic slide show program that simulates the 35-millimeter slide carousel but has additional features such as random-access retrieval of individual slides and the synchronizing of a sound track for a full audio-visual presentation. These slides can be displayed on a color monitor or even a large screen using a video projector.
- North Star computers are being used as hosts to drive large screen displays of electronic billboard advertising in shopping malls.

Other microcomputers are incorporating color graphics into computer-aided learning courseware and public-access market-research terminals, and marketing presentations are being prepared and, through the decoder, transferred onto video tapes.

Hard-copy service bureaus will soon be available that will provide any page creator the capability to download NAPLPS-encoded pages by telephone and have 35-millimeter slides, overhead transparencies, and other film media produced for them overnight and delivered the next day. Furthermore, paper hard copy is obtainable with the use of jet ink plotters—ideal for charts and graphs that

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HIGH SYSTEM THRUPUT— 150 characters per second advanced logic seeking impact printing with an accelerated print head slew rate and turnaround makes PrintMate™ 150 a high speed performer.

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EXPANDABLE PRINT BUFFER—PrintMate™ 150 models A2 and B2 have a factory installed 16K buffer. Both the 4K buffer model A1 and the standard 2K buffer model B1 are optionally expanded in increments to 16K. The PrintMate™ 150's expanded buffer allows application extensions for high speed interleaved printing and spooling, greatly improving the host computer's performance in applications that are print bound.

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need to be inserted into textual reports.

Because NAPLPS is display-resolution insensitive, these same files, although created at a lower resolution, can be redisplayed through a higher-resolution decoder with no modification to the original file. The hard copy, whether film or paper, becomes a higher-quality image. Additionally, broadcast-quality graphics and NTSC- (National Television System Committee) standard video tapes are being used by broadcasters to augment their graphics requirements. Even audio-visual producers are using this same method to bring down the costs of their productions while preserving the quality.

What other color-graphics system can provide a universal communications coding format for virtually any microcomputer? What other color-graphics protocol specification is in the public domain? What other color-graphics display generator (decoder) has a choice of over 32,000 colors, 16 of which are displayable simultaneously, among a host of other features? What other color-graphics system can boast the use of a conventional color television as a display monitor and can be purchased for a price starting at $1100?

Only decoders implementing full NAPLPS can satisfy these features and others. With this capability now within the reach of the majority of microcomputers, the challenge of creative, interactive graphics software lies with all microcomputer users, whether they be hobbyists or professional programmers. The challenge is here today at a price competitors can really only dream about.

Zal Press, Manager
Business Graphics
Marketing Group
Norpak Ltd.
1351 Washington Blvd., Suite 3000
Stamford, CT 06902

In Defense of User Protection

In the last year I have read several articles regarding software piracy. Due to this piracy, the creators of software are becoming more and more reticent about making available the source documents and code for a program.

Their caution is well placed because of the wholesale program theft that has taken place in some instances. Then, too, it's possible that the creator stole some major part of the program from someone else, and the lack of an available source listing prevents anyone from proving it.

Before we get too far down the road to complete nonavailability of source code, may I propose some protection for the legitimate user?

First, companies can and do go out of business every day. While one software creator may not, another may. Without the source code to update the program for system and language enhancements yet to come, that program will become worthless and be lost.

Second, because of market conditions, a developer may cease to offer the software or cease to update it. As a result, the software eventually becomes worthless without source to allow the updating of it.

Third, the program offered may have been almost worthless to start with due to errors. The developer made a fast buck, and the buyer was taken. At least with source, some corrections can be made.

A fourth reason for some user protection is that a successful creator may decide

that creation is what he is good at and he'd rather not be bothered by support, sales, etc., and so he enters into a royalty agreement for the program with an independent dealer. Now suppose this dealer wants to sell packages but not help you, the buyer, recover from a system crash or a program bug. Without source or even data on file structures being available, you have to start over after every crash.

There is a way out of this morass of uncertainty, and that is an industry-wide uniform software trust agreement, enforced by a trade journal's refusal to accept advertising of software unless the creator or vendor has placed the source code in trust with an independent third party who holds both the names of the legitimate licensees and the latest source files and documentation.

Vendors should be responsible for providing copies of all user licenses and regularly update the source code on file with the trustee. In return, the trustee agrees to hold source documentation inviolate (sealed) unless a vendor commits certain acts (I'll discuss these acts later on). Thus, protection exists for the vendors (in that the source is still protected) and for the legitimate user as well.

To the legitimate user, source becomes available, for a fee, in the event that the vendor ceases to function.

The trustee has these responsibilities: (1) to hold source code and related documentation sealed and inviolate unless certain acts are committed, (2) to notify only licensed users at their last known address by first class mail as to the acts committed, and (3) to provide to the licensed users only, for a fee related to the reproduction cost, the source code and documentation, when permissible.

What are these vendor acts and subsequent trustee actions? First, in the event of total sale of program rights to another vendor, the trustee should notify licensees of the event and the name and address of the buyer who has assumed the support obligation. In the event of adjudgment of the developer as bankrupt, ceasing of the vendor to do business, decision by the vendor to cease to offer support, or sale of program rights without an obligation to assume existing package support, the trustee shall so notify licensed users and make available for one year source and documentation for a fee.

There remains the question of users who find program vendors/creators either unwilling or unable to provide adequate support for their packages to licensed users. For this some mechanism should allow licensed users to petition the trustee if they feel that a vendor is providing inadequate support. If some threshold level (say 5 percent) of the licensed users of a program complain to the trustee of inadequate service, the trustee should be required to notify all licensees that complaints have been received. If the trustee gets a positive response from a majority of the users that such is the case, the trustee should then provide source code and documentation to users for a fee.

Such an agreement can adequately protect vendors as long as they want to be protected and will probably protect the user for longer than the economic life of the package.

Whatever methodology is created to protect both the user and the creator, total and permanent unavailability of source to

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a legitimate user is not an acceptable answer.

William E. Young, CPA
13901 Jefferson Davis Hwy.
Woodbridge, VA 22191

Minspeak Applauded

I read with great attention the "Minspeak" article by Bruce Baker (September 1982 BYTE, page 86). Minspeak is the most exciting use of computer technology that I have encountered because it goes beyond the use of the computer to manipulate data and/or symbols and deals with the fundamental issues of human communication and the way we think.

While Mr. Baker deals almost exclusively with the application of Minspeak to the nonspeaking population, the fundamental idea behind his invention, I believe, has a great deal to say about how we think and how we communicate whole thoughts to one another in speech and nonspeech worlds.

I commend Mr. Baker and BYTE for moving beyond hardware and software into the genuinely exciting new realms of electronic technology and its applications to human problems and potentials.

David O. Justice, Dean
School for New Learning
DePaul University
23 East Jackson Blvd.
Chicago, IL 60604

Computer Poetry: Art or Craft?

Kevin McKean's article "Computers, Fiction, and Poetry" (July 1982 BYTE, page 50) nearly supplies some important implications about the nature of creativity. The examples of computer-written poetry suggest that computers can now make many judgments rapidly but cannot make them wisely. The reason seems to be that the computer, unlike the poet, uses programmed instruction to apply types of judgments to many words. The poet makes individual judgments on a word-by-word basis. Thus, in writing "And delves the parallels in Beauty's brow," Shakespeare probably thought "delves" a good word for its "l" and "e" sounds, matched in "parallels," and for the overall dreamlike, wistful quality that the word contributes to the line. Of course, he may have had other reasons as well.

Today, because western culture seems to have weaker ties with tradition than in the past, and because ours is more than ever a culture without a sense of history, it is understandable that considerations of creativity focus on the ceaseless fluctuations common to the thought process, rather than on the decisions that artists make after much thought. Still, an artist may draw upon any or all of his life's history in order to pass judgment on a single word. His intellect, his moral integrity, his honesty, his passion, his love, his hope, his hate, his fear, his skepticism, his faith—in short, the sum of the poet's whole existence gives him the ability to make artistic judgments. And a sense of tradition supports the artist's individuality, which includes his powers of artistic discernment. Thus, in our ever-changing, prone-to-forgetfulness world, the popularity of computers is assured, but computers still lack what Keats called "the

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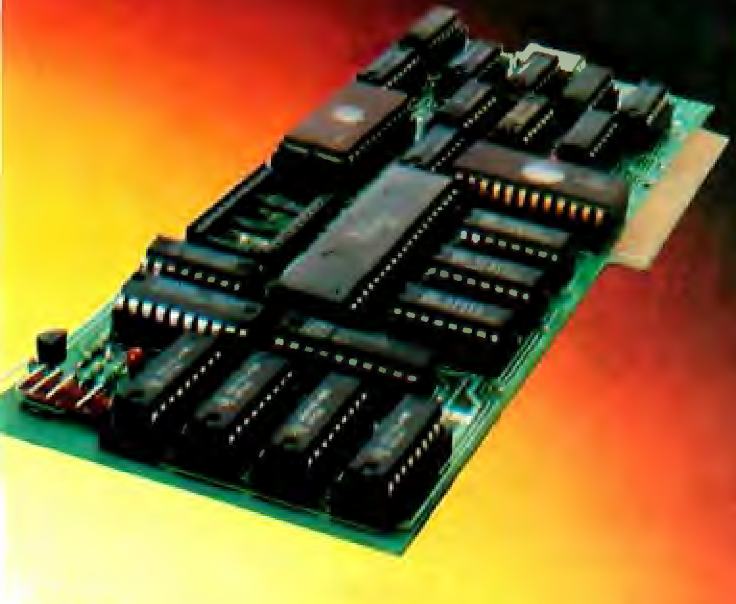

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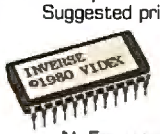

- •French
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- •Inverse
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Suggested price $29.00 each.

Dvorak EPROM (Enhancer)—$29.00
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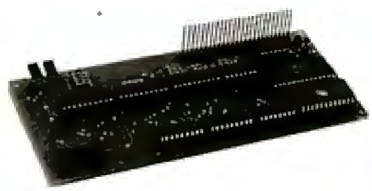
The Soft Video Switch is an automatic version of the popular Switchplate. It knows whether it should display 40 or 80 columns or Apple graphics. It does the tedious work of switching video-out signals so you don't have to. The Soft Video Switch can be controlled by software. May be used with any Videoterm with Firmware 2.0 or greater. The single wire shift mod is also supported.

Package price is $35.00.

ENHANCER][



The Enhancer][features a typeahead buffer. Your keyboard has upper and lower case, and will auto repeat any key held down. A single keystroke can become a word or an entire sentence. Controlled by a powerful microprocessor, Enhancer][allows you to re-map your keyboard or add specialized features. Changing a chip creates a totally different keyboard. Enhancer][Utilities Disc included.

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FOR APPLE II COMPUTERS, Mircobuffer II features on-board firmware for text formatting and advanced graphics dump routines. Both serial and parllel versions have a power-efficient low-consumption design. Special functions include Basic listing formatter, self-test, buffer zap, and transparent and maintain modes. The 16K model is priced at $259 and the 32K, at $299.

FOR EPSON PRINTERS, Microbuffer/E comes in two serial versions — 8K or 16K (upgradable to 32K) — and two parallel versions — 16K or 32K (upgradable to 64K). The serial buffer supports both hardware handshaking and XON-XOFF software handshaking at baud rates up to 19,200. Both interfaces are compatible with standard Epson commands, including GRAFTRAX-80 and GRAFTRAX-80+. Prices range from $159 to $279.

ALL OTHER COMPUTER/PRINTER COMBINATIONS can be untied by the stand-alone Microbuffer In-line.

The serial stand-alone will support different input and output baud rates and different handshake protocol. Both serial and parallel versions are available in a 32K model at $299 or 64K for $349. Either can be user-upgraded to a total of 256K with 64K add-ons — just $179 each.

SIMPLE TO INSTALL.

Microbuffer II is slot-independent. It slips directly inside the Apple II in any slot except zero.

Microbuffer/E mounts easily inside the existing auxiliary slot directly inside the Epson printer.

The stand-alone Microbuffer is installed in-line between virtually any computer and any printer.

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knowledge of contrast, feeling for light and shade, all that information (primitive sense) necessary for a poem."

If you could accurately enter your whole life into a computer without leaving the minutest fact out, then the computer could possess a chance of becoming artistic. But even then the computer would have to be considered the protégé of its programmer. For now, computers may be profitably used as electronic thesauri, as servants to the new *craft* of electronic poetry-writing. As far as the *art* of poetry is concerned, computers will have to wait.

Rob Zseleczky
19 Tanglewood Lane
Chatham, NJ 07928

Not-So-Standard Automobiles

In part 1 of his article "An Introduction to the Human Applications Standard Computer Interface" (October 1982 BYTE, page 291), Chris Rutkowski used the early development of the automobile as a case study to explain how microcomputer technology is still in its formative years because it has not come up with a standardized, easy-to-use format. This is a viable analogy, but Chris was a little off on his time frame. He says "you would be able to climb into the typical automobile of 1925 and drive it away." For most readers of BYTE today this would not be true. In 1925 approximately 50 percent of the cars being sold in the United States were Model T Fords. The Model T Ford used a pedal-controlled planetary transmission that a modern driver would not understand without instruction or prior use. Other 1925 makes also had irregular controls, such as spark levers, hand throttles, oddly placed starter buttons, etc. Actually, the standardization of most automobile operations took much longer than Chris surmised. Hopefully, the process will not take so long in the microcomputer industry.

Fred K. Fox
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Delhi, CA 95315

Total Talk Talks Back

In response to David Stoffel's article "Talking Terminals" (September 1982 BYTE, page 218), I would like to thank BYTE for giving this subject the attention it deserves. However, as the manufacturer of one of the products described by Mr. Stoffel, I'd like to state that numerous inaccuracies appear in his article.

Contrary to the impression given in the article, Total Talk from Maryland Computer Services Inc. (MCS) offers both a user-definable vocabulary and full numbers capabilities (it can speak 123 as "one two three" or "one hundred and twenty-three"). To my knowledge, MCS was the first to offer these features. It is also false that Total Talk does not have a cursor locator. Total Talk has had this since the product was introduced in June of 1980.

The author fails to mention many of the advantages of incorporating speech into an existing terminal. Total Talk offers an Enunciation key to tell you the terminal's status and the function of a key without executing the function; the device can vocalize the terminal's communication parameters and can set tabs and margins. Also you can define keys to perform specific tasks, such as say the line, say the word, and spell the word. This is essential to the nontechnical user in that escape codes do not have to be memorized.

The approach that places the speech box between the terminal and the host has several disadvantages. What is displayed on the screen is not an accurate representation of what is stored in the speech box's buffer. This is a severe disadvantage when the blind operator must interact with sighted co-workers or instructors. Full-page editing cannot be accomplished.

Capabilities that are very useful to Total Talk's users but were not mentioned in Mr. Stoffel's article are notification that the cursor is at the end of the line, moving the cursor forward and backward either a word at a time or a line at a time without speaking the word or line, and reading up and down columns.

Mr. Stoffel's comment that "Total Talk loses data after receiving 120 characters" shows a lack of understanding of the terminal. Total Talk has three sophisticated handshaking capabilities—XON/XOFF, Data Terminal Ready, and Inquire/Acknowledge. If your host computer does not support these capabilities, then you simply cannot use "Log Bottom," a feature that reads the data as it appears on the screen. If the terminal is configured correctly, data is not lost.

The article states that screen-oriented programs like Wordstar are not practical using speech output. We take exception to this because our customers are using Total Talk and Information Thru Speech (our

talking microcomputer/terminal) for this purpose every day. This also raises the question of why our Information Thru Speech terminal, which has been on the market since January of 1982, was never mentioned.

Finally, Mr. Stoffel hopes that the price of talking terminals will go down or their capabilities will increase. This is exactly what happened this year when MCS announced more powerful machines and a decrease in prices from 15 to 50 percent.

J. Michael Mason, Vice-President Marketing
Maryland Computer Services Inc.
2010 Rock Spring Rd.
Forest Hill, MD 21050

Terminology Correction

The use of terminology in Jack L. Abbot's review "Systems Plus: FMS-80" (October 1982 BYTE, page 447) was disturbing. The article was well written, informative, and provided a reasonable set of data from which to draw some conclusions and comparisons to other systems. However, to call FMS-80 a "relational" DBMS (database-management system) is appalling. It is bad enough that vendors misuse terminology, but a publication should not further perpetrate such misguidance. Some purists might argue that FMS-80 is not even a DBMS. And there are purists who have strict rules on the definition of a relational DBMS. In either case, most experts agree that a relational DBMS has, at a minimum, specific functional (e.g., project and join) and representational (e.g., tabular user view) components as its foundation. What will you tell your readers when the true relational DBMS is developed for microcomputers? As the leading journal for small-systems users, BYTE should attempt to use standard systems terminology when appropriate and not allow vendors to mislead the public any further than their advertisements do.

I do not want to detract from an extremely powerful personal computer tool such as FMS-80. I am currently evaluating file-management software for personal computers and have been surprised by the comprehensiveness and depth of functions of such packages. These rival many of the tools offered on larger systems and should virtually eliminate for most users the need to create their own programs.

Michael Lutz, Manager
Data Administration
Davis Chemical Division
W.R. Grace & Co.
POB 2117
Baltimore, MD 21203

User's Column Under Fire

As a subscriber to BYTE, I am compelled to write questioning the professionalism of your monthly User's Column written by Jerry Pournelle.

BYTE is an informative computer magazine that stands head and shoulders above any other small systems journals. All the hardware reviews are concise and informative. Steve Ciarcia does an excellent job of breaking hardware design down to a simple process for most hobbyists. Sol Libes keeps the latest information on new products available for all readers.

However, I find Mr. Pournelle's monthly column neither useful nor coherent. All I understand from his column is that he is always very busy and has many friends that allow him access to free hardware and software. In the Septebmer 1982 BYTE, he explained that he belongs to a large number of clubs and organizations and doesn't know how to do all the activities he does each month.

That kind of text has no place in BYTE. As a reader, I am concerned with the topics covered in the column, not with what the author did while preparing it. When reading User's Column I feel that I am reading a letter from a long lost friend who is trying to tell me everything that has happened during the last three years.

User's Column is both useful and necessary, but please keep it up to the fine standards that BYTE is known for. In future issues, don't allow Mr. Pournelle to ramble incoherently page after page.

Ron Dyer
40 Godstone Rd., Suite 305
Willowdale, Ontario
M2J 3C7 Canada

I was appalled by Jerry Pournelle's recent defense of software hacking (see "User's Column: A BASIC and Pascal Benchmark, Elegance, Apologies, and FORTH," October 1982 BYTE, page 254). I defy you to name any other engineering discipline in which disorganized, patch-as-you-go approaches are considered to be acceptable practice.

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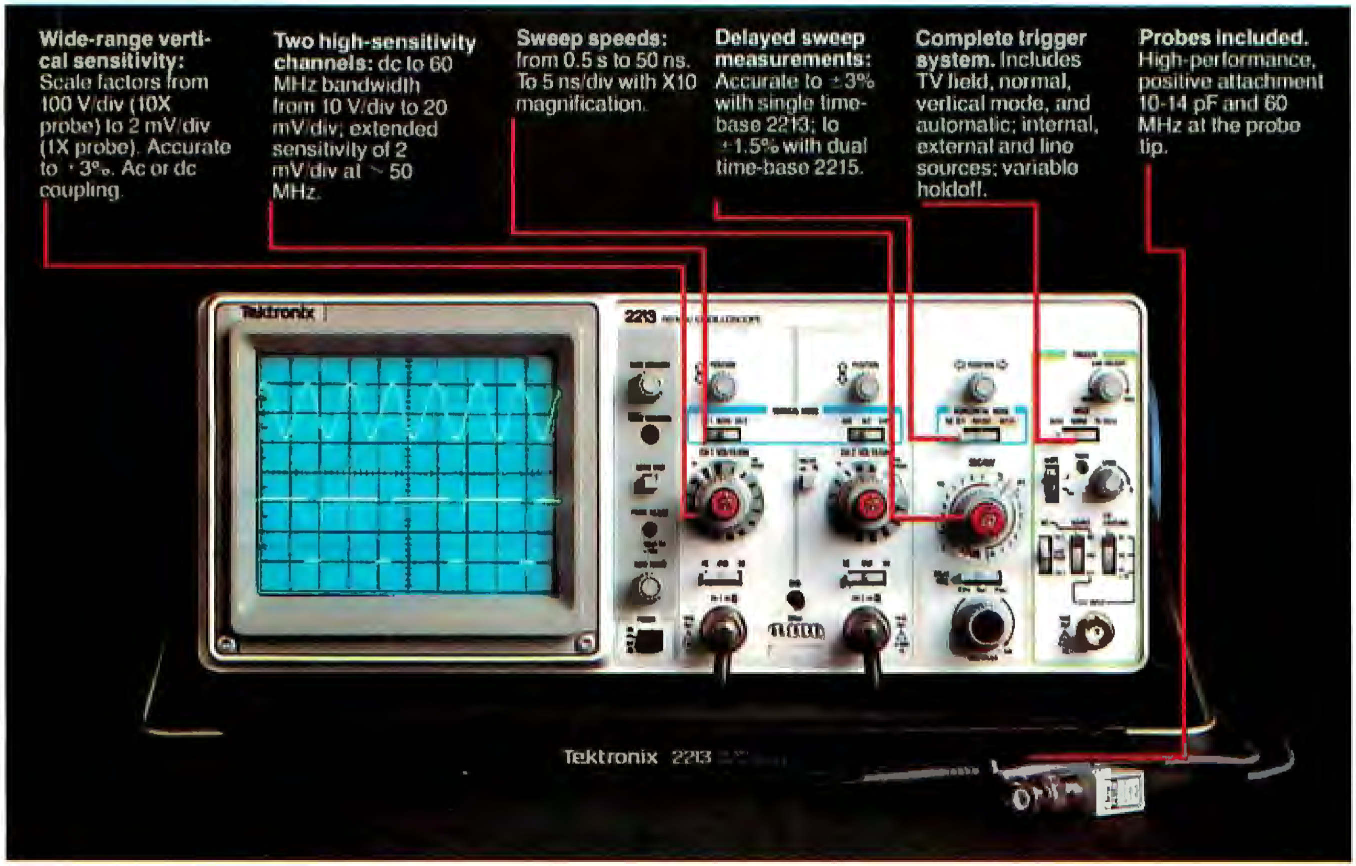

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Daniel Ross
Succinct Systems
1346 River St.
Santa Cruz, CA 95060 ■

BYTE's Bits

Data General Opens Customer Center In Dallas

Data General recently opened a customer training center in Dallas, Texas. The center was established to provide local access to the firm's training services for end-users and OEMs (original equipment manufacturers) in the southwestern United States. The center has three classrooms, administrative offices, and a systems training laboratory housing an Eclipse computer and linked Dasher terminals capable of accommodating 18 users simultaneously.

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Data General maintains training centers in Atlanta, Boston, Chicago, Los Angeles, Washington, D.C., six European countries, and Australia-New Zealand. For more information on the newest training center, contact Customer Education, Data General Corp., 4350 Alpha Rd., Dallas, TX 75234, (214) 458-2945. ■

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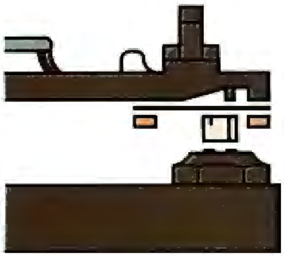

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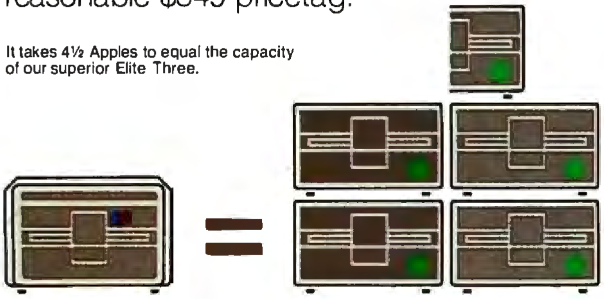

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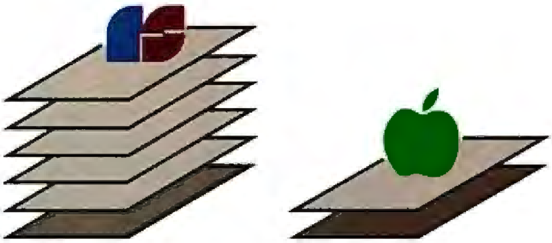

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The Lisa Computer System

Apple designs a new kind of machine.

Gregg Williams
Senior Editor

I had an interesting conversation with an engineer on a recent flight from San Francisco to New York. He knew only a little about microcomputers, but he was aware that their presence is slowly becoming more common in the workplace. "Sure, the industry is healthy, but it's still only reaching a few people," he said. "Most people won't use computers—they're afraid of them, they don't know what to use them for, or it's too much trouble to use them. Before computers become *really* profitable, they're going to have to be very easy to use. They have to be simpler. They've got to be useful in the office."

He continued, "We've got to stop using paper—which means the computer has to do word processing, filing, electronic mail, *everything*—or it'll be too much trouble having some things on the computer and others on paper. Then you've got to be able to talk to other computers—other computers like yours and some big corporate computer that's halfway across the country. Sure, it's a lot of stuff, but when you get all that together, *then* you'll see computers really take off."

Photo 1: *The Lisa computer system.*

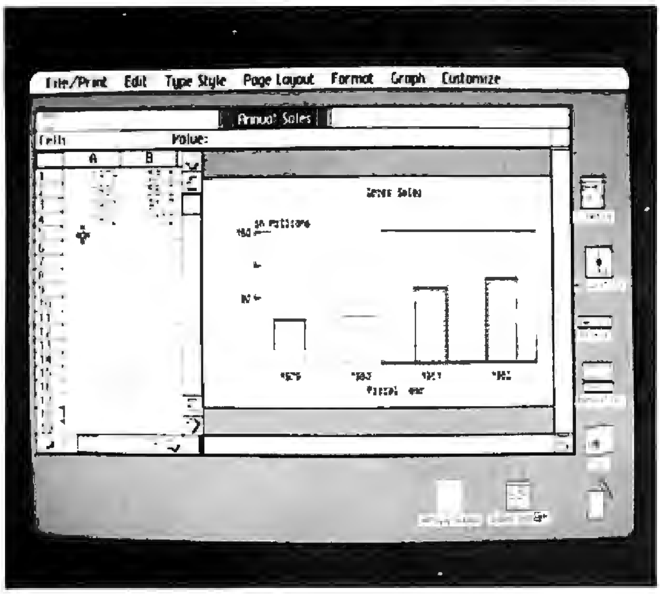
What could I say? Not very much, for two reasons. First, he was absolutely right—we need all that and more before computers become as commonplace as color TVs and electric typewriters. Second, I had agreed not to talk about a computer I had just seen that meets many of his points: Apple Computer's highly secret Lisa computer (see photo 1).

The Lisa at Work

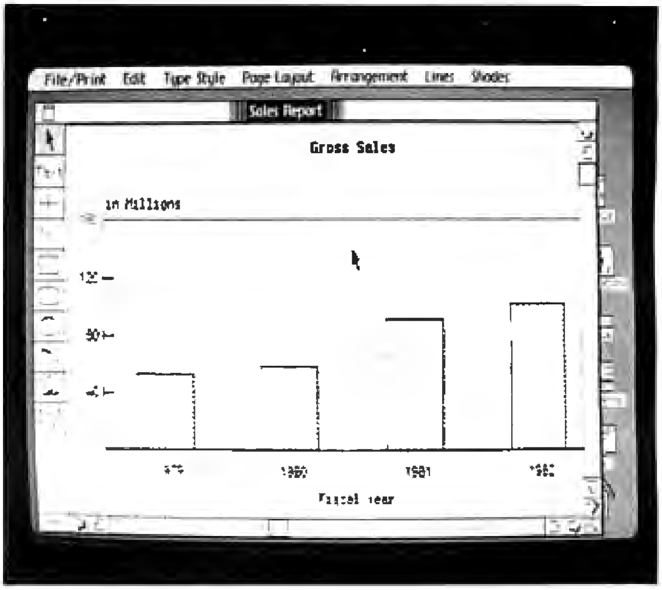
Before we take a detailed look at what the Lisa is and how it came about, let's look at an example of what it can do. Suppose I'm writing a report for my boss and I want to prepare a chart to illustrate a certain point. With a few movements of the *mouse* (more on this pointing device later), I "tear off" a sheet of Lisa Graph "paper" (thus activating a program called Lisa Calc and displaying an empty grid on the screen) and give it the heading "Annual Sales." I then type my numbers into the grid, name the graph and the *x* and *y* axes, and request a bar graph. *Voilà*: I get the bar graph (superimposed on top of the data) shown in photo 2a. At this point, I can simply print the graph or save it for inclusion with my report, but I'm not satisfied with the way it looks. I then use the mouse to "cut" the graph from the Lisa Graph paper and put it in a temporary storage place called the *clipboard*. I can then "throw away" the Lisa Graph "paper" I was using.

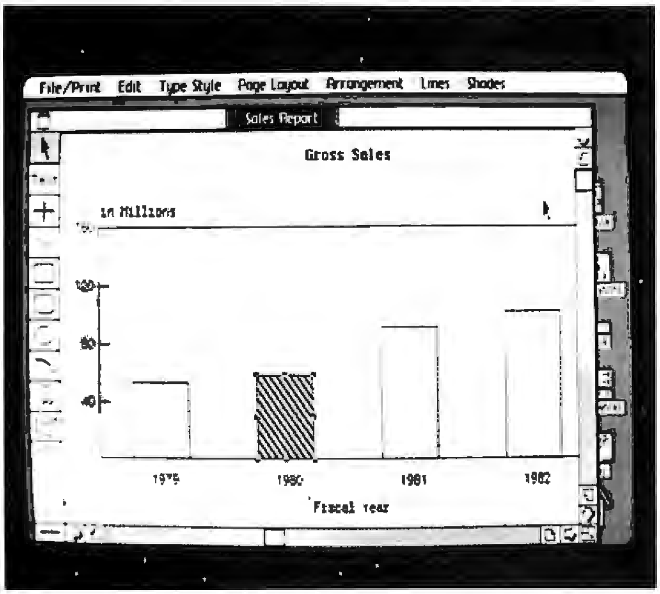
My next step is to "tear off" a sheet of Lisa Calc "paper" and paste my "Annual Sales" bar chart from the clipboard onto it. Photo 2b shows the result. I want to make the bars darker, so I use the mouse to move the cursor (the arrow pointing diagonally up in photo 2b) onto the rectangle and tell the computer that I want to work on that bar by clicking the button on top of the mouse twice. (I could almost as easily have selected all four bars, but I'll just do one here.) As a result, the bar

(2a)



(2b)



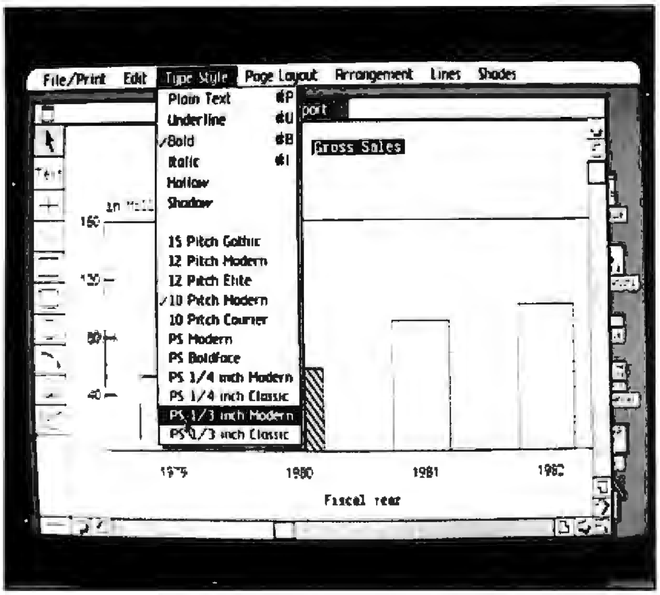


Photos 2a-j: *Creating a chart using the Lisa Graph and Lisa Draw programs. See the text for details of how the image is generated and changed.*

is selected, as shown in photo 2c. (In the Lisa system, you first select what you want to work on, then you select the action you want performed.) The small black squares that appear on the edge of the object are called *handles*; not only do they show which object has been selected, they also serve as "handles" by which the cursor can move or alter a shape.

Now that the bar is selected, I move the cursor to one of the menu titles at the top of the screen (also shown in photo 2c). I see the menu of possible actions by pointing the cursor at the menu title and holding down the mouse button (photo 2d). Here, the menu is a grid of 36 varieties of shading that can be used to fill the selected area. When I move the cursor to the desired shade box and let up on the mouse button, the pop-up menu, as it is called,

(2g)



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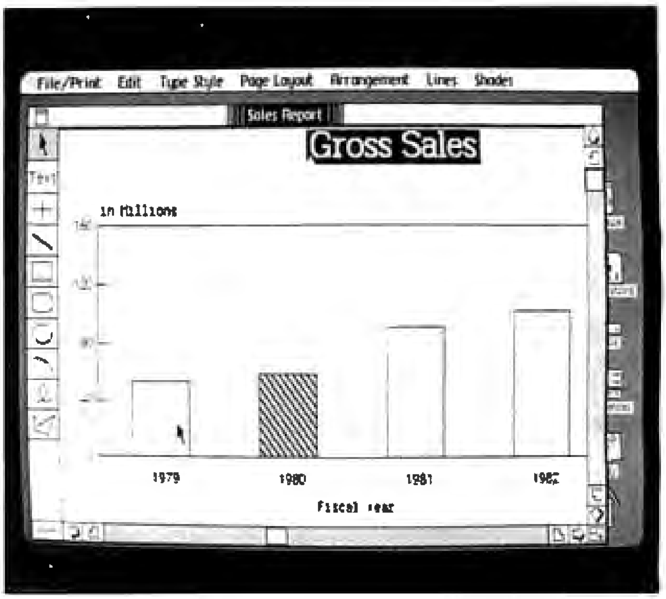

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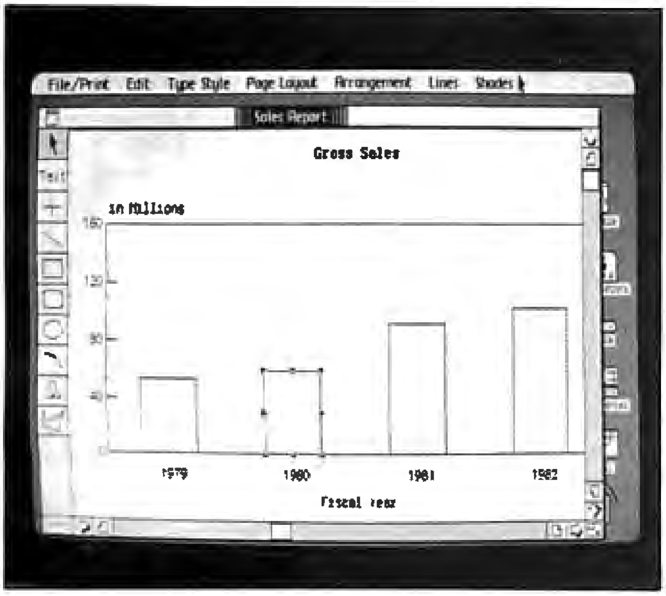

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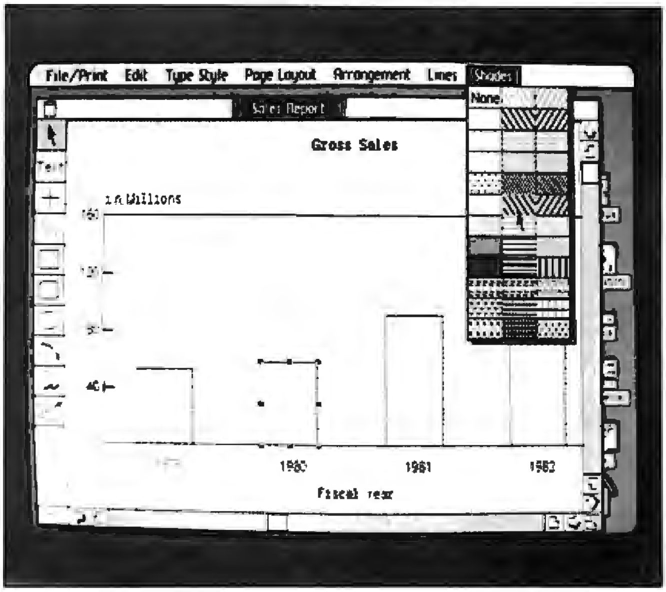
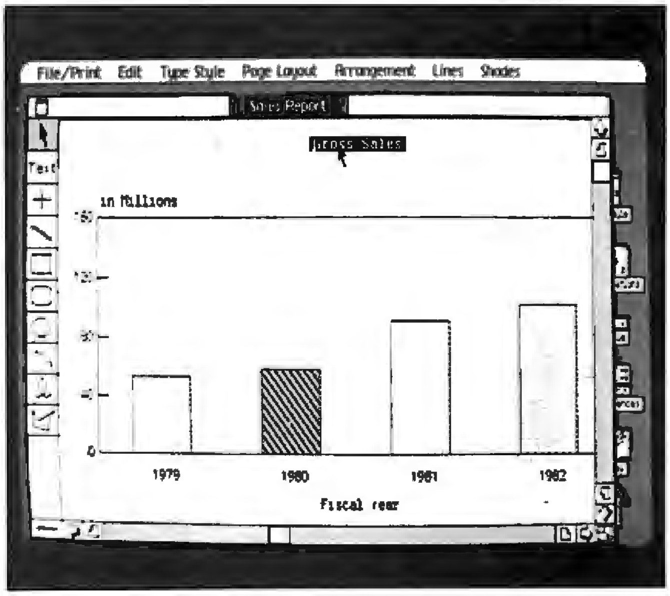


(2f)

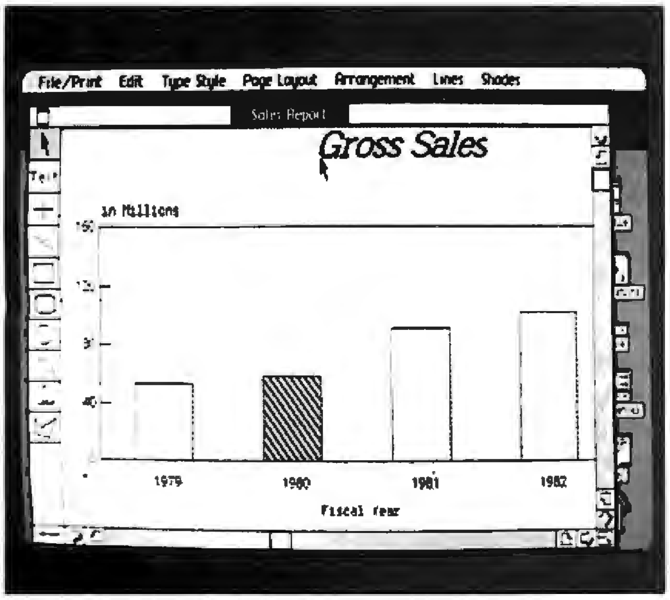


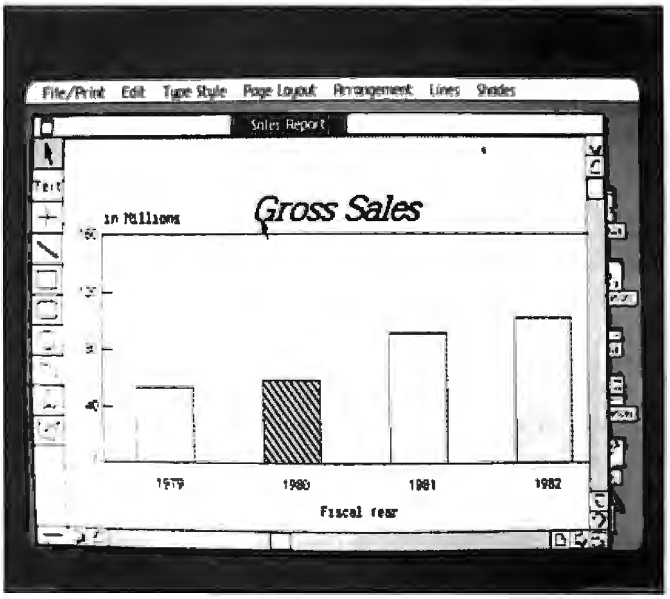
disappears and the shading fills the box (photo 2e).

It is equally simple to change the size, type style, and position of the title "Gross Sales." By holding down the mouse button when the cursor points just to the left of the first letter and letting it up when the cursor points just past the last letter, I can select an area of text that the Lisa then puts in reverse video (photo 2f). When I select an option from the "Type Style" menu (photo 2g), the text is redisplayed in its new size and style (photo 2h). I then modify the title to an italic font in a similar way (photo 2i). Finally, I pick up the title with the cursor, "drag" it to a new location, and leave it there (photo 2j). Many other alterations are possible. When I'm satisfied with the graph, I can print it, save it, or do both.

This example conveys only a fraction of the speed and the ease of use associated with the Lisa computer and the programs that go with it. Now that we've seen the system at work, let's take a look at what makes it so different.

(2i)





The Evolution of Software

It is instructive to see to what degree software is a part of Apple products. The basic Apple II, released in 1977, comes with about 16K bytes of object code. The Apple III, released in 1980, has about 200K bytes of code. The Lisa has more than 2 megabytes (2048K bytes) of code, a staggering figure that hints at the tremendous effort that goes into implementing a good piece of software.

The history of microcomputing has been exciting so far because it has enabled individuals working in their spare time to make significant contributions to the state of the art. But that has changed: now most state-of-the-art software is the province of teams of programmers hired by companies, as opposed to individual programmers working for themselves. As programs grow more sophisticated (requiring teams of programmers) and have to be more carefully planned to meet users' needs (requiring experts in given fields to be added to the team of designers), the implementation of programs is becoming a team effort. The days of the successful entrepreneur/programmer are probably gone.

Photo 3: *The "mouse" pointing device is about the size of a package of cigarettes and has one button on top.*

Foundations of the Lisa Design

The design effort that resulted in the Lisa computer is remarkably innovative because the designers did what designers *should* do—define the product's prospective customers, determine their needs, and *then* design a product to meet those needs. Apple was also willing to give its designers enough time and money (with no marketing restrictions attached) to first design and then create a computer that redefines the expression "state of the art." Granted, the Lisa's designers drew heavily on previous work done at Xerox PARC (Palo Alto Research Center), but they refined several borrowed elements and combined them with numerous innovations. (For further information on the design process, see "An Interview with Wayne Rosing, Bruce Daniels, and Larry Tesler" on page 90.)

Apple started this project with the intention of creating not only a product but the foundation for a whole new computer technology, one that would create computers literally anybody can use. The company's first task was to devise a new *user interface*—that is, a new and better way for humans to interact with the computer. The result was an internal (to Apple Computer Inc.) "User Interface Standards" document that describes how a user interacts with the Lisa system.

Although the Lisa design has several important elements, four stand out: the machine's graphics-mouse orientation, the "desktop" and "data-as-concrete-object" metaphors, and the integrated design of the hardware and software. Let's look at each of these in turn.

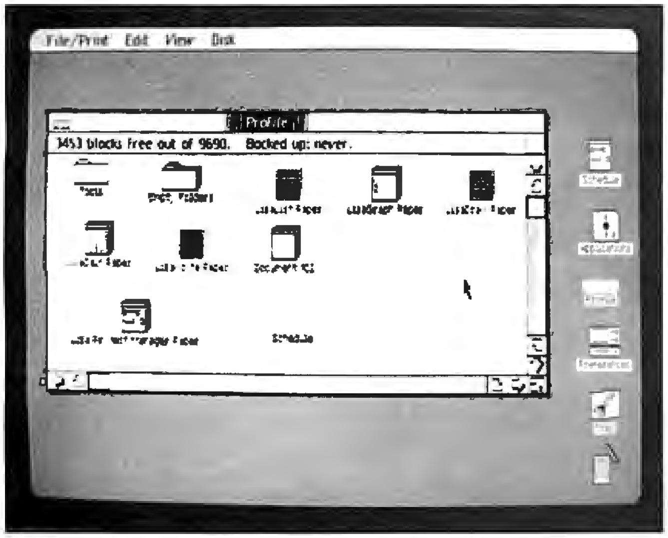
The graphics-mouse orientation: The traditional text display and keyboard input device make for a computer that is—let's face it—not too easy to use. Apple decided that the graphics resolution of the machine had to be high enough to use pictures (often called *icons* by Apple) in place of text. (For example, see the icons on the right-hand side of photo 2a.) Pictures are more easily recognized and understood than text. Because of this, you can probably figure out that the garbage-can icon in photo 2a is used to throw something away.

Apple also knew that it needed a new, easier-to-use input device to move the frequently used arrow-shaped cursor. The designers passed over such devices as light pens and touch-sensitive video panels in favor of the *mouse*, a pointing device used in several Xerox PARC machines. The mouse, which is about the size of a pack of cigarettes, has a small bearing on the bottom and one or more buttons on the top (see photo 3). When you hold it in your hand and slide it across a flat surface, the mouse sends signals to the computer, which guide the video cursor in the direction that you've moved the mouse. The mouse Apple designed has only one button; Apple broke with the conventional wisdom of two- and three-button mice after user tests indicated that people aren't always sure which button to push on a multiple-button mouse.

With graphics of sufficient quality and a mouse, the Lisa lets you get what you want by pointing at it. Because the video cursor moves in direct response to the way the hand moves the mouse, you feel as if you're actually pointing at something on the screen. This has the positive psychological effect of making you feel in control.

The "desktop" metaphor: When you turn on the Lisa system, the screen is empty except for the presence of several icons. The Lisa computer depends on the metaphor that the video display is a desktop, while the icons are objects on the desktop. Each peripheral connected to the Lisa (floppy and hard disks, printers, and other peripherals connected by interface cards) is represented on the desktop by either an icon (if it is not in use) or a rectangular area called a *window* (if it is available for use). The Lisa computer normally replaces the conventional file directory with a collection of objects displayed in the window of the associated mass-storage device. Each file is represented by an object of some sort—usually a report, a tool, or a document—and objects can be grouped together in folders, which are also treated as objects. (Actually, the

(4a)



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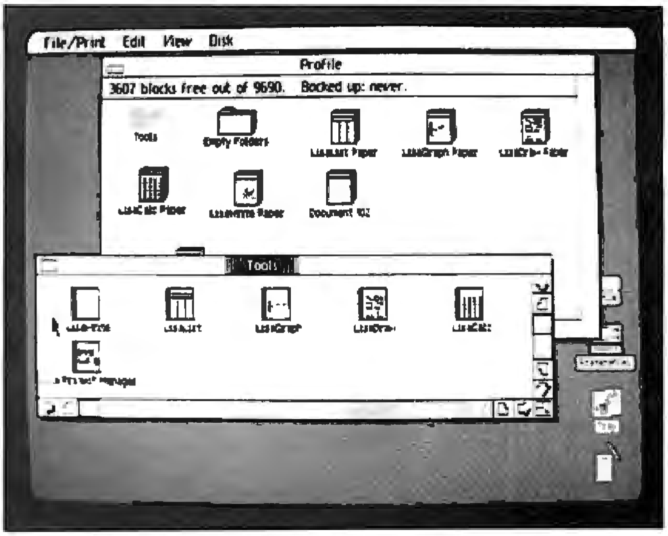

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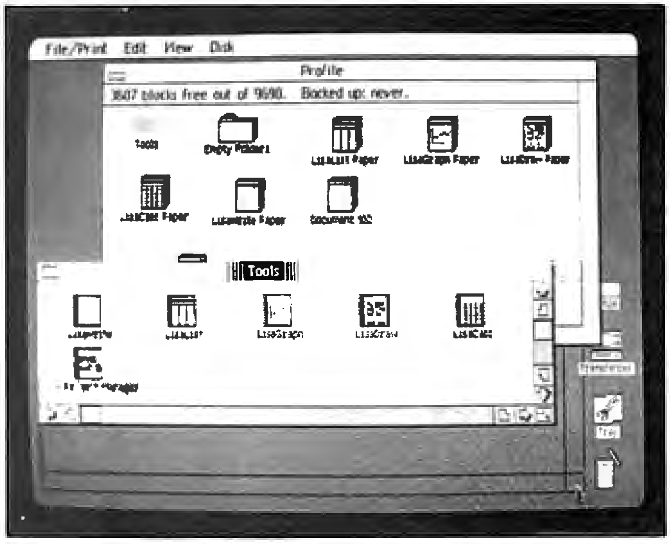

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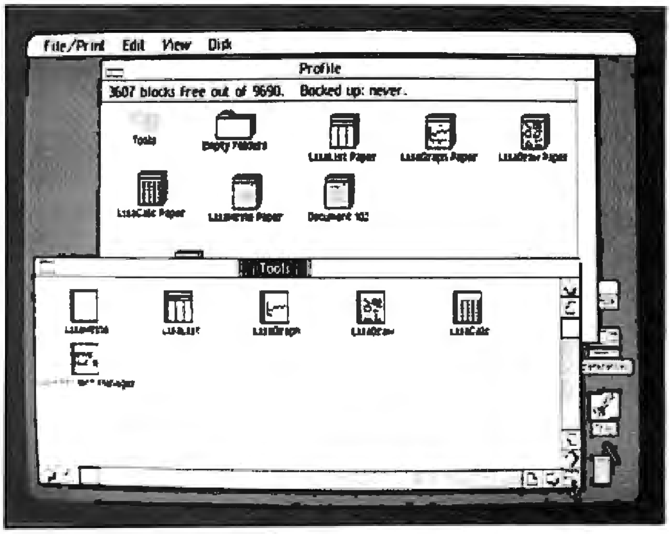


Photo 4a-d: *File management on the Lisa system. Files, collections of files, and peripherals appear as pictures or icons (4a). When you open the Tools icon, its contents appear in a separate window (4b). The user can dynamically manipulate the window in several ways; in photo 4b-d, the window is enlarged.*

computer can give you a conventional directory on request, but only traditional computer users will ask for this option.)

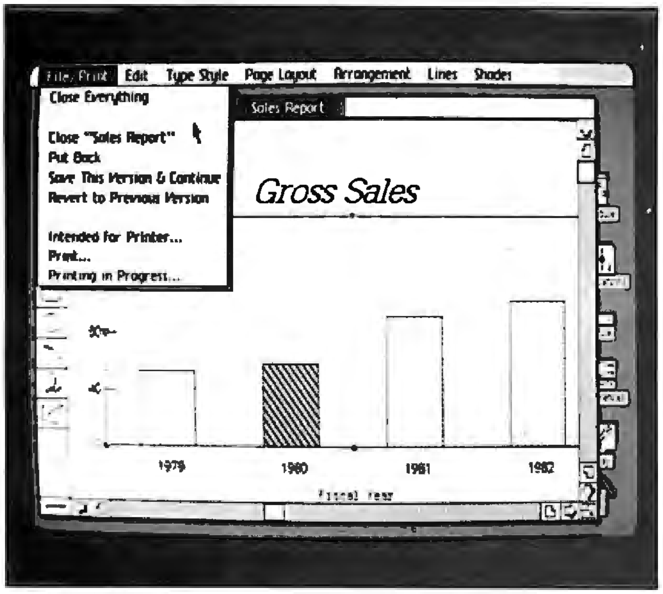
An example of the Lisa file system will illustrate how useful this metaphor is. From a cleaned-up desktop with nothing but icons on the right of the screen, I use the mouse to point to the Profile (hard disk) icon and click the mouse button twice; this has the effect of "opening" the Profile and displaying its contents. The Profile icon changes to a white silhouette and its original black-on-white shape expands to a window named "Profile." (Photo 4a was taken after three items—shown as black icons—had been selected for manipulation. When the Profile icon is first opened, all of the icons inside it are white—that is, unselected.)

To view and then work with the contents of the Tools folder, I put the cursor on the folder and click the mouse button twice. The icon expands, leaving a gray silhouette and a window named "Tools," as shown in photo 4b. The window is just that—a window into whatever the Tools folder contains. The symbols on the margin of each window are points from which the cursor can direct several operations on the window. For example, when the cursor points to the small folder icon in the upper left-hand corner of the Tools window and the mouse button is clicked twice, the folder "closes" and the video display reverts to the image it had before the folder was opened.

If the Tools folder contains more than the window can show, you can do one of two things to see the additional contents. First, you can scroll the window either horizontally or vertically. Second, you can put the cursor on the expand/contract icon (in the lower right-hand corner of the window), hold down the mouse button, and move the cursor. An outline of the window follows the cursor (photo 4c); when the mouse button is released, the window grows to its new size (photo 4d).

Once you've been shown the mechanics of manipulating objects and windows, you have a working knowledge of

(5a)



(5b)

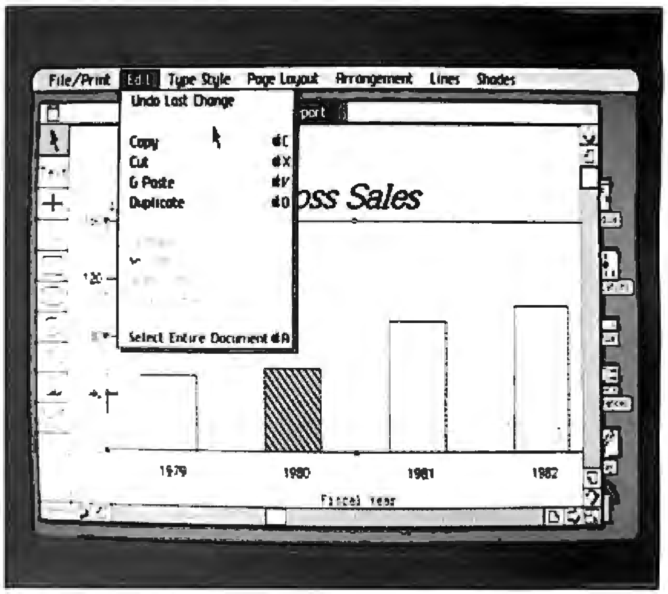


Photo 5a-d: *Additional pop-up menus for the Lisa Draw program.*

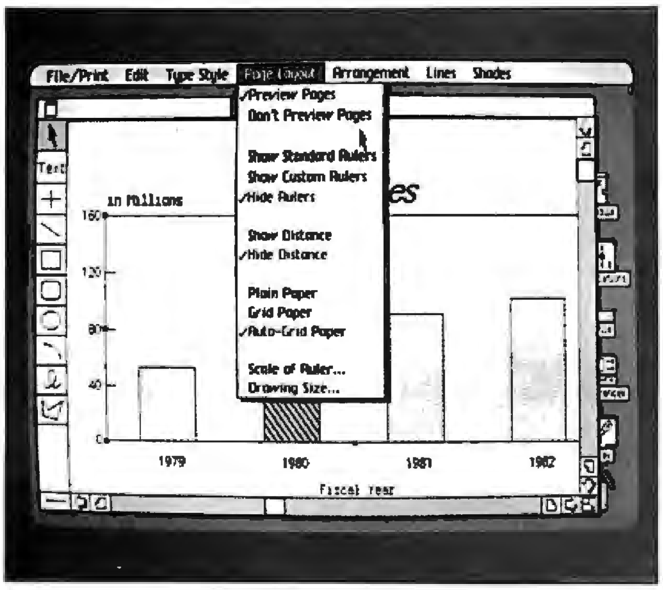
several essential operations of the Lisa file system (called the "Desktop Manager"). The desktop metaphor does two things for you. It helps you to remember certain operations because they make sense in the context of the object-related icons. Second, it draws on your general knowledge of office supplies and how they are used. These elements help Apple achieve its objective of creating a system that people can learn to use some aspect of in under 30 minutes.

The "data-as-concrete-object" metaphor: More than anything else, this metaphor is the foundation of the Lisa computer design and its probable success. As you can see from the example above, the Lisa file system makes you feel as if you are actually moving and changing objects, not merely manipulating abstract data. The Lisa Graph/Lisa Draw example shown in photos 2a through 2j creates the same illusion, as do all the other Lisa application programs.

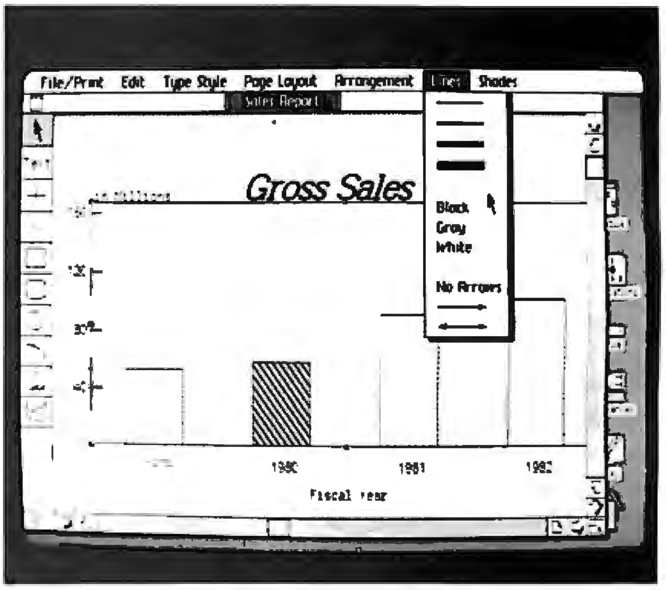
The "data-as-concrete-object" metaphor depends on a condition most computer programs don't fulfill: that intuitively reasonable operations can be performed on objects *at any time*. Most computer programs have modes that restrict your activities at any given time; for example, many word-processing programs don't let you do numeric calculations and then incorporate them into the document you're writing. With the Lisa application programs, however, you can switch your attention from a sheet of Lisa Write "paper" to a sheet of Lisa Calc "paper" and back with no problem, just as you could if they were two sheets of paper on your desk.

Because you deal with recognizable objects such as folders and reports, you feel secure in the knowledge that your data will not disappear. "After all," it seems to be telling you, "computer files can mysteriously disappear, but folders, reports, and tools do not. If a file disappears, there's a logical explanation—either you threw it away or

(5c)



(5d)



you filed it elsewhere. In either case, the situation is still under your control." In other words, the "data-as-concrete-object" metaphor *demystifies* the computer by transforming data into physical objects that behave in a predictable and reasonable way.

Integrated design: Not only is the Lisa computer the result of an integrated design, it is also the result of an *iterated* one. The Lisa hardware and software were designed only after Apple had identified the needs of its target users. Once a given version of the system was implemented, it was tested by the kind of people who would eventually be using it. The test findings dictated hardware and software changes, and Apple went through the design/test/revise cycle several times until everybody was satisfied with the result. This ensures that the Lisa does not fall prey to a problem common to microcomputers: being technologically sophisticated, but still hard or inconvenient to use.

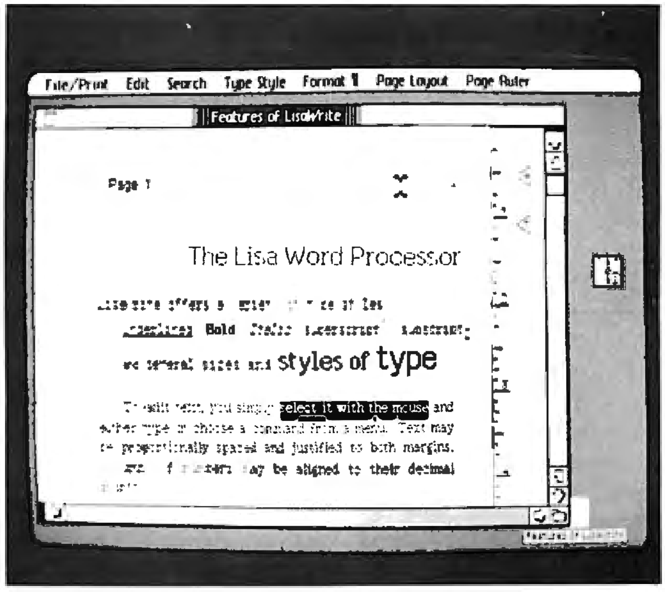


Photo 6: *A document being prepared using Lisa Write.*

During the iterations of the design process, the Apple design team looked for opportunities to have separate Lisa programs do their tasks in the same way. It then incorporated these common operating procedures into the Apple user-interface standard and tried to apply them to other Lisa programs. The result is a large amount of common behavior and structure among all the Lisa programs. For example, you enlarge or move a window the same way whether it is a Lisa Calc window or a Lisa Draw window. You also open, close, copy, and rename objects the same way throughout the system.

The "Undo Last Change" command allows you to undo the effects of the last command you issued.

According to Apple, this attempt at standardization has two advantages. First, it shortens the time an average person takes to become comfortable with a system from a range of 20 to 40 hours (Apple's estimate, based on tests it conducted) to several hours. Second, it lets you apply what you learn in one program to all other programs. This commonality among Lisa programs is largely responsible for the ease with which beginners learn how to do something useful on the Lisa computer; it usually takes less than half an hour, even for people who have never sat in front of a computer before.

The Lisa Application Programs

The Lisa system will be offered with six application programs. Both new packages and improved versions of the first six programs will be offered at a later date, and in time third-party software developers working with cooperation from Apple will create additional programs. At this writing, no price had been set for the programs, but Apple expects them to cost between $300 and $500 each, a justifiable price for programs of this caliber.

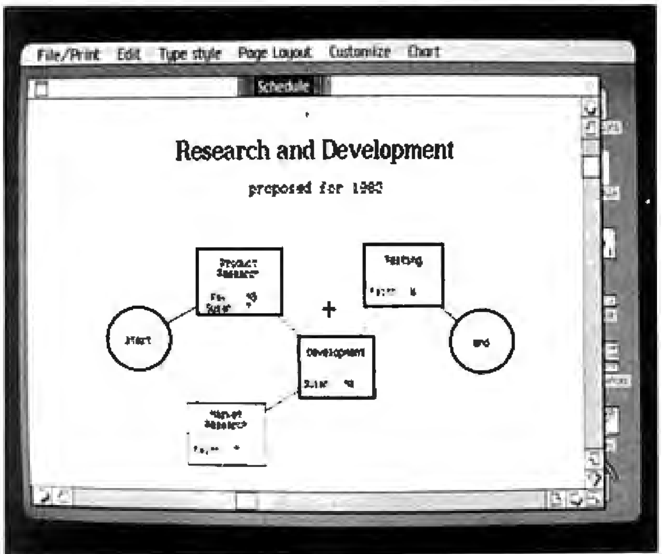
I don't have room here to describe all the features of each program. Instead, I will comment briefly on each one and say that, in general, all of them have more options and features than most people will use. (See photos in which pop-up menus are visible for an idea of some of the commands available.) One in particular deserves mention: the "Undo Last Change" command, which is available in every program. This wonderful command lets you undo the effects of the last one you issued. It's a tremendous security blanket that enables you to experiment and work without worrying about making an irrevocable mistake.

Here are the six application programs (a telecommunications program, Lisa Terminal, is covered in the section on "Communications and Databases."):

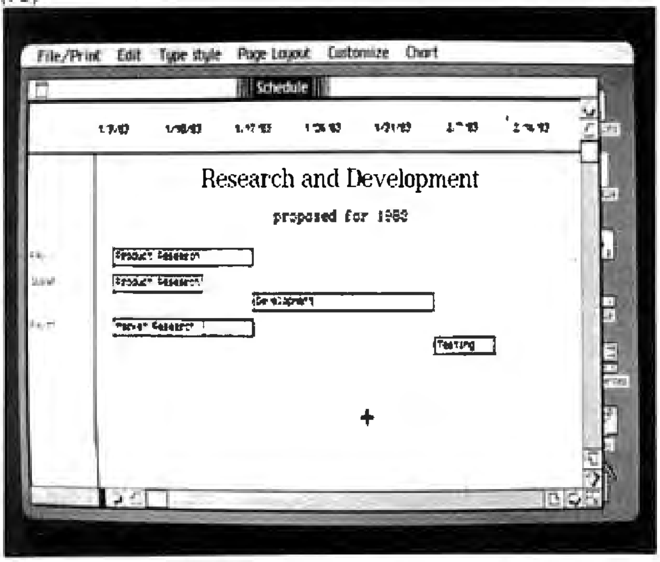
Lisa Draw is easily the showpiece of the Lisa system. The example in photos 2b through 2j shows only a small part of what it can do. See photos 2d, 2g, and 5a through 5d for some of the pop-up menus. Lisa Draw enables you to draw lines, boxes, circles and ellipses, arcs, and polygons—all with the mouse. You can add text at any place in any of 11 typeface/size combinations. In addition, you can modify any typeface with any combination of underline, bold, italic, hollow, and shadow styles for a combination of 11×2^5 or 352 distinct kinds of type. Lisa Draw has grids and rulers that can be displayed to help make drawings neat. Shapes can be selected and centered by a given horizontal or vertical edge. You also put Lisa Draw in an "auto-grid" mode that causes lines and shapes to align themselves with the grid you have chosen. Drawings can cover as many as 25 pages; Lisa Draw prints them out a page at a time and you join the edges together to make a larger drawing—a convenient feature if your drawing can't fit on one page. This program is a joy to use.

Lisa Write is the best "what-you-see-is-what-you-get" word processor I've seen. Between the keyboard and the mouse, you can add, change, delete, and move text, change its appearance, reformat it, and do just about

(7a)



(7b)



(7c)

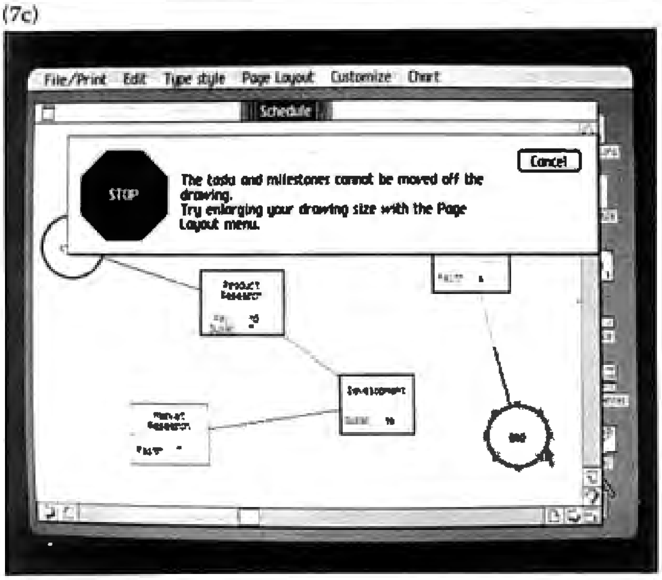


Photo 7a-c: *The Lisa Project Manager program. Photo 7a shows a simple PERT chart with tasks on the critical path being heavily outlined; 7b shows a Gantt chart, which shows personnel utilization; 7c shows the kind of typical error message used throughout the Lisa system.*

anything you'd want to in a word processor. Of course, you can see each page exactly as it will appear on paper (see photo 6). My only criticism of the program is that the version I saw paused a second or so between when I typed a phrase and when it appeared on the screen. The delay is due to the large amount of processing the machine has to do before it can display the new text (and perhaps scroll other text down), but the designers are aware of the problem and are working on minimizing the time delay in the final version.

Lisa Project is used to keep track of projects and personnel, and it does so using PERT (Program Evaluation and Review Technique), Gantt, and task charts. Using the mouse and the keyboard, you can add, delete, move, change, and label activity boxes. Each box contains the activity name and its personnel and time requirements. The Lisa Project program displays the PERT chart (see photo 7a), drawing a heavy outline around the activity boxes on the *critical path* (a path of activities for which delays will lengthen the duration of the project). The program can also optionally use such information as worker vacation times and the length of the work week to influence the final chart. You can also have the program show the early-start, early-finish, late-start, and late-finish dates associated with the PERT method. The Gantt chart (photo 7b) shows resource utilization over time, including unutilized resources (shown in gray). The task chart (not shown) displays tasks by their early-start date.

Like the rest of the Lisa system, Lisa Project gives you incredibly clear error messages. For example, when you try to take the "end" circle off the screen, you get the error shown in photo 7c, which must be answered before you can continue.

Lisa Calc is as sophisticated a spreadsheet program as any other on the market. In this instance, I don't think the mouse improves on cursor keys because one hand has to alternate between the mouse (to move the spreadsheet cursor) and the keyboard (to enter data into the spreadsheet cells). In any case, most people who want a Lisa computer are interested in the kind of structured numeric recalculation that spreadsheets are good at, and Lisa Calc certainly fills this need. Of course, data can be traded between Lisa Calc and other Lisa programs without restriction, which means, for example, that you can "paste" a section of spreadsheet data into a document being prepared by Lisa Write. Photos 8a and 8b show the process of displaying the formula of each cell along with its value.

Lisa List, a single-user database that permits records of up to 100 fields totaling 1000 bytes, probably illustrates best the "data-as-concrete-object" metaphor. When you add, change, or search for records, you work directly on the list visible in the window, not on an auxiliary display (like a data-entry screen) that limits you to working on the current record only. Record fields are defined as being one of eight data types (text, number, date, money, time, social-security number, phone number, or zip code), and Lisa List does automatic type-checking during data entry. Photo 9 shows an example of a Lisa List window. One slight problem is that the social-security number, phone number, and zip code fields have fixed formats—for example, zip codes are limited to five digits. You must revert to the general-purpose text format if you want to be able to convert to 9-digit zip codes or use foreign telephone numbers.

Lisa List has many attractive features. Of course, you can display or print parts of the list in many ways; you can sort the list in several ways or select records according to given criteria. You can move the cursor with either the mouse or the arrow keys. The contents of fields are stored internally in a compact form to increase the overall storage capacity of the program. In addition, Lisa List has two very useful features that every database should have: the ability to add fields to or change field widths in an existing file and the ability to put any amount of information in a field regardless of its stated width (field width influences only how much data is visible).

Lisa Graph is an application program that creates a bridge between the number-oriented Lisa Calc and the picture-oriented Lisa Draw. Lisa Graph takes a matrix of numbers (entered either by the user from Lisa Graph or transferred from another source) and creates virtually instantly a bar, line, mixed bar and line, scatter (*x-y* plot), or pie chart. Photo 2a shows a typical Lisa Graph window, and the sequence of photos 2a through 2j shows how Lisa Draw can customize a drawing from Lisa Graph.

Reliability

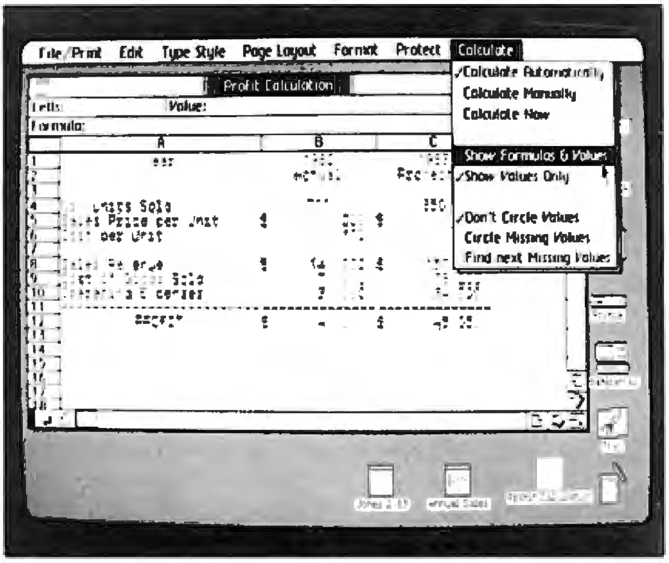
Computers are worthless if nobody uses them, and the Lisa system has made great strides toward eliminating that possibility. Certainly, it has been designed to be easy to use. But the Lisa system will probably be used by computer novices because of its *reliability*, both in the physical and psychological sense.

Physical reliability is the kind that makes an engineer feel secure. Apple IIs, for instance, have a reputation for being very reliable, and I'm sure that the Lisa computer was engineered with even more care. (For example, the Lisa is constructed as a series of modules, any one of which you can pull out without tools. And despite its internal complexity, it was engineered to dissipate excess heat without a cooling fan—*that's* engineering!)

I can't say how reliable the Lisa is overall because I don't have enough direct experience with it. But I do know that Apple has concentrated on improving the reliability of the source of a great many problems: the floppy disk. Despite the features of the Lisa disk drive that put it at the leading edge of disk technology (see the text box "The Lisa Hardware" for more details), Apple claims that the hardware (assisted by its sophisticated disk-accessing software) has an error rate so low that Apple couldn't quantify it during tests. Apple said, however, that the hardware makes less than one error in one trillion (10^{12}) operations.

Apple has also adopted a redundant data structure for information on the disk that lessens (or sometimes eliminates) the effect of losing a sector of information. This redundancy is on three levels—blocks, files, and

(8a)



(8b)

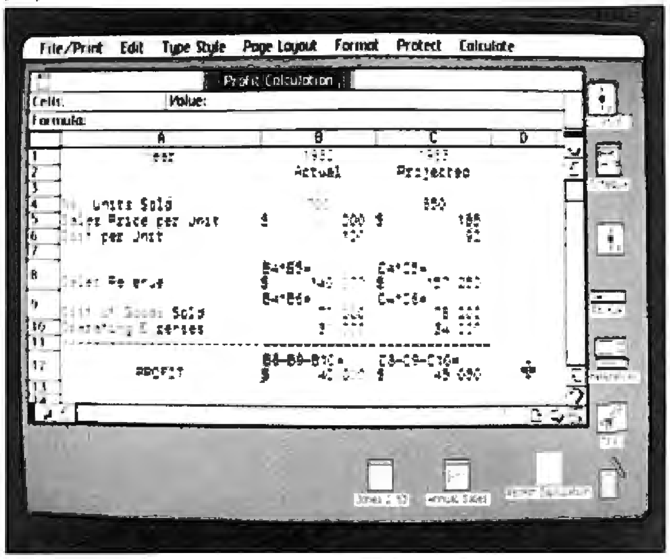


Photo 8a-b: *The Lisa Calc program. Photo 8a shows a simple spreadsheet; 8b shows the same spreadsheet after the "Show Formulas and Values" command is executed.*

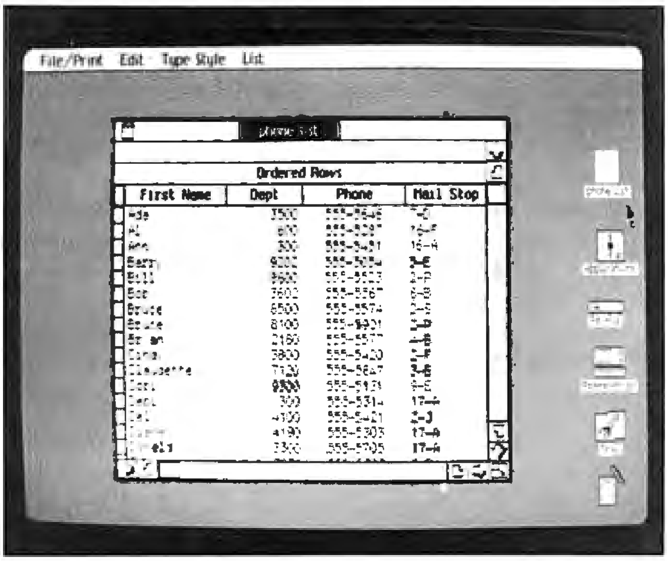


Photo 9: *The Lisa List program, a single-user list-management program.*

The Lisa Hardware

Reporting on the technical specifications of a computer toward the end of an article is unusual for BYTE, but it emphasizes that the why *of Lisa is more important than the* what*. For part of the market, at least, the Lisa computer will change the emphasis of microcomputing from "How much RAM does it have?" to "What can it do for me?" For example, it is almost misleading to say that the Lisa comes with one megabyte of RAM, even though the fact itself is true. That doesn't mean that the Lisa is sixteen times better than machines that have 64K bytes of RAM. Nor does it necessarily mean that the Lisa can work on much larger data files than other computers; its application programs each take 200K to 300K bytes, which significantly reduces the memory available for data. It's more instructive to say, for example, that the Lisa with one megabyte can hold a 100-row by 50-column spreadsheet (as its advertisements state). With this in mind, let's take a look at the Lisa.*

The Lisa keyboard.

"Lisa" stands for Local Integrated Software Architecture, but it's really just an excuse to retain Apple's pet name for the project. The Lisa has a 68000 microprocessor, which is a true 16-bit microcomputer that has a 16-bit data bus, a 24-bit address bus (giving access to 16 megabytes of memory), and 32-bit-wide registers (all but the 16-bit status register). The 68000 in the Lisa runs at a frequency of 5 MHz. It can have up to 1 megabyte of memory with parity and comes standard with one megabyte (1024K bytes).

The video display is a 12-inch monochrome monitor (black and white, not tinted) with a resolution of 720 by 364 pixels. The interlaced image is refreshed at 60 Hz, which eliminates the possibility of eyestrain from subliminal flickering. The video display is completely generated by internal software, so the Lisa can use multiple character sizes and fonts without restriction. It also means that Apple is not restricted to any one style of video image; the designers can radically change the behavior of the system with a new release of software.

The Apple 871 disk drives design (called "twiggy drives" inside the company) are significantly different from conventional floppy-disk drives. Each one uses a 6504 microprocessor as a "smart" interface between it and the Lisa. The drives use special high-density, double-sided floppy disks that have two oval cutouts in the jacket (see photo below). These are essential because the two disk heads, in addition to being on opposite sides of the flat magnetic media, are not pointed at each other with the magnetic media between them, as is the case in all other double-sided floppy-disk drives. Instead, a pad presses the rotating magnetic media to the disk head on the opposite side of the media as is conventionally done with single-headed floppy disks.

Each formatted disk holds 860K bytes of information at a density of 62.5 tracks per inch; together the two drives (standard on the Lisa) hold 1.72 megabytes of data. Each drive also contains a mechanism that releases the disk for removal under program control, which prevents the user from removing a floppy disk prematurely. As with other Apple products, the floppy disks rotate only when the drives are reading or writing data, thus extending the lives of both the drives and the medium.

Apple has done several things to achieve its unusually high data density. The designers used an encoding scheme that keeps a constant data density of 10,000 bits per linear inch; this allows the outer floppy-disk tracks, which have a larger circumference, to store more data than the tracks nearest the center of the disk. In addition, the disk-access system software can move the disk heads in fractions of a track width to search for and find the middle of the track. That's an important feature when you're reading disks with small variations in track width.

In addition, the Lisa comes with one Profile (Apple's 5¼-inch Winchester-type hard disk) to the Lisa through its parallel port. It adds 5 megabytes of magnetic storage to the Lisa system, and speeds up the overall operation of the system. Additional Profiles can be added via interface cards.

The Lisa computer is never really turned off. It stores "system preferences" (things like speaker volume and video contrast) and system-configuration information inside the computer. Even when it is turned "off," it draws enough power to keep the clock/calendar and CMOS memory containing the above information working. When it's unplugged (for example, when it's being moved to another location), internal batteries preserve the clock/calendar status and CMOS memory for up to 20 hours.

The Lisa includes two programmable serial ports and one parallel port as well as three expansion-board slots, each of which connects directly to the system bus and has direct memory access (DMA) capabilities. Because none of these slots is filled in any "basic" configuration of the Lisa, they are available for future expansion (unlike the IBM Personal Computer's five slots, most or all of which are used for much-needed video-display and memory cards). Other features include a built-in speaker and a real-time clock (which can be programmed to execute tasks or turn the computer itself on or off at a given time), a microprocessor-controlled detachable Selectric-style keyboard, and a mouse.

I must thank Apple for including something I've wanted to see for a long time: unique serial numbers encoded into memory. The Lisa has two of these: an actual serial number

The Lisa floppy-disk drive, along with the special floppy disks it uses.

Inside the Lisa computer. Note the three connectors for expansion boards.

and a 48-bit number meant to be used as a "mail address" identification number for a network of Lisa computers. Two unique identification numbers will help to prevent the unfortunate but very real problems of software piracy and the existence of copy-protected disks that won't work for even their legal user. Software can be "mated" to the serial number of a given machine so that it can be backed up endlessly but will not run on another Lisa computer. True, a persistent few will outwit even this scheme, but it will practically eliminate a manufacturer's sales losses from copied software.

An interesting aspect of the Lisa is that it abandons hardware graphics chips like the NEC 7220 for system software that requires the 68000 microprocessor to generate and maintain the video image. At first, I questioned the wisdom of this decision because it makes the 68000 assume a heavy computational burden that could be transferred from software to hardware. But according to the designers, the use of a dedicated hardware graphics chip would itself limit and slow down the system (for a discussion of this, see the interview on page 90). In particular, the 68000 clock was set at 5 MHz instead of the usual 8 MHz to give the hardware just enough time to access the 32K bytes of screen memory during the machine cycles in which the 68000 is not using the address lines. This gives the Lisa access to the video memory that is transparent to the 68000 (hardware graphics chips severely limit access to the video memory) and results in a static-free image. (Much of the static or "hashing" in graphic video images results from the system accessing the video memory while the circuitry is using it to generate the video image.)

Apple will also be offering the Apple Dot Matrix Printer and the Apple Letter Quality Printer. Apple's engineers tested many existing printers, chose two (from C. Itoh and Qume, respectively) that best met their needs, then had the companies produce modified versions with Apple-specified hardware and software changes. Apple needed such exacting print quality because the Lisa software is very demanding of both printers. For example, both printers will reproduce almost exactly both the text and graphics that can be displayed on the Lisa screen. In addition, Apple has created special print wheels for its Letter Quality Printer so that you can print normal, italic, underlined, and bold characters without changing print wheels (quite a nice move—who's going to change print wheels several times a page just to get true italics?). The amazing thing about the Apple Dot Matrix Printer is that Apple plans to sell it for around $700 (the Letter Quality Printer will sell for about $2100). Unfortunately for Apple II and III owners, these printers' tricks are done entirely in software on the Lisa and won't transfer to other Apple computers.

Ease of use is the first thing that a novice **Lisa** user experiences.

A reproduction (at 80 percent) of printing from the Apple Dot Matrix Printer.

disks—and a given level in error is correctable by data in the next lower level. On the block level, each 512-byte block of data has a 24-byte area of *hint bytes*. These identify the file to which the block belongs and its block number within the file. On the file level, each file contains a header that duplicates information in the disk catalog. On the disk level, each floppy disk keeps a file of information about the status of each file on the disk. The Lisa system software automatically tries to reconstruct information that is lost, so it recovers from errors that would halt other computers.

Psychological reliability is the kind that makes an office worker secure. The Lisa floppy-disk drive is unique in this respect. On the Lisa computer, you can't yank your floppy disk out any time you want to (if you could, you might, for example, remove the disk before files on it are updated). Instead, you press the Disk Request button beside the disk-drive slot. The software in the Lisa computer checks your work space, closes any files belonging to that disk (thus updating the file), then ejects the floppy disk so you can remove it.

A similar thing happens when you turn the Lisa "off" (actually, it's never completely off; it just goes into a low-power mode). In any case, when you hit the Off button, system software automatically closes all open files, thus transferring the information in them to their respective floppy disks, and releases the disks from the Lisa disk drives. In addition, the software records the status of the "desktop" so that, when the computer is reactivated, Lisa automatically returns it to the appearance and state it was in when the Lisa was turned "off." Although those who have worked with computers before will find these features hard to get used to, most newcomers will be reassured by them.

The design of the Lisa application programs (which are the only things most Lisa users will see) is another example of psychological reliability. Many people have vague fears of computer programs because they think they'll do something wrong and cause a catastrophe that will make them look foolish. This won't happen with the Lisa system for two reasons. First, the Lisa software is designed to be very understandable. The metaphors make people comfortable with the manipulation of data, error messages are both clear and complete and tell you what alternatives you have, and, in general, the programs let you know where you stand and the consequences of a given action. Second, the Lisa computer has the "Undo Last Change" command mentioned earlier. With this command, even the most uncertain users will not hesitate to act in a way they think is appropriate. The way Lisa programs work, the user probably *is* right, and if he isn't, he knows he can undo whatever happens. People who won't trust most computer programs will trust Lisa programs.

Communications and Databases

As the engineer I talked to pointed out, no computer is going to be the most important piece of equipment in an office unless it can easily interact with other computers. This need has been integrated into the design of the Lisa system in several ways.

First, a communications program called Lisa Terminal allows the Lisa computer to emulate several popular terminals (Digital Equipment Corporation's VT52 and VT100 terminals and Teletype Corporation's ASR-33). The Lisa Terminal program includes all the options that a given terminal allows, even down to simulated status lights. A future Apple terminal program will enable the Lisa to emulate the IBM 3270 family of terminals.

Second, Lisa computers can be connected together via a new local network called Apple Net, which Apple hopes to promote as an industry standard because it feels that other networks have major cost or performance problems. According to Apple, Apple Net meets four criteria that it thinks are important: it can be easily installed by the user, it is highly reliable, it is easily extendable to include more nodes or to interface with other networks (like Ethernet and other Apple Net networks), and it has a low per-node

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(under $500) cost. A-Net has a bandwidth of 1 megabit per second, can have up to 128 nodes, uses a shielded two-conductor wire for interconnecting nodes, and can have a maximum node-to-node distance of 2200 feet. Apple Net uses the same method as Ethernet to avoid message collisions (CSMA/CD—carrier-sense, multiple access with collision detection) and is compatible with the Ethernet on the top five of the seven levels of communication protocol. For those who want it, though, Apple will also make Ethernet interfaces available at a cost of about $1500 per node.

Third, Apple has distant plans to make it possible for Lisa computers to talk to non-Lisa computers and to shared or remote databases. Although the people at Apple did not discuss specific products, they told me enough to assure me that they are planning extensions in this direction that will make it even more useful.

When these items are available for the Lisa, Apple will have overcome a very big problem: really integrating the computer into the full office environment. That usually includes both local and remote computers. Whatever the needs of a given office, the above products ensure that the Lisa computer will be as useful as any other "office automation" product available from other companies.

Service

The people I talked to at Apple made it clear that, with regard to Lisa, they were going to offer better service options than any other computer company, including IBM, DEC (Digital Equipment Corporation), and Wang. A diagnostic program called Lisa Test (supplied with the Lisa) enable it to isolate the computer failure to a single board or component; in the case of severe problems (when the disk drives aren't working, for example), a built-in test program that runs whenever the Lisa is turned on will diagnose and report on the problem. As I mentioned before, the Lisa is designed so that you can take it apart without tools (a detailed manual explains how).

Apple offers several service options. If you have on-site service (available through a joint agreement with RCA), you simply call Apple and let a service person fix the problem. For large-quantity customers, Apple can provide training to teach employees how to do in-house repairs. For individuals, Apple Care Carry-In Service is available.

In addition, Apple is planning what it calls Direct Phone Support. For a yearly fee, the user will have access to a toll-free number that is answered by a highly trained support person. Apple has high standards for this service, and I'm sure that, once the service has started and is running smoothly, Apple will deliver what it promises. The company expects its representatives to answer 90 percent of the calls received; people whose problems cannot be answered immediately will be called back when the answer is found. If equipment needs to be repaired, the Direct Phone Support person will call the

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Documentation and Training

I have seen only drafts of miscellaneous pieces of Lisa documentation, but they indicate that the final documentation will be superb. Apple plans to provide the *Lisa Guide*, an interactive teaching program about the Lisa system, and reference books for each application package; each reference book will begin with a short tutorial section that will get users doing useful tasks in under half an hour. Other documentation may be included, but the information was not available at the time we went to press.

Even though the Lisa is meant to be a very easy product to use, Apple will provide training to make sure that people learn how to use it. As one Apple spokesperson put it, "Training is part of the Lisa product." Apple will offer extensive training to all Apple dealers and to selected groups from companies that make large-volume Lisa purchases. Apple will also make training kits available to multiple-unit purchasers to help them train their employees. Individual Apple dealers may offer additional special training.

Future Plans

In the microcomputer industry, products are generally announced early (sometimes before they are designed) and released in preliminary versions before all the features have been integrated into them. Apple is to be commended for resisting this practice. In fact, the company seems to have released a more complete first version of the Lisa than most companies do with their products; the first Lisa sold will be a fine machine.

However, the ambitious and talented people who designed and implemented the Lisa computer have already envisioned and planned for quite a bit more than they can implement by release date. I'm sure they have some ideas they don't want to publicize (and rightly so), but here are some things they were willing to talk about:

•By 1984, Apple plans to replace its 512K-byte memory card (two of which can be fitted into the Lisa computer) with 1-megabyte cards, thus increasing the memory capacity from 1 to 2 megabytes.

As for languages, Apple plans to introduce versions of BASIC, Pascal, COBOL, and even the language/ operating system Smalltalk as soon as possible, and others will follow.

•As soon as possible, Apple plans to introduce versions of BASIC, Pascal, and COBOL for the Lisa. The BASIC will be compatible with Digital Equipment Corporation's BASIC Plus (unlike IBM Personal Computer BASIC, it will be able to use the extra memory above the first 64K bytes). The first releases of these languages will be "plain vanilla" versions that don't interact with the computer's special features (e.g., mouse control of the cursor, windows, the "desktop" metaphor), but later versions will probably integrate these languages into the Lisa system.

•Another language that will be available for the Lisa computer is Smalltalk. I was pleased to see Smalltalk working on a Lisa computer—a year and a half has passed since our special Smalltalk issue in August 1981, and no commercially available computer to date has used it. Smalltalk on the Lisa computer will change that. It is a very "possessive" language that directly controls the machine it is implemented on, so it will probably never be integrated into the Lisa environment—but then, it doesn't need to be.

•Smalltalk is just one example of a language/operating system that can occupy the Lisa machine. The Lisa will also support Digital Research's CP/M family of operating systems and Microsoft's Xenix (a licensed version of Unix that includes business-related extensions). Outside developers will be encouraged to carry operating systems

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across—one such possibility is Softech Microsystems' UCSD p-system.

•Apple will be making enhancements to the existing Lisa application programs. On first release, the only limitation in sharing data among Lisa application programs is that you won't be able to "paste" graphic images into a Lisa Word text document (you can, however, add text to a Lisa Draw drawing). Bruce Daniels, one of the Lisa designers, told me that the design allows for adding graphics to a text document but that they simply can't implement the feature in time for the first software release. It will be added by the next release.

•Apple is very conscious of the fact that the success of the Lisa will be heavily influenced by the availability of good third-party software. To encourage such software, the company will make available a "programmer's toolkit" package of software and documentation sometime this year. This toolkit will give third-party programmers all the information they need to build on the considerable utility software (window-control, disk-accessing, intelligent graphic-redrawng, and memory-management routines, for example) already available in the Lisa operating system. (The operating system itself is about half a megabyte of code, though only 200K to 300K bytes of it are resident in memory at the same time.) In addition, the toolkit will list the user-interface conventions that were used to create the existing six application packages and will strongly suggest that third-party software will be better received (by both Apple and the consumer) if it follows these conventions. The Apple-generated application programs are so wonderful that most programmers will consider it an achievement to create similar software.

Caveats

I wrote this article after working with a Lisa computer for several hours and studying various Lisa documents. The application packages were completely functional, but I was told changes were still being made to them. The released versions of software may be faster because debugging aids were probably slowing down the version I saw.

Performance

The Apple Lisa was faster than I remembered a similar machine being (an experimental Xerox machine running Smalltalk) and faster than I expected it to be. Granted, a 68000 microprocessor is in the computer, but it was being asked to do a lot—including the manipulation of 32K bytes of video-display memory. Objectively, I must report some delays (30 seconds, maybe) when loading in files, but these were shorter than what I usually encounter using CP/M-based business programs. In any case, I didn't notice any delays while actually *using* a given program, which is where you spend most of your time, anyway. I expect that the Lisa computer you'll see in Apple showrooms will be slightly faster than the one I saw.

Conclusions

As you can tell, I am very impressed with the Lisa. I also admire Apple for deciding to make the system without being unduly influenced by cost or marketing constraints. The Lisa couldn't have been developed without such a deep commitment, and no other company I can think of could afford such a project or would be interested in doing it this way (the Lisa project reportedly cost over $50 million and used more than 200 person-years of effort!). In terms of the actual, as opposed to symbolic, effect it will have on both the microcomputer and the larger-computer market, the Lisa system is the most important development in computers in the last five years, easily outplacing IBM's introduction of the Personal Computer in August, 1981.

As this went to press, Apple announced that the Lisa will be sold in one configuration only: the computer with 1 megabyte of RAM, two floppy-disk drives, the Profile hard disk, the six application programs (Lisa Draw, Lisa Write, Lisa Project, Lisa Calc, Lisa List, and Lisa Graph), and Lisa Test diagnostic program; the price of this package is $9995; it will be available in the U.S. this spring, and modified foreign-language versions will be available this summer.

Fortunately for us, the history of computing does not stop with the Lisa. Technology, while expensive to create, is much cheaper to distribute. Apple knows this machine is expensive and is also not unaware that most people would be incredibly interested in a similar but less expensive machine. We'll see what happens.■

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Build a Handheld LCD Terminal

A single-line display is quite adequate for many troubleshooting and monitoring applications.

Steve Ciarcia
POB 582
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The Circuit Cellar was a lonely place after the tumult of finishing up the complicated and seemingly endless MPX-16 project, which had occupied almost my every waking moment for months. I was dreading a call from my editor at BYTE, who was sure to ask what my next project would be. For once, I was stuck without an idea.

As the wind whistled outside, I decided to check how hard it was blowing. I turned on the radio, expecting to hear a synthesized computer voice describing the current weather conditions, but got only static. I groaned as I realized that something must be wrong with my automatic talking weather station.

The talking weather station was my project exactly a year ago (see reference 1). It combined a single-board Zilog-Z8-based computer with various weather instruments and a speech synthesizer in a machine that could transmit weather information in the form of English speech using a low-power FM radio transmitter. It worked flawlessly through its first New England winter, chattering ceaselessly for many months. I've used it to collect reams of data concerning average wind speeds and temperatures on my little hill here in the wilds of Connecticut.

The computerized weather station is only about 50 feet from the Circuit Cellar, but it might as well have been 10 miles. I didn't know if the problem was in the transmitter, the weather instruments, or the computer. To troubleshoot it, I had to drag about half of my test equipment out under the station's lofty perch, find plugs for everything, and balance a Televideo 925 video terminal on the fender of my truck.

But matters turned out to be not so bad as I had feared. Once the equipment was set up, I had little trouble; it took only a single line of output displayed on the terminal to diagnose the problem, which was easily remedied. And as I carried the equipment back to its home, I realized that I had an article idea.

Analyzing the Problem

Not all computer troubles are so simple that they can be diagnosed by one line of display, but many are. I had found it necessary to drag out an AC-powered 24-line by 80-column terminal to observe just the one line. But wouldn't it have been nice to have a portable one-line terminal for such simple situations? I could have saved the heavy stuff for applications requiring a more complex display.

The Z8- (actually Z8671-) based brain of my weather station, if you will recall, is the Z8-BASIC Microcomputer (a device sometimes called the Z8-BASIC Computer/Controller or simply the Z8 board), presented in the July and August 1981 Circuit Cellar articles (see reference 3). Since that time, many of you have built Z8 boards (mostly by using the kit available from The Micromint) and reported to me on how you are using them. The feedback I get is that many Z8-BASIC Microcomputers are being used in dedicated control or data-reduction applications in which a terminal is often not required, or if one is attached to the system, it only monitors the system's functions, perhaps displaying error codes or computed results.

A Portable Terminal

Why not small displays for small computers? For many years, experimenters had only 6-digit LED (light-emitting diode) hexadecimal displays. Is there nothing between this and a full 24 by 80 terminal?

This month I'd like to present a relatively simple project that might serve to fill the gap between little hexadecimal displays and full-function terminals. The Circuit Cellar Handheld LCD Terminal consists of a single-line 16-character liquid-crystal

Z8 is a trademark of Zilog Inc.

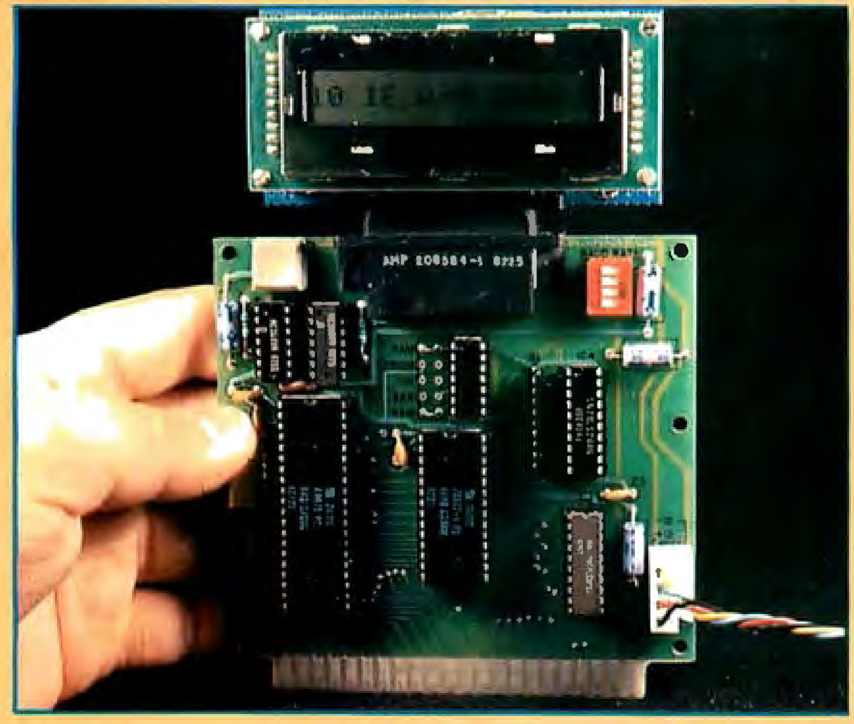

Photo 1: *The Circuit Cellar Handheld LCD Terminal installed on a Z8-BASIC Microcomputer system.*

display (LCD) with additional components added to form a full-duplex serially interfaced computer terminal suitable for attachment to any small control computer. The CY300 LCD-controller integrated circuit from Cybernetic Micro Systems encapsules the entire display circuitry in a single chip and requires only 15 mA (milliamps) at 5 V (volts). Two additional chips are required to convert TTL (transistor-transistor logic) voltage levels to RS-232C voltage levels.

The display can be configured for serial or parallel input, and by attaching a parallel ASCII (American National Standard Code for Information Interchange) keyboard, you can configure a complete terminal for the Z8-BASIC Microcomputer (or some other small computer). The unit (excluding the keyboard) measures 3½ by 1½ by 1½ inches.

I'd like to start by discussing the CY300's general features, and then we can look at a description of a terminal built using the CY300.

Cybernetic Micro Systems CY300

The CY300 Dot-Matrix LCD Controller is designed to provide an easy-to-use peripheral device that displays ASCII characters and allows cursor editing operations. The CY300 provides several modes of operation to provide various levels of display capability. Its pinout specifications are shown in figure 1a on page 56.

The CY300 is a TTL-compatible CMOS (complementary metal-oxide semiconductor) 40-pin device configured to control 16-character alphanumeric dot-matrix liquid-crystal displays that use the Toshiba T3891 LCD-driver chip, as shown in the block diagram of figure 1c on page 56. The CY300 accepts parallel and serial data inputs and can generate 64 different ASCII characters, as shown in figure 2 on page 57.

A blinking-block cursor normally indicates the position in the display where a character will next appear, but the cursor can be moved to highlight a particular character. The CY300 displays the characters it receives, storing them in a buffer until it gets a Return character. It then outputs the contents of the buffer on a serial channel. The CY300 is designed to drive a console display for small microcomputers, and as I have suggested, such a display can be used to replace a CRT (cathode-ray tube) terminal in many systems.

The CY300 contains the circuitry to perform several different functions. Two types of input interfaces are offered. The first is a parallel input port. You can connect a keyboard to this, which will enable you to enter commands or messages to the display and make typing corrections before sending the text out to the host computer. In simple display-only applications, the parallel input can be used to generate display messages.

The second interface is a serial data link, consisting of two lines, a serial input and a serial output. Generally, the host computer would be connected to these lines, with the serial output used to send short strings of characters (entered from the parallel keyboard input) to the computer, and the serial input used to receive messages or responses from the computer. The serial interface operates at 5-V logic levels only, so connection to an RS-232C port requires the use of external driver and receiver circuits to translate the voltage levels.

The CY300 also contains an internal 32-character line buffer for storing the messages shown on the display and control logic for generating the proper dot patterns for the displayed characters.

Parallel Input Operation

The CY300 can display data from either its parallel or serial input. The general scheme for parallel interfacing of the CY300 is shown in figure 3.

In parallel input, the circuitry sending the data simply places logic states representing the bits of an ASCII character on the 7 lines of the input bus, waits until the Ready line is high, and then lowers the $\overline{WR}$ (write) strobe line. As the $\overline{WR}$ strobe is held low, the Ready line goes low (indicating a busy state) and then returns to

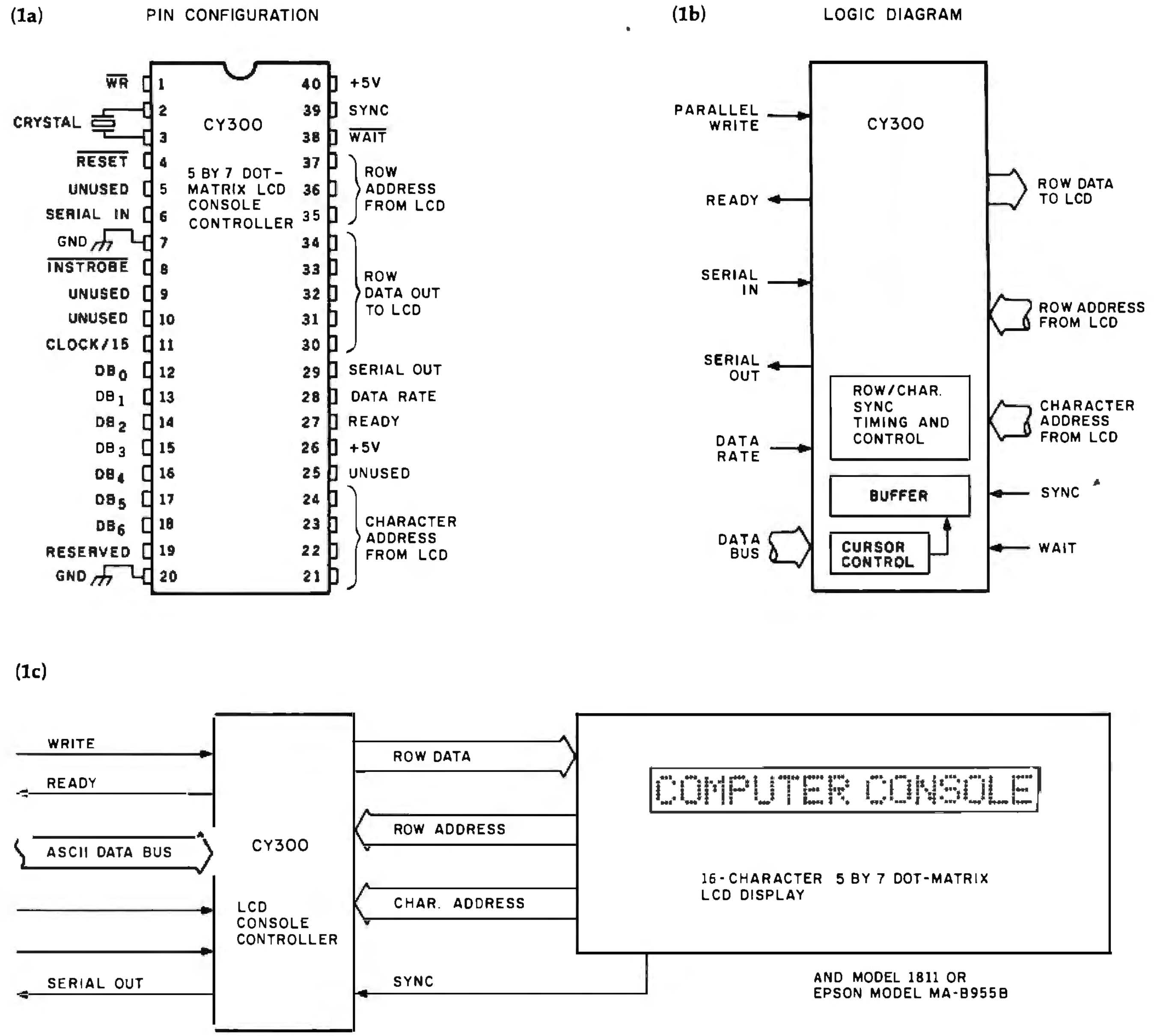

Figure 1: *Descriptive information on the Cybernetic Micro Systems CY300 LCD Console Controller. Figure 1a shows the pinout specification of the CY300, 1b is a functional logic diagram of the CY300, and 1c shows a block diagram of a display system using the CY300.*

the high state. When the Ready line is high again, the CY300 is prepared to receive the next character by repeating the process.

In manual-input mode, the blinking cursor indicates the location of the next character to be entered. A character can be erased by using the ASCII Rubout code (hexadecimal 7F), which causes the cursor to move left one space; an ASCII space (hexadecimal 20) is then written into the new cursor location.

The cursor can be moved left one position using the cursor-control character Control-A (hexadecimal 01) and can be moved right one position with Control-B (hexadecimal 02). These control characters do not delete any displayed characters but may place the cursor over a character already entered. The cursor always indicates the location where the next character entered will be displayed. Thus if the cursor is over a character that has already been entered, the next input character will overwrite the existing one, and the cursor will move one position to the right.

Serial Input Operation

The CY300 can accept data from a serial source as well; the setup is shown in the block diagram of figure 4. Unlike the parallel mode, in which the sending circuit waits for a Ready signal, the serial input mode is asynchronous. The normal RS-232C 8-data-bit format is used for both serial input

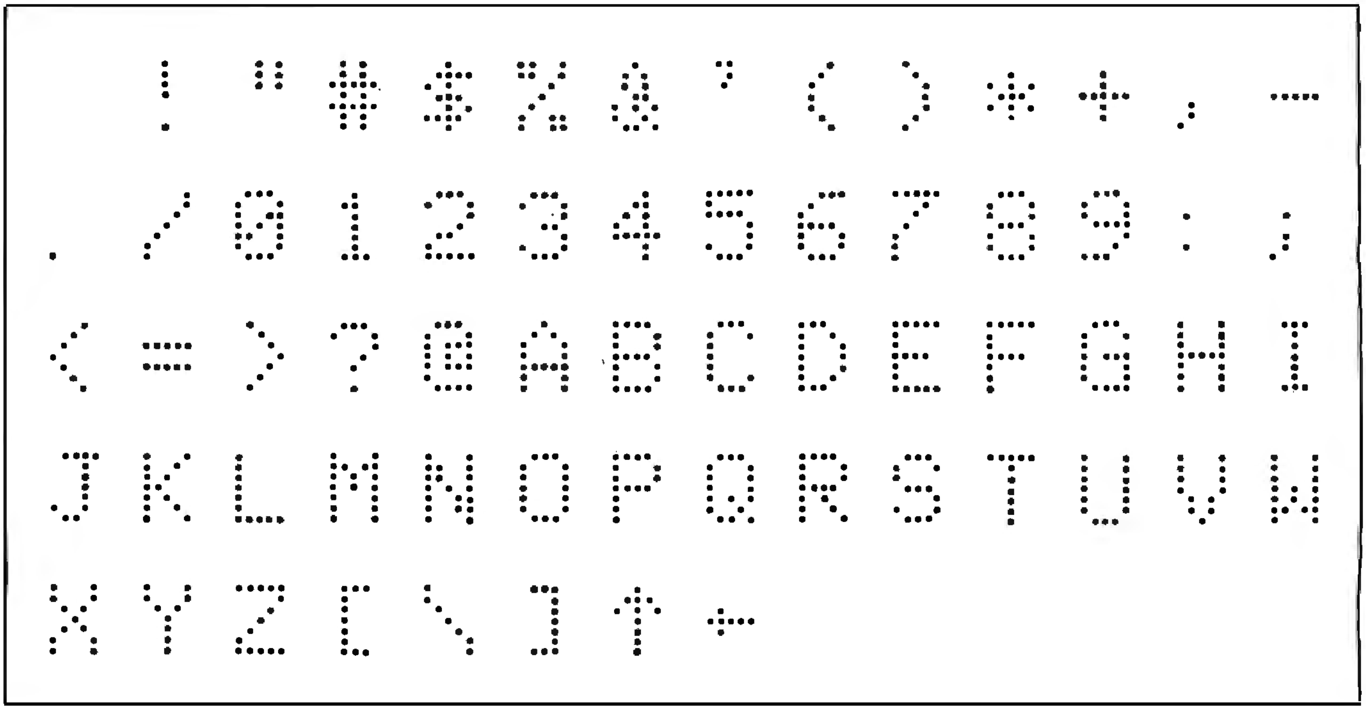

Figure 2: *Dot-matrix character set produced by a liquid-crystal display driven by the CY300.*

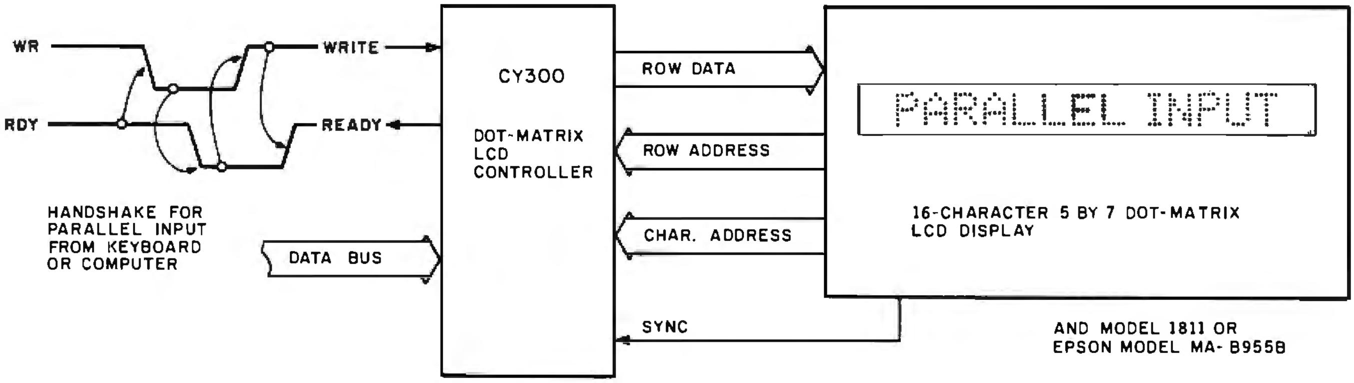

Figure 3: *Block diagram of a parallel interfacing and timing requirements for the CY300.*

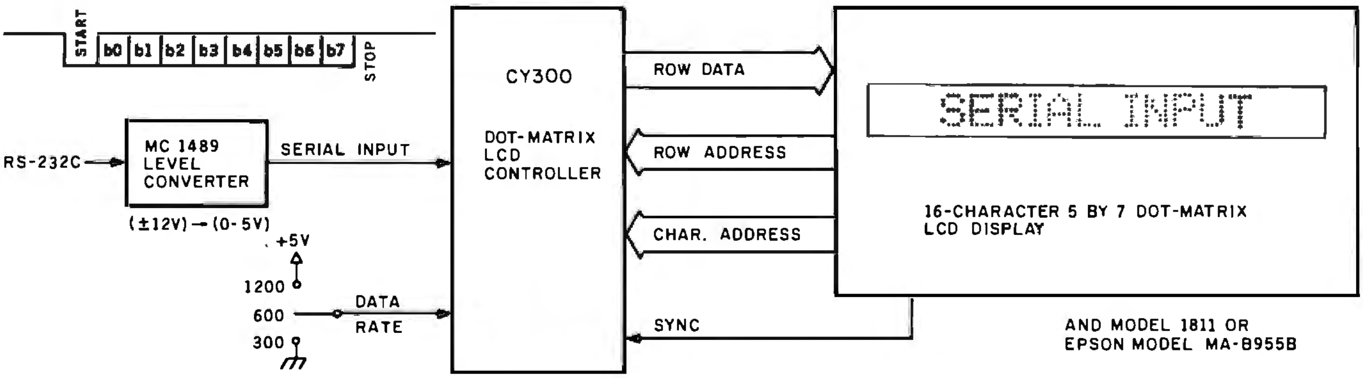

Figure 4: *Block diagram of a typical serial-input arrangement used by the CY300.*

and output: that is, a low-going start bit, followed by 8 data bits (least significant first, most significant last) and at least 1½ stop bits (1½ bit periods in the high state). After the stop bits have been sent, the CY300 is ready to receive the start bit for the next transmitted character.

The serial communication protocol of the CY300 is compatible with the RS-232C character format. However, the transistor-transistor logic of the CY300 operates between 0 and 5 volts (allowing the CY300 to be powered by a single +5-V supply), and RS-232C interfaces normally operate at ±12 V, so the serial input and output lines are typically routed through voltage-level translators if the CY300 is to be connected over any significant distance to an RS-232C port. However, in the case where the CY300 and host computer are physically adjacent, they can be connected directly together, operating at 5-V logic levels, without the translator circuits between them.

Other voltage protocols, such as RS-422A and RS-423A, also can be used for serial communication. These require different driving circuits, but the logical format of the characters is the same for all the common serial protocols, so we need only supply the appropriate driver and receiver circuits for the interface in use. For an RS-232C interface, the MC1488 driver chip and MC1489 receiver chip are the most popular. The CY300 serial output line would be connected to the 1488, while the 1489 would be connected to the serial input line.

The CY300 gives us a choice of three different data rates for the transmission of characters over the serial link. This choice is controlled by the Data-Rate-Select line, pin 28. If the line is connected to +5 V, 1200 bps (bits per second) is selected (the line should be connected directly to the power supply without a pull-up resistor; otherwise, the CY300 may choose the wrong rate). If the line is left unconnected to anything, 600 bps is selected. If the line is connected to ground, 300 bps is selected. These data-rate selections assume the use of a 6-MHz (megahertz) crystal.

Display Driver Interface

The 16-character display module I chose for this project is not just a bare LCD but includes its own controller/driver circuitry. The CY300 is specifically designed to work with 16-character LCDs driven by the Toshiba T3891 LCD-driver chip or its equivalent. Examples of such displays are the AND Model 1811 and the Epson MA-B955B.

Electronically, the 16-character 5- by 7-dot-matrix display appears to the interface circuitry as 16 sets of 7 rows (each row containing 5 data bits, 1 bit for each dot). The T3891 is designed to coordinate the reception of this row data with the information source and drive a dot-matrix LCD. Thirteen signals passing between the CY300 and the T3891 accomplish this. They are:

Sync: synchronizes dot pattern between T3891 and CY300

AD*x* lines: 4-bit character-position address from T3891

S*x* lines: 3-bit row-position address from T3891

D*x* lines: 5-bit row data from CY300 to T3891

The dot-pattern control logic is synchronized to the display's clock signal using the Sync line, which indicates when the display is ready for the next dot pattern. The CY300 uses the row- and character- (column) address information from the display to generate the proper dot pattern, based on its internal character generator and the contents of the line buffer.

When the T3891 begins its display sequence, it merely sets a character and row address of the specific display point. The CY300 examines its display buffer and simply outputs the 5 data bits that should go in that addressed location. Using the T3891 greatly simplifies the LCD interface.

Circuit Cellar Handheld Terminal

Figure 5 is a schematic diagram of the Circuit Cellar CY300-based terminal (shown in photo 2 on page 62).

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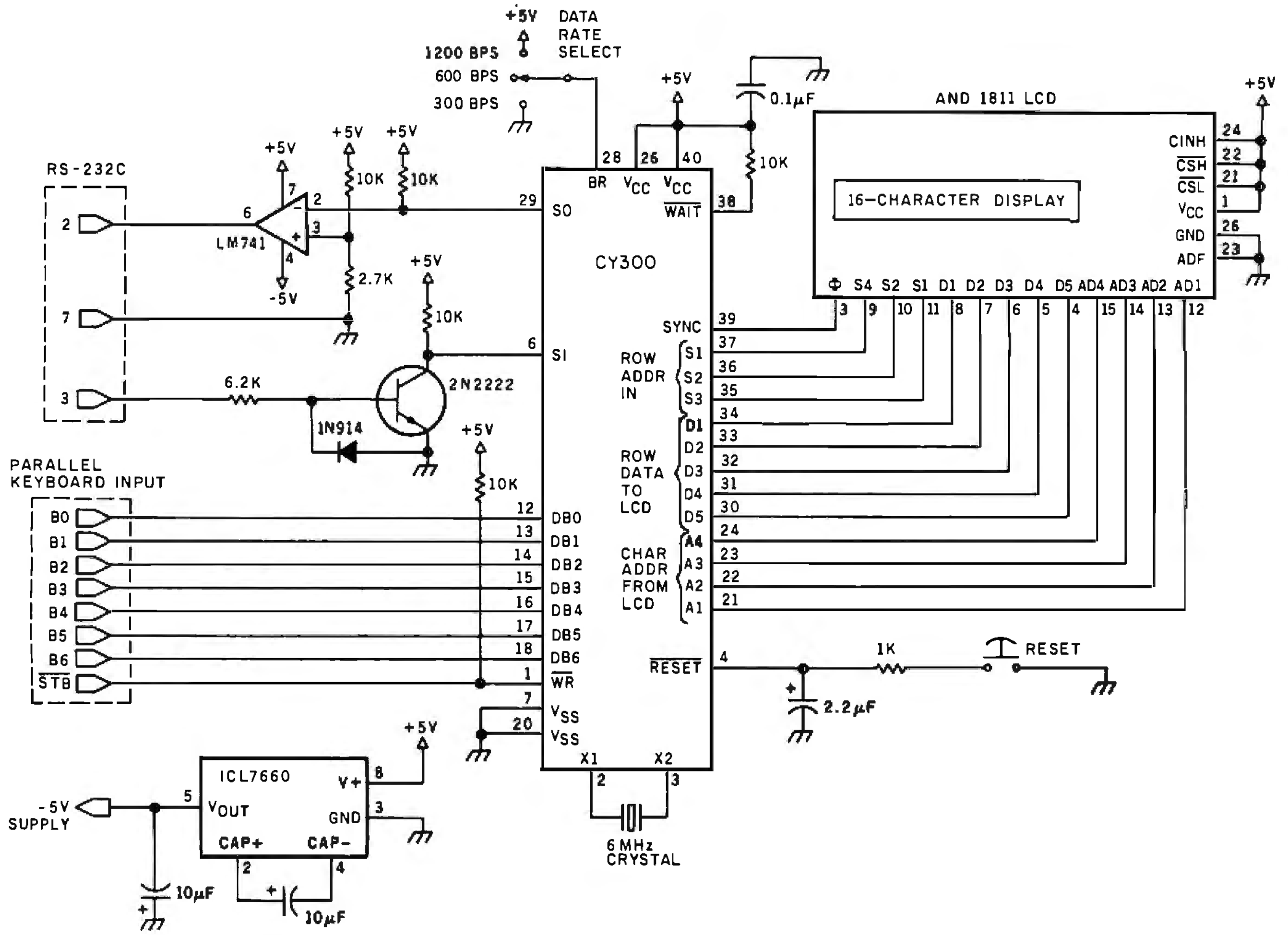

Figure 5: *Schematic diagram of a single-line LCD computer terminal built around the CY300 and the AND 1811 display module. This style of RS-232C driver circuit was designed to use minimal ±5-V power, so it's not guaranteed to work through a long cable to the host computer.*

With minor exceptions, it is configured much like the examples shown in the block diagrams presented earlier. It can function as a serially interfaced display or, if equipped with a parallel keyboard, as a full-duplex ASCII terminal.

In assembling my prototype, I used an AND 1811 display and mounted all the rest of the components behind it (as shown in photo 2b). This specific form of prototype construction was employed so that the finished display could be plugged directly into the RS-232C DB-25 connector on top of a Z8-BASIC Microcomputer.

Normally, when I am connecting a TTL-level device to an RS-232C port, I would install level-converters such as the MC1488 driver and MC1489 receiver in between. The dual-polarity (±12 V) power required for the driver could be derived from the Z8 board's power supply. However, the useful portability of the terminal would be suspect if it required you to either drag along an extension cord for AC power to a separate power supply or hook up three separate battery cells.

I pondered this impasse briefly and then decided to take advantage of a little-known part of the RS-232C signal specification.

RS-232C signals have two defined states: marking and spacing. The marking state extends from −3 V to −15 V, and the spacing state extends from +3 V to +15 V. The transition region between is undefined. (See Ian Witten's article "Welcome to the Standards Jungle" on page 146 for more information on RS-232C's idiosyncrasies.)

Note that the defined regions of marking and spacing fall within the 5-V range that TTL parts can generate. Especially for short cable lengths and at low data rates, RS-232C works just fine at these lower voltages. With that fact in mind, I designed this terminal to use as little power as possible, drawing that power from a single +5-V source.

So that it could receive full-voltage RS-232C levels, I used a transistor level-converter on the input line. For output, an operational amplifier (op amp) is configured as a "rail-to-rail" saturation switch, with a −5-V supply provided by an Intersil ICL7660 DC-to-DC-converter chip. This CMOS device converts +5 V to −5 V at currents up to 15 mA. Using this combination of components, the RS-232C output level is generally about ±4 V.

The major advantage of this ap-

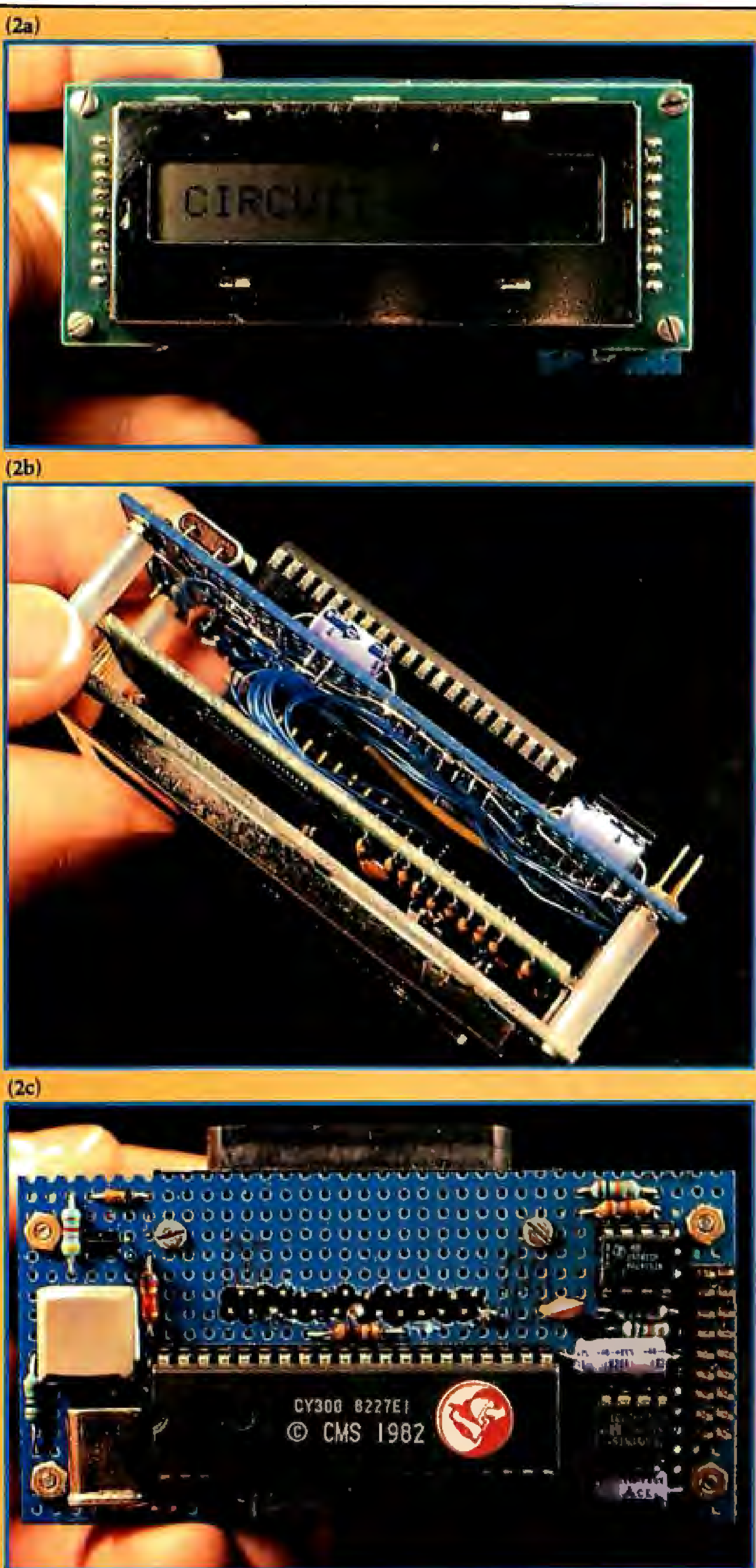

Photo 2: *Close-up views of the LCD-terminal prototypes: front (2a), side (2b), and rear (2c).*

proach is that it uses only a single voltage with very low power consumption. The terminal circuit requires less than 15 mA (excluding power for the keyboard). Given the power-supply voltage tolerances of the components and the communication line, the entire package could be powered by four 1.2-V nickel-cadmium (NiCd) AA cells (providing a total potential of 4.8 V) or five 1.5-V alkaline cells (6 V total) driving a type-7805 regulator.

Finally, while you might use this handheld terminal just for its display, a keyboard can be attached. The keyboard should present 7 bits of ASCII data in parallel, with the data-ready condition signaled by a negative-going (high-to-low transition) strobe.

There are two ways to correct typing errors: the first is to use the ASCII Rubout character; the second is to use the Control-A and Control-B characters, which move the cursor without modifying the display.

Terminal-Mode Operation

The Circuit Cellar Handheld LCD Terminal can replace a standard video terminal for simple BASIC-language programming on a computer such as the Z8-BASIC Microcomputer. Using the keyboard, you can type statements into the CY300; these are immediately displayed on the LCD. The CY300 provides cursor editing to correct mistakes before you type the Return character. When Return is typed, the contents of the CY300's buffer (the current display on the LCD) are sent to the computer over the serial channel. If a computer response is called for, the computer sends the response over the serial input channel to the CY300, which then displays the response characters on the LCD.

The normal operation of the Z8

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BASIC interpreter is as follows: upon power-up the interpreter sends a user-prompting character (a colon) to the console display to inform you that the system is ready for command entry.

You can enter a command or statement at any time by typing ASCII characters into the CY300. The first input from the keyboard (over the parallel channel) will clear the liquid-crystal-display buffer and appear left-justified.

The input line is terminated by a Return character. At the occurrence of the Return, the contents of the display buffer are transmitted to the computer over the serial channel, and then the display buffer is cleared.

Editing Operations

With the keyboard connected to the parallel interface on the CY300, you have the ability to correct typing mistakes before sending commands to the Z8 board (or other host computer). Note that you can no longer edit the command after the Return character is typed, but until then any corrections can be made.

There are two ways to correct typing errors. The first and probably more often employed way is to use the ASCII Rubout character. (On some keyboards this character may be produced by a key labeled "Delete".) When the Rubout character is typed, the CY300 cursor moves one space to the left and replaces the character at that space with a blank. The cursor remains at this new position until another character is entered, allowing you to back up the cursor, remove what has been typed, and reenter the corrected text. Multiple Rubouts will continue moving the cursor to the left, removing any characters that were in the display, until the leftmost position is reached.

The second way to correct typing mistakes uses the control characters that move the cursor without modifying the display. The Control-A character moves the cursor one character position to the left, while the Control-B character moves the cursor one character position to the right. The display is not modified as the cursor is moved. However, if you enter new characters after moving the cursor, the new characters appear at the current cursor position, overwriting any characters that were there previously. This method of correction allows you to save typing if only a single character need be changed near the beginning of a line. Before typing the Return character, though, you must put the cursor back at the end of the input line, because the CY300 transmits only the characters from the beginning of the display until the character just before the current position of the cursor.

In Conclusion

I don't expect you to junk your video-display terminals after reading this article. Obviously, you'll need a 24 by 80 (or similar size) screen for many purposes. But there are applications for which a portable, battery-operated single-line display is more suitable than a large, full-feature terminal. The sophistication of the CY300 represents a major advance in LCD technology, and I'm sure many of you have applications ready for just such a device.

Oh yes . . . about my weather station. After moving the mountain to Mohammed I was a bit displeased to find that someone had accidentally unplugged the power to the weather instruments. Of course, the problem was not hard to remedy. And if anything like it ever happens again, I'll be ready with my Handheld LCD Terminal.

Next Month:

A new integrated circuit from Texas Instruments makes it easy to build a reliable low-speed modem. ■

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.*

Ciarcia's Circuit Cellar, Volume I, *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II, *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III, *contains articles that were published from July 1980 through December 1981.*

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

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3. Ciarcia, Steve. "Build a Z8-Based Control Computer with BASIC." Part 1, July 1981 BYTE, page 38. Part 2, August 1981 BYTE, page 50.
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6. Leibson, Steve. "The Input/Output Primer, Part 4: The BCD and Serial Interfaces." May 1982 BYTE, page 202.

The following items are available from:

Micro Projects Inc.
POB 420
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1. Cybernetic Micro Systems CY300 Dot-Matrix LCD Controller chip $65
2. Intersil ICL7660 DC-to-DC voltage converter chip $4

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Sources of liquid-crystal displays are:

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The manufacturer of the CY300 LCD-controller integrated circuit is:

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Circle 182 on inquiry card.

Apple's Enhanced Computer, the Apple IIe

It's like having an Apple II with all the extras built in.

Robin Moore
Warner Hill Rd. RFD #5
Derry, NH 03038

It all began in the summer of 1977 at the West Coast Computer Faire. A fledgling computer company with an unusual name—Apple Computer—introduced a new hobby computer called the Apple II. The new Apple II was an impressive machine. It had BASIC in ROM (read-only memory), a built-in Teletype-style keyboard, high-resolution color graphics, and, once the new 16K-bit semiconductor memory devices became available, its memory could be expanded all the way up to 48K bytes. One of the first true home computers, it was completely self-contained, needing only a TV set for a display and a common cassette recorder for data storage.

Today, almost everyone is familiar with the Apple II. It can be found in homes, schools, laboratories, and businesses, and is being used in a wide variety of ways. During the past five years, an entire subindustry has sprung up around it that has, in turn, stimulated further Apple II sales.

It had been obvious for a while at Apple Computer that a replacement for the Apple II was needed. The Teletype-style keyboard, uppercase only 40-column display, and the maximum of 64K bytes of memory were becoming limitations as the marketplace changed and software became more sophisticated. The design was getting old and technology had changed enough to allow a redesign with significantly fewer parts. A new design could also address foreign requirements for special keyboards, displays, and video signals better than the Apple II. Although the Apple II was a tremendous success, it was clearly time to design a successor.

Enter the Apple IIe

For about the same price as the Apple II, the Apple IIe (e for enhanced) provides a variety of exciting new features and capabilities. Rather than start from scratch and design an entirely new machine, Apple Computer Inc. chose to make a very careful series of enhancements and improvements while keeping the flavor and style of the Apple II. Although completely redesigned internally, the Apple IIe is clearly a member of the Apple II family.

Even though it looks almost the same as the Apple II, the Apple IIe (see photo 1) gives you a great deal more for your money. The base-priced machine includes 64K bytes of memory (expandable to 128K bytes), Applesoft BASIC in ROM, a 63-key keyboard that produces both uppercase and lowercase characters and has special-function keys, seven expansion slots for I/O (input/output) devices, and a video interface that can display 24 lines in a 40-column-wide format with both uppercase and lowercase characters (this can be easily and inexpensively expanded to 80 columns). In addition to the standard Apple II I/O expansion slots, the main circuit board also holds a special auxiliary connector that is used primarily for various video- and memory-expansion options. Along with Applesoft BASIC, the internal 16K bytes of ROM hold an improved monitor, built-in self-test routines, extended memory-management routines, and an 80-column firmware package with extended editing features that can be used with the 40-column display.

The quality of the product is highly

Design Credits

Although it is impossible to give credit to all the people involved, three people deserve special mention. Peter Quinn, the POS Hardware Section Manager, was responsible for the team that designed the Apple IIe. Walt Broedner designed the Apple IIe hardware, including its two custom integrated circuits. Rick Auricchio is Broedner's software counterpart—he modified the original Apple II Plus firmware and added all the new code that is in the Apple IIe firmware.

About the Author

Rob Moore is a design engineering manager who also maintains a strong interest in FORTH, graphics, and computer music.

Photo 1: *An Apple IIe system made up of the Apple Monitor III, the Apple IIe computer, and a Disk II 5¼-inch floppy-disk drive.*

Photo 2: *The rear panel of the Apple IIe. Instead of the plastic slots found in the Apple II, the Apple IIe's metal back panel is designed to mount 9-pin, 19-pin, and 25-pin D-type connectors in precut recesses, providing more reliable connections and reduced RF interference. The built-in game-paddle connector has also been changed to a 9-pin D-type; however, the older-style connector is still available inside the case to accommodate existing devices.*

evident. The case is rugged structural foam, the keyboard has a nice touch and dished keytops, and the back panel (see photo 2) has an array of openings that fit the 9-pin, 19-pin, and 25-pin D-type connectors commonly used for serial I/O devices. It appears obvious that the Apple IIe was designed from the ground up to meet the new FCC (Federal Communications Commission) RFI (radio-frequency interference) regulations. The computer has a metal bottom pan, a metal back panel (rather than plastic as in the present model), and the removable cover is shielded with conductive paint and grounded with metal gaskets at the front and back edges. Some other nice touches include: the "D" and "K" keys (the ones that the middle fingers of a touch-typist's hands fall on) have small bumps on their surfaces; the connector openings on the back panel come with plastic caps to cover them if connectors aren't installed; the top cover has tabs in the rear to help lift it open, and screw holes to help keep it shut when desired (schools should like this feature).

The Keyboard

The keyboard is the most obvious difference between the Apple II and the Apple IIe. It is essentially an enhanced version of the Apple III's keyboard without the numeric pad; the keyboard on the Apple IIe (see photo 3) has 63 keys, while the Apple II has 53, and the layout is slightly different. Although the changes seem minor, they make the new keyboard significantly easier to use, especially in word-processing or screen-editing applications.

One of the most significant changes is indicated only by the Caps Lock key. The Apple IIe keyboard provides full uppercase and lowercase operation. When Caps Lock is latched down, however, it operates much like the original Apple II keyboard and produces only uppercase characters. If the two solder pads on the main board labeled X6 are connected, programs can check to see if the Shift keys are pressed by reading the PB2 input in the game-paddle port. (This supports a common Apple II modification and many existing word-processing programs.)

To correct a limitation of the old Apple II keyboard, the new keyboard can produce all 128 ASCII (American National Standard Code for Information Interchange) character codes. This was accomplished in the Apple IIe by adding some new character keys, along with Tab and Delete keys, to improve its word-processing capability. (The added keys, with different keycaps, will be used in European versions to provide an ISO [International Organization for Standardization] standard keyboard layout.)

Two interesting additions are the Open-Apple and Solid-Apple keys, which are positioned one on each side of the space bar. If you press Control, Open-Apple, and Reset simultaneously, the Apple IIe will write some arbitrary data into each page of memory and then simulate a power-up cold start. This eliminates the need to turn the Apple off and then on again to exit a protected program (a definite annoyance), but prevents people from making unauthorized copies of protected software.

Pressing Reset while holding Control and Solid-Apple invokes the built-in self-test software, which responds with "KERNEL OK" if the memory and circuitry pass the tests. Open-Apple and Solid-Apple may also be read individually and used as special-purpose keys by various programs—they are internally connected to the game-paddle port inputs PB0 and PB1. Other improvements include a full set of cursor-control keys positioned to the right of the space bar, auto-repeat on all keys after a 0.9-second delay, and a relocated Reset key. (The Reset key is placed apart from the main keyboard to keep it from being pressed accidentally. In addition, the Control key must be pressed simultaneously with the Reset key to have an effect; this behavior, standard on the Apple IIe, was an option on later models of the Apple II Plus.)

Internally, the keyboard is completely different from that on the Apple II. The Apple IIe keyboard is a simple array of switches—the keyboard-scanning circuitry has been moved to the main printed-circuit board, which also holds a special numeric pad connector. A ROM on the main board maps the keyboard-switch closures into the appropriate ASCII codes and can be changed to provide foreign or special keyboards. (Incidentally, the American version of the ROM is only half used. The other half holds a Dvorak keyboard map that can be accessed with a few jumpers and etch cuts.) For programmers, the keyboard provides an additional "Any key down" flag; it can be read by examining location C010 hexadecimal. This will allow pro-

At a Glance

Product
The Apple IIe computer

Manufacturer
Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

Components
System Unit

Size:	width 15.2 inches (38.6 cm); depth 18 inches (45.7 cm); height 4.5 inches (11.4 cm)
Power Required:	107 to 132 VAC, 60 Hz, 60-80 watts maximum
Processor:	1-MHz 6502 8-bit microprocessor
Memory:	64K bytes of memory; 16K bytes of monitor in ROM (includes self-test, Applesoft BASIC, and 80-column routines)
Standard:	keyboard for text and data entry; internal and external video connectors; 1-bit programmable audible speaker; audio cassette recorder input and output connectors; seven I/O expansion slots to hold peripheral devices and interfaces; external game control connector with four analog inputs and three TTL or switch inputs (similar internal connector includes three TTL-level outputs)
Video Display:	Two Uppercase/lowercase Text Modes •24v by 40h standard •24v by 80h optional •character set stored in ROM Two Standard Graphics Modes •40h by 48v sixteen-color graphics (40 by 40 with four text lines) •280h by 192v bit-mapped array with half-dot-shift logic (280 by 160 with four text lines)—with appropriate software this can provide: 560 by 192 monochrome graphics with some limitations 280 by 192 monochrome graphics 140 by 192 six-color graphics with some limitations 140 by 192 four-color graphics
Video Outputs:	Both outputs provide NTSC-compatible video, negative sync, 2-V peak-to-peak
Keyboard:	63 keys for text and data entry; N-key rollover; auto-repeat on all keys (15 Hz) after 0.9 seconds; four cursor-control keys; Caps Lock; two special-function keys; keyboard allows input of all 128 ASCII characters
Disk Drives:	System supports up to six 140K-byte 5¼-inch floppy-disk drives; data is stored using Apple Computer's 6/8 GCR (group-coded-recording) encoding

Operating System
Apple's DOS 3.3 single-user, single-task, program-driven operating system provides multiple file types, random-access and sequential text files, random disk allocation, individual file protection, and slot-based I/O

Options
Standard options include 80-column text card; extended 80-column text card with 64K bytes of additional bank-switched memory; Apple Disk II floppy-disk drives and controllers

Available Software
Includes almost all existing Apple II software. New software includes Applewriter IIe word processor ($195) and Quickfile IIe database system ($100)

Hardware Prices

Apple IIe main unit	$1395
Apple IIe system with main unit, Disk II and controller, Monitor III, monitor stand, and 80-column text card	$1995
Apple Monitor III (green screen)	$249
Apple Disk II (with controller/without controller)	($545/$395)
80-Column Cards (standard/Extended card with 64 K memory)	($125/$295)

Optional Documentation

Apple IIe Owner's Manual	$20*
Applesoft Reference Manual (two volumes)	$30
Applesoft Tutorial	$25
Applesoft package (both books plus disk of software)	$50
BASIC Programming Manual (Integer BASIC)	$7
The DOS Manual (DOS 3.3)	$10* **
DOS Programmer's Manual (available March, 1983)	n/a
DOS User's Manual with Tutorial (March, 1983)	n/a
Apple IIe Reference Manual	$30
Apple IIe 80-Column Text Card Manual	$20*
Apple IIe Extended 80-Column Text Card Supplement	$15*

* included with associated Apple product, available optionally
** one-page errata sheet available free from dealers

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Photo 3: *The Apple IIe keyboard. With uppercase and lowercase characters, N-key rollover, auto-repeat on all keys, and special-function keys, it provides a mix of functions found on both typewriter-style and computer keyboards. Unfortunately, the left-arrow key is inconveniently placed for its use as a backspace key while using BASIC. The special Open-Apple and Solid-Apple keys are used to invoke the self-test routines, simulate a power-up cold start, and may be read as paddle push buttons 0 and 1.*

Photo 4: *The Apple IIe video display. Photo 4a is an example of the 40-column text display showing both uppercase and lowercase characters available. Photo 4b shows the Apple IIe 80-column display. The plus sign within the cursor shows that you are in Escape mode, which provides expanded editing and cursor-control functions.*

grams to provide their own auto-repeat or special pause functions, overriding the auto-repeat built into the keyboard.

Text-Display Modes

The standard Apple IIe displays 24 rows of 40 characters (see photo 4a). It provides normal (white on black) and inverse-video (black on white) modes for all characters, and a flashing mode for the uppercase characters and special symbols. If you try to display a lowercase character in flashing mode, the display shows a flashing special character instead. Although this may seem strange, it emulates exactly what is displayed by Apple IIs that have been modified with added lowercase adapters, and is done this way for compatibility with those machines. The Apple IIe also provides an alternate character set where there are only two modes—normal and inverse—but the characters are always displayed correctly.

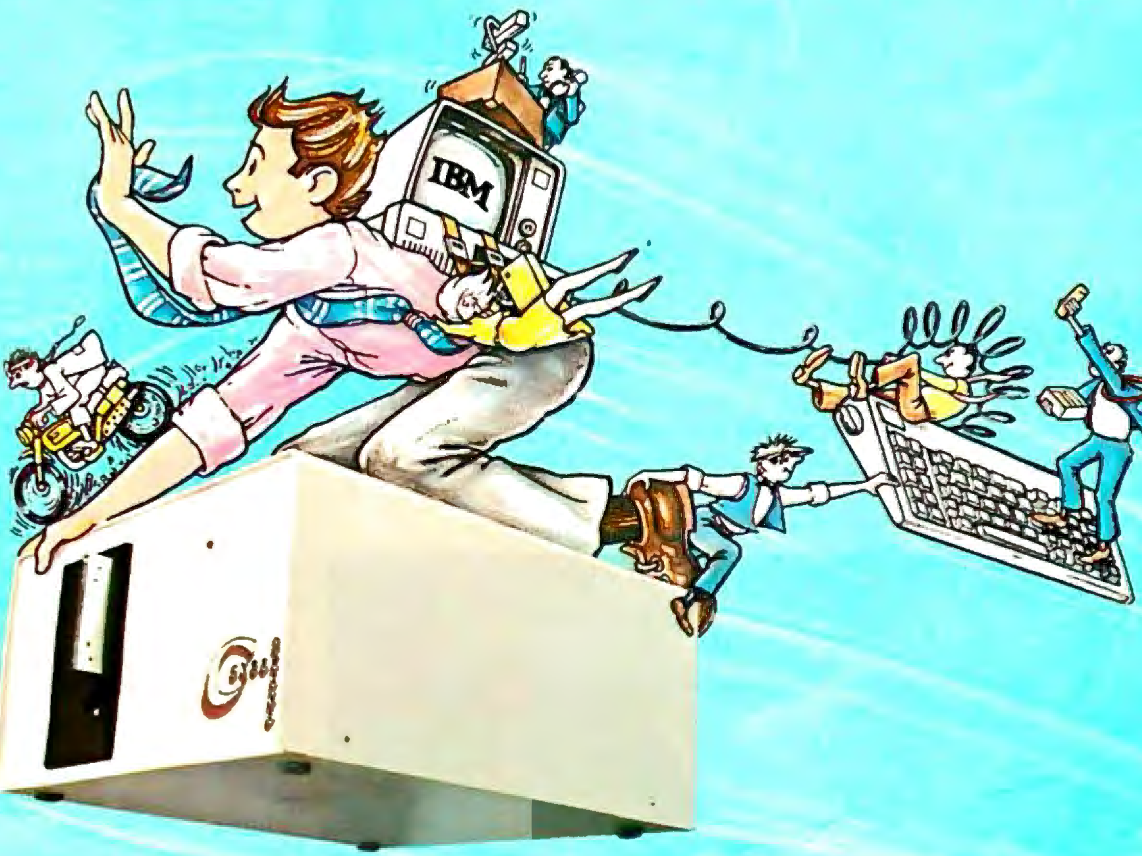
Although the ability to display both uppercase and lowercase characters is a definite improvement, I suspect that few users will stay with the 40-column display. The two 80-column options are just too useful—and too inexpensive—to be ignored.

The 80-Column Display Options

To accommodate users who need a display wider than 40 columns, the Apple IIe offers two 80-column option cards: the 80-column text card and the extended memory 80-column card, which includes 64K bytes of additional memory. Either of these cards can be plugged into the auxiliary connector, and they are both just memory cards. Photo 4b shows an example of the 80-column text display.

The actual 80-column display circuitry and firmware are already built into the Apple IIe. In fact, by setting the appropriate soft switches, you can see an 80-column display on any Apple IIe—every character in the normal 40-column display will be displayed twice. Both of the 80-column cards (see photo 5) provide the additional display memory required for 80-column operation; however, the 80-column text card is inexpensive

Performance Breakthrough...



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HUNTINGTON BEACH, CA 92647
714/848-1922

Photo 5: *The Apple IIe 80-column text card (bottom) and extended memory 80-column card (top). The 80-column text card provides an additional 1K-byte text/low-resolution graphics display page, while the extended memory 80-column card duplicates the entire Apple IIe 64K-byte address space.*

Photo 6: *Apple IIe graphics. See the text for a full explanation of the modes available.*

because it is simply a 1K-byte memory card.

The extra (separate) display memory is needed because the 80-column circuitry displays twice as many characters in the same period of time as the 40-column circuitry. This doubles the rate at which the display accesses memory; if the Apple's main memory was used, this wouldn't allow the processor any memory cycles. The designers found an ingenious solution to this dilemma. The Apple IIe's display always accesses memory at the 40-column rate, allowing the processor all the memory cycles needed. When in 80-column mode, however, the display circuitry reads both the main memory and auxiliary display memory simultaneously, saving the character that is read from the auxiliary memory and displaying it after the character read from the main memory. This allows the display to operate twice as fast but doesn't affect the operation of the processor.

One of the nicest things about the Apple IIe 80-column option is that it is compatible with all other Apple IIe display modes. In the old Apple II, people often used two monitors with 80-column cards—one for the 80-column display and one for 40-column text and graphics—because the available 80-column cards had separate video outputs for the 80-column text.

The 80-Column Firmware

The 80-column routines built into the Apple IIe ROMs provide a number of advanced cursor-control and editing features. One of the most interesting is the lowercase restrict mode. If you type a Control-R when the 80-column firmware is active, the keyboard input is restricted to uppercase only (just as if Caps Lock was pressed) unless you are between quotes. This mode is handy because Applesoft BASIC and DOS 3.3 won't accept lowercase commands—it locks you into uppercase except when typing in BASIC string constants (which can accept lowercase).

To maximize its compatibility with existing software, the Apple IIe 80-column firmware emulates an 80-column card installed in I/O slot 3 (the standard location). If one of the two 80-column option cards is installed, typing PR#3 will activate the internal 80-column routines and disable any firmware installed in slot 3. Once activated, the 80-column firmware and its extended editing features can be used in either 40-column or 80-column mode. In fact, by setting one of the soft switches, you can use the 80-column firmware even if you don't have the 80-column card installed.

To help you keep track of which display software is active, the Apple IIe displays three different types of cursors. A small checkerboard cursor indicates that the 80-column firmware is inactive. A larger block cursor is displayed when the firmware is on, and a + (plus sign) within the block indicates that the firmware is in "Escape mode" and is waiting for another keystroke, which will be interpreted as a cursor-movement command.

The 80-column software is also

compatible with other languages. If you have Apple's Pascal 1.1 or one of the Apple II CP/M systems, these both can load in 80-column mode and operate correctly without any additional patches or modifications.

Graphics

Like the Apple II, the Apple IIe offers two standard graphics modes. The low-resolution mode produces 16-color graphics, with either 40 by 48 pixels (picture elements) or 40 by 40 pixels and four lines of text. The standard high-resolution mode provides a 280 by 192 bit-mapped pixel array with half-dot-shift logic (see photo 6). Depending upon the software used, this mode can be used to provide limited 560 by 192 monochrome graphics, 280 by 192 monochrome graphics with no limitations, 140 by 192 six-color graphics with limitations, or 140 by 192 four-color graphics. (The vertical dimension is reduced to 160 pixels if you want four lines of text at the bottom.)

The 80-column options are the keys to the new Apple IIe graphics features. With the proper software, the Apple IIe can provide double-density graphics in both low-resolution and high-resolution modes. Either of the 80-column cards will support the double-density low-resolution graphics, but you will need the extended memory 80-column card if you want to use the double-density high-resolution mode, which can also provide 140 by 192 graphics with 16 colors! At the time this article was written (November 1982), no software was available to support these new graphics modes; however, it will undoubtedly be available soon, either from commercial vendors or user's groups.

The double-density graphics modes are provided by the 80-column display circuitry. Instead of simply displaying bytes sequentially from the main memory, it displays bytes alternately from the main memory and the auxiliary memory, at twice the normal rate. Although this capability was designed to provide an 80-column text display, the designers soon realized that it could also be used to provide additional graphics modes.

Use of the double-density graphics has three requirements. First, you need a Revision "B" main circuit board; this will probably be the only type shipped after the first month of production. Second, you must connect two pins on your 80-column card; this is explained in the *Apple IIe Reference Manual*. Third, you must turn on the AN3 output to the game-paddle connector; this can be used to switch between normal and double-density mode. (Unfortunately, the Apple IIe sent to BYTE for review had a Revision "A" main board. Thus, there is no photo of the new graphics modes included with this article.)

Inside the Box

The most significant differences between the Apple II and the Apple IIe are internal. The main printed-circuit board has been totally redesigned and incorporates many new features and options unavailable in the Apple II.

The power supply is unchanged, but there are now seven I/O expansion slots instead of the eight found in the Apple II. Part of the Apple IIe memory emulates a 16K-byte RAM (random-access read/write memory) card (commonly installed in Apple IIs), and the card's former location, I/O slot 0, is no longer present.

The most obvious change is a reduction in the number of ICs (integrated circuits). Where an Apple II with a keyboard enhancer, a 16K-byte memory card, and an 80-column card included about 120 ICs, the Apple IIe provides the same features with just 31 ICs. A large part of this reduction is due to the use of 64K-bit dynamic memories, rather than 16K-bit ones. The entire 64K-byte memory of the Apple IIe occupies just 8 ICs.

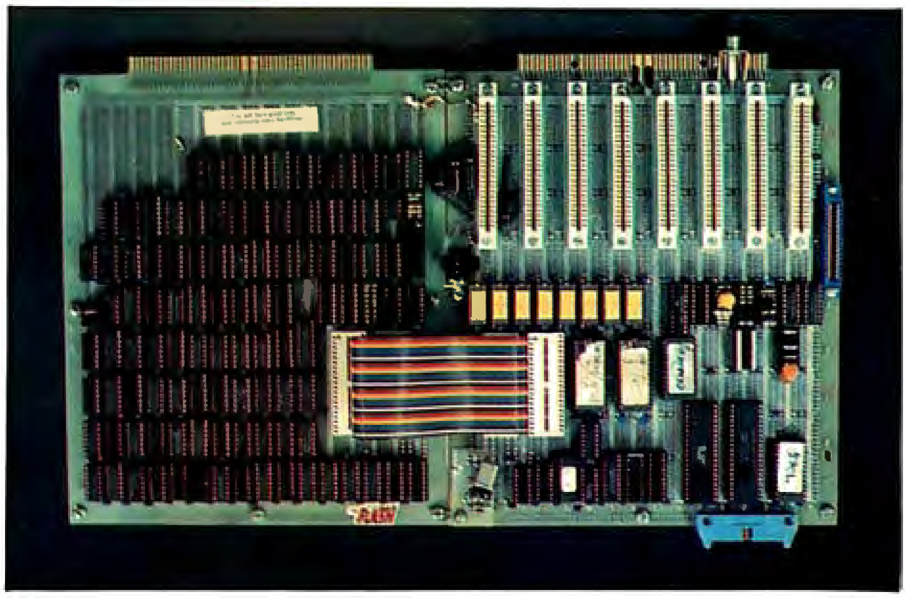


Photo 7: *The Apple IIe engineering prototype wire-wrap boards. The custom MOS IOU and MMU ICs are emulated with discrete logic on the board to the left, while the Apple IIe main board prototype is on the right.*

Another significant reduction in IC count is provided by two custom-designed MOS (metal-oxide semiconductor) ICs—the IOU (input/output unit) and MMU (memory-management unit)—that manage memory and I/O decoding and provide many of the new internal features. Photo 7 shows the engineering breadboard of the Apple IIe main board and a second board that emulates the IOU and MMU with standard 7400-series ICs, so that the designs could be completely tested before committing them to silicon. The IOU and MMU emulations required about 50 and 60 ICs

Photo 8: *The Apple IIe main circuit board. The 31 ICs on this board replace the 120 ICs found in a standard Apple II, including a memory card, 80-column card, and keyboard enhancer, as well as providing a number of new features not available in the Apple II.*

respectively. In the final board (shown in photo 8), these 110 ICs are replaced with just two components.

Working together, the IOU and MMU generate all memory-addressing and I/O-decoding signals. The MMU is primarily responsible for supporting the 6502 processor. It accepts addresses from the processor, does any necessary memory-bank switching, and converts the address to the multiplexed form required by the dynamic memories. The IOU provides similar functions for the video display. It also includes the video-timing logic, keyboard control, and other miscellaneous functions. To support foreign versions of the Apple IIe, the IOU includes video circuitry to provide both the American-standard NTSC (National Television System Committee) signals and European-standard PAL signals. The IOU ICs are customized during assembly by the manufacturer by connecting the internal bonding wires to the appropriate set of pads on the IC chip inside the package.

The Auxiliary Connector

Although I/O slot 0 is no longer present, a new "auxiliary connector" can be used in a variety of ways. In the factory, the auxiliary connector is used to connect special test equipment to the Apple IIe. With this equipment and the signals available at the auxiliary connector, problems can be localized to one or two ICs.

Once in the customer's hands, the auxiliary connector is used to hold various video and memory options. Its set of signals provides access to a number of areas in the Apple IIe and can, in fact, be used to totally disable the internal video-generation circuitry, so that an alternate video generator can be installed. Currently, the only options supplied by Apple Computer Inc. for the auxiliary slot are the two 80-column cards. However, other devices should soon be available from Apple and other manufacturers.

The Extended Memory 80-Column Card

Besides an 80-column display, the extended memory 80-column card provides an additional 64K bytes of memory. Rather than switching blocks of auxiliary memory into a fixed address range, the designers chose to replicate the entire 64K-byte addressing space on the auxiliary card and provide a series of soft switches that enable either the main memory or auxiliary memory in various address ranges. The documentation points out that "even though an Apple IIe with an extended memory 80-column card has a total of 128K bytes of programmable memory in it, it is not appropriate to call it a 128K-byte system. Rather, there are 64K bytes of auxiliary memory that can be swapped for main memory under program control."

To help programmers use the auxiliary memory, the Apple IIe 80-column firmware provides two special routines: AUXMOVE and XFER. Using these two routines, you can store and retrieve data in the auxiliary memory or transfer control to a program that resides there.

AUXMOVE is used to copy data from main memory to auxiliary memory or vice versa. You simply store the data's starting address, ending address, and destination address in memory locations; set or clear the processor's carry flag to indicate direction; and call AUXMOVE. XFER is used in a similar fashion in order to jump from programs in main memory to others in auxiliary memory (or vice versa). XFER may also be used to switch stacks and zero pages as you transfer from one section of memory to the other.

These two routines, and the auxiliary memory, open up some interesting possibilities. It appears to be possible, for example, to have an entire Pascal system residing in main memory, while a DOS 3.3/BASIC system is in auxiliary memory, and be able to transfer control between the two systems at will.

Soft Switches

To support the auxiliary memory and 80-column display software, the Apple IIe provides a number of new soft switches and adds a few new features to the old ones. (A soft switch, in an Apple II or Apple IIe, is a memory location that can be accessed to cause some hardware change to take place.)

Existing soft switches in the Apple II were used to select various video

(1a)

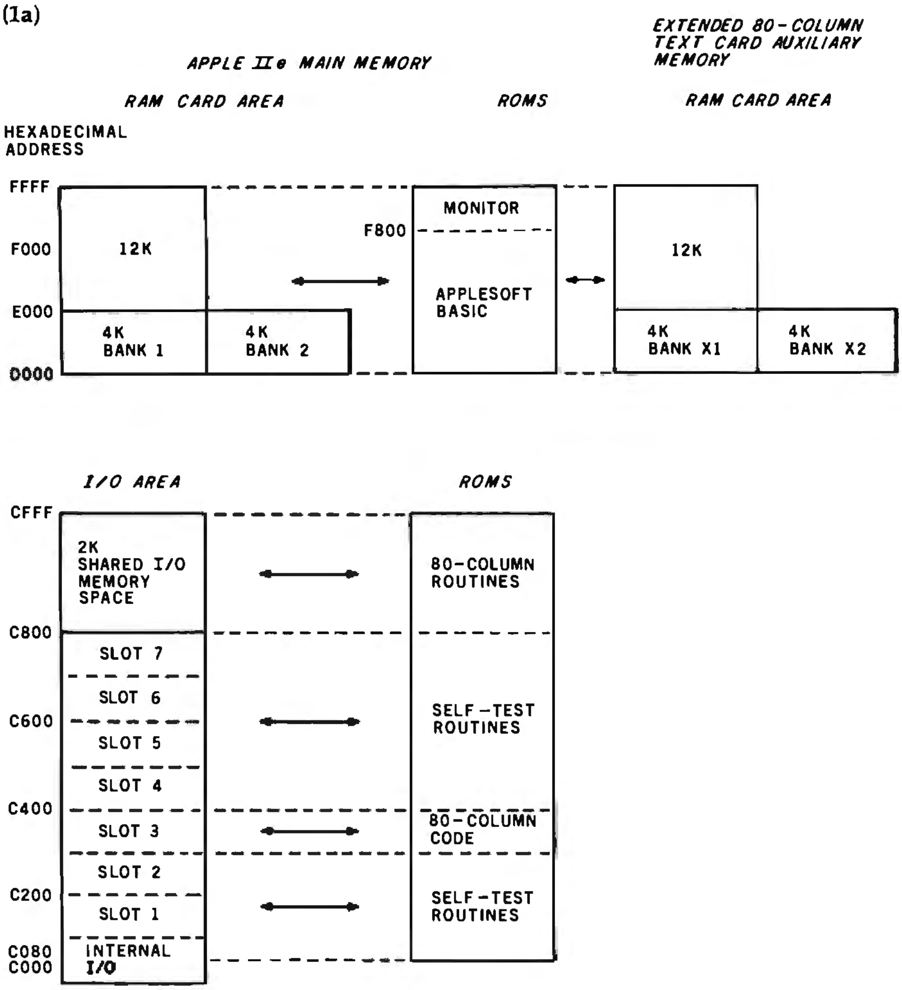


Figure 1: *Apple IIe memory maps. Within the Apple IIe's main memory, ROM can be switched to replace RAM in various address ranges. When the extended 80-column text card is used, it adds 64K bytes of switched memory. Areas of RAM and ROM that can be switched are indicated with arrows. In the 80-column text and double-wide graphics modes, the computer's main memory and the auxiliary memory on the card are accessed simultaneously to double the display density. Figure 1a (above) shows the language-card RAM and I/O areas, while figure 1b (on page 82) shows the main RAM and display areas of memory. The 80-column text card includes the alternate text page x1 only.*

modes and control the internal I/O devices (keyboard, game paddles, speaker port, and cassette port). If a 16K-byte memory card was added, it included additional switches to disable the card or to enable areas on the card as read-only or read-write memory. When using the switches, however, the programmer had to keep track of them. There was no way to read them back.

The Apple IIe makes many of the existing soft switches, and all the new ones, readable. Specifically, you can read back the states of the video-mode switches, the 16K-byte memory-card-area switches, and all the new auxiliary-memory switches by examining locations between hexadecimal C010 and C01F. To help provide better graphics animation, you can also read the "vertical blanking" from the video display, thus allowing you to change the contents of memory while it is not being used to create the video display.

The auxiliary memory is supported by several new switches that change the display from main to auxiliary memory, enable display areas in both memories at once for 80-column text or double-density graphics, and control reads and writes to the auxiliary memory. Other switches allow you to overlay portions of the I/O-slot memory space with the internal ROM 80-column firmware or self-test routines, and select either the standard or alternate display character sets. (Figures 1a and 1b provide memory-switching maps for the Apple IIe.)

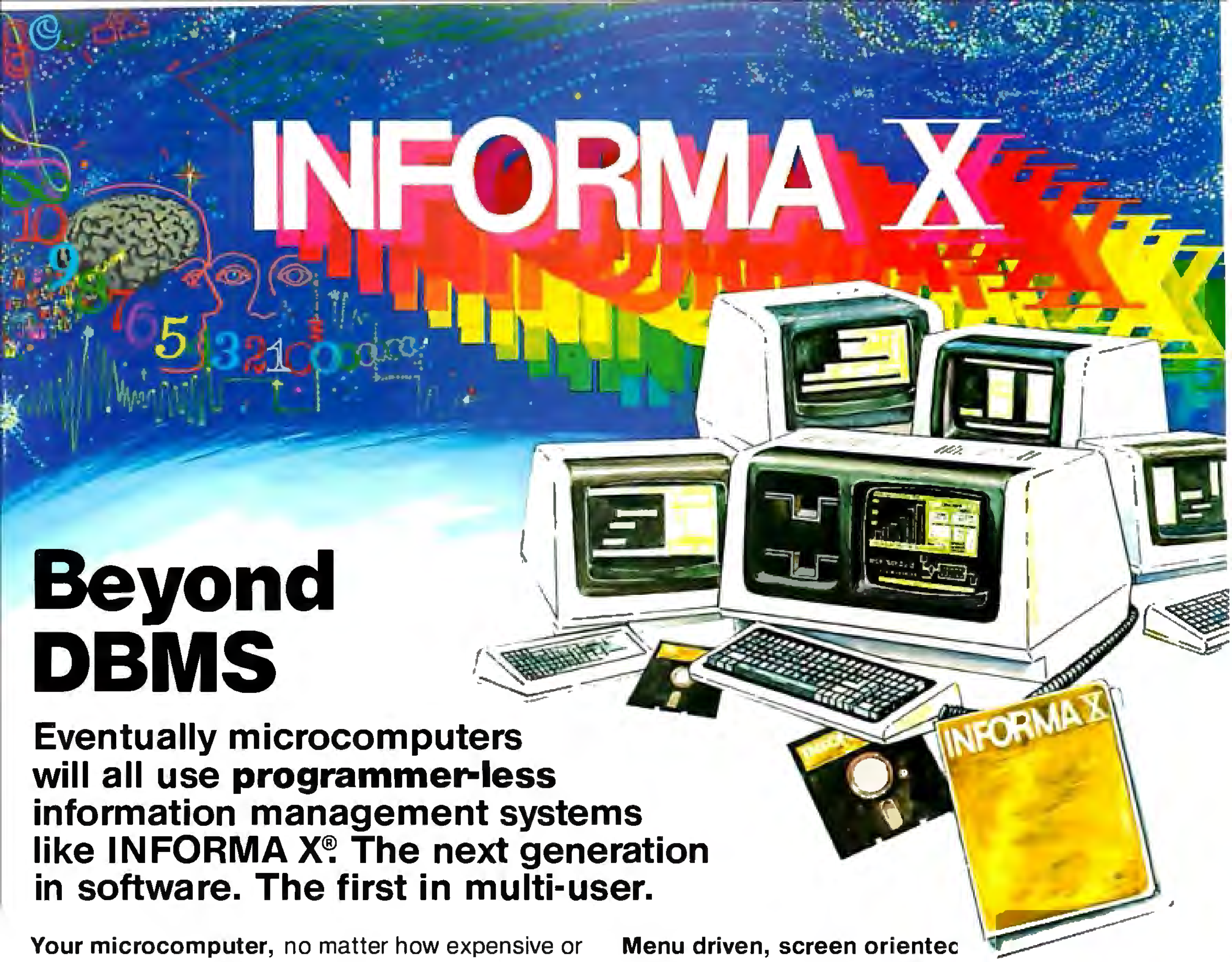
Apple II Compatibility

One of the major concerns during the design of the Apple IIe was its level of compatibility with the Apple II. Literally thousands of programs are written for the Apple II, and numerous hardware products are designed to plug into Apple II I/O slots. User surveys had shown that the volume of available software was a prime consideration among purchasers. It was therefore obvious that the new machine had to be compatible with virtually all existing Apple II hardware and software products, while still including the desired new features and design improvements.

The designers succeeded admirably. The Apple IIe is physically a complete redesign; logically, however, it is compatible with almost all existing Apple II software and hardware add-ons. This goal was not met simply—more than 150 software products and numerous peripheral devices were tested for compatibility during the Apple IIe development process.

Unfortunately, a few Apple II-based products from other manufacturers won't work properly in an Apple IIe—primarily because their designers did not follow Apple's interface guidelines. In general, accessory cards that occupy one of the I/O slots and do not connect directly to an IC socket will operate correctly. Others that connect directly to the main circuit board or to the keyboard will not be compatible without redesign.

Examples of cards that *will* work in an Apple IIe include 80-column cards, serial and parallel interfaces, graphics tablets, disk controllers, and memory cards that do not connect to an IC socket. To maximize compatibility, Apple II-style video- and game-paddle connectors are provided inside the case, even though the new-style connectors are now on the back panel. This allows existing video switches, joysticks, and game controls to be used with the Apple IIe (although they may cause excessive



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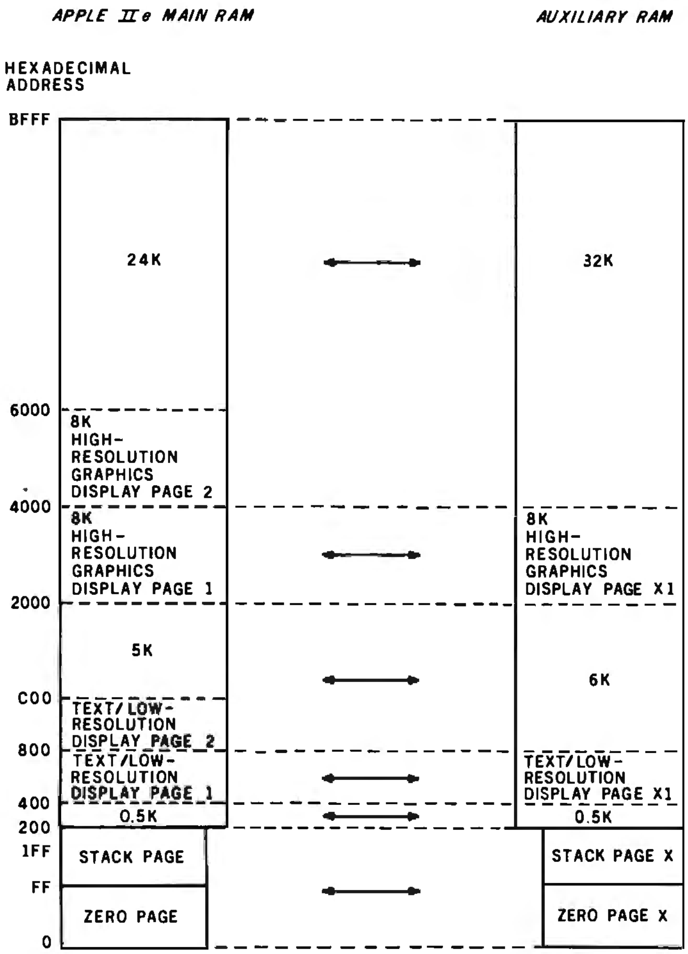

Figure 1: (continued)

RF interference).

Devices that won't work in an Apple IIe include keyboard enhancers, lowercase display adapters, numeric pads (existing designs), and memory cards that connect to an IC socket with a small flat cable. Fortunately, the capabilities of most of these devices are already included in the Apple IIe.

It is much harder to quantify which Apple II software products will or will not work in an Apple IIe. To support the new hardware features, certain changes had to be made to the ROM monitor routines, and these changes may affect programs that use the monitor. Approximately 40 standard entry points and routines in the monitor have been documented by Apple Computer, and all these have been left intact and operate correctly, even though the actual code may have changed somewhat. However, some programs use undocumented entry points and these may or may not run properly.

It seems safe to assume that all programs written in higher-level languages will work. Thus, software written in Integer or Applesoft BASIC, FORTRAN, PILOT, Logo, and Pascal should run correctly (providing that no strange monitor CALLs were made), along with CP/M programs that use the standard BIOS (basic input/output system) CALLs. Also, any software sold by Apple Computer will be compatible with the Apple IIe. In addition, a great deal of commercial software has been tested at Apple Computer, and your local dealer should know which products are compatible with the new machine. (If in doubt, you should ask the dealer to demonstrate the program on an Apple IIe before purchase.)

Software

As with most new computers, a great deal of software isn't available yet specifically for the Apple IIe, but the machine doesn't require it. Most of its new features can be applied to make existing Apple II software easier to use. At least initially, the Apple IIe will use the same DOS 3.3 disk operating system that is currently used in the Apple II, although it will probably be repackaged on a new master disk.

Apple Computer Inc. has done a great deal to make writing programs for the Apple IIe as easy as possible. The *Apple IIe Reference Manual* provides precise technical descriptions of every area of the machine, and the built-in memory-management routines will encourage programmers to take advantage of the extended memory option. Because the 80-column firmware acts like a conventional 80-column card in I/O slot 3, programs that use 80-column displays can easily be compatible with both the Apple IIe and the Apple II.

To help programmers identify the type of machine and which options are present, the *Apple IIe Extended 80-Column Text Card Supplement* to the reference manual provides an identification routine, with examples in assembly language, BASIC, and Pascal. To aid outside developers (Apple considers them extremely valuable), 120 Apple IIes were lent to various vendors during the eight months prior to the product introduction. This allowed a large number of software and hardware suppliers to prepare a variety of new products—eighteen programs from ten companies are scheduled for introduction coincidentally with the Apple IIe.

One interesting new program for the Apple IIe is simply called "Apple presents Apple IIe." Primarily a keyboard tutorial, it uses humorous text and excellent graphics to guide you in a friendly fashion through the features of the Apple IIe keyboard. The section that teaches the cursor keys includes two simple but well-designed maze games where you guide a rabbit or gnome through a maze with the cursor-control keys. These made an immediate hit with our 3-year-old, who within 15 minutes was guiding the rabbit through the maze and laughing at its antics when it hit the walls.

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Applewriter and Quickfile

Applewriter IIe and Quickfile IIe are Apple Computer's first two major software products that are designed to use all the new Apple IIe features. Both are enhanced versions of the same programs for the Apple III, and both are characterized by being extremely friendly to the user—they provide clear, simple prompts, multiple menus to select options, and numerous "help" screens to guide you through the program operations. Although at the time this article was written (with Applewriter) the documentation was preliminary, it appears to follow the format of the other Apple IIe manuals—clear and friendly.

Applewriter IIe is a document-oriented word processor with numerous editing and print-formatting features. It will run with or without the 80-column display and extended memory options, but will use them if they're present. One of the more interesting features of Applewriter IIe is called WPL (word-processing language). WPL allows you to compose and execute a series of Applewriter commands that are stored in a disk file. It provides looping, conditional execution, and subroutine calls, effectively allowing you to automate the production of form letters, invoices, or other repetitive tasks. WPL also provides a turnkey capability that can be used to automatically execute a WPL program after you load the Applewriter IIe disk.

To get familiar with Applewriter IIe, I used it to prepare this article. I was particularly impressed with the print-formatting capabilities. It was very easy to set up a standard manuscript page—double-spaced, one-inch margins, with headers and footers—and I could preview the actual appearance of the result by printing to the display rather than the printer. It did, however, take me a while to get used to some of the editing features. When you delete characters, words, or paragraphs, Applewriter deletes from right to left. This is fine if you are correcting a mistyped character immediately but seems a little awkward otherwise. On the whole, I liked Applewriter and recommend that you look it over if you are considering purchasing a word processor for your Apple IIe.

Quickfile IIe is an information-filing system (or database manager) that allows you to store and retrieve information, search and sort your files, and print reports in formats that you define. It also has math capability—you could set it up, for example, to file a list of checks and their amounts, and it could also balance your checkbook for you.

Quickfile IIe is also compatible with Applewriter IIe. Quickfile reports can be included in Applewriter documents, and Quickfile files can guide the production of Applewriter form letters. I didn't get a chance to spend much time with Quickfile, but it appears to be very well done, as is most of Apple's software.

Documentation

The new Apple IIe manuals are so good they must be seen to be believed. In a spiral-bound format, slightly larger than the Apple II manuals, they are extremely clear and readable—presenting their information in an easy step-by-step manner. It is obvious that Apple spared no effort or expense when designing them.

The *Apple IIe Owner's Manual* is an excellent example of the right way to introduce a beginner to a first computer. Using clearly written text and numerous color photos, it starts out by telling you how to unpack and set up the computer and then explains the various parts of the system in layman's terms. As you read through the manual, points of special interest and warnings are clearly noted and possible error messages are explained. Nine pages are devoted to the keyboard alone—they describe how to use each of the functions available and how they are commonly used in programs. Further chapters introduce you to the system hardware, the DOS 3.3 disk operating system, the display features, and various computer applications. Other chapters describe

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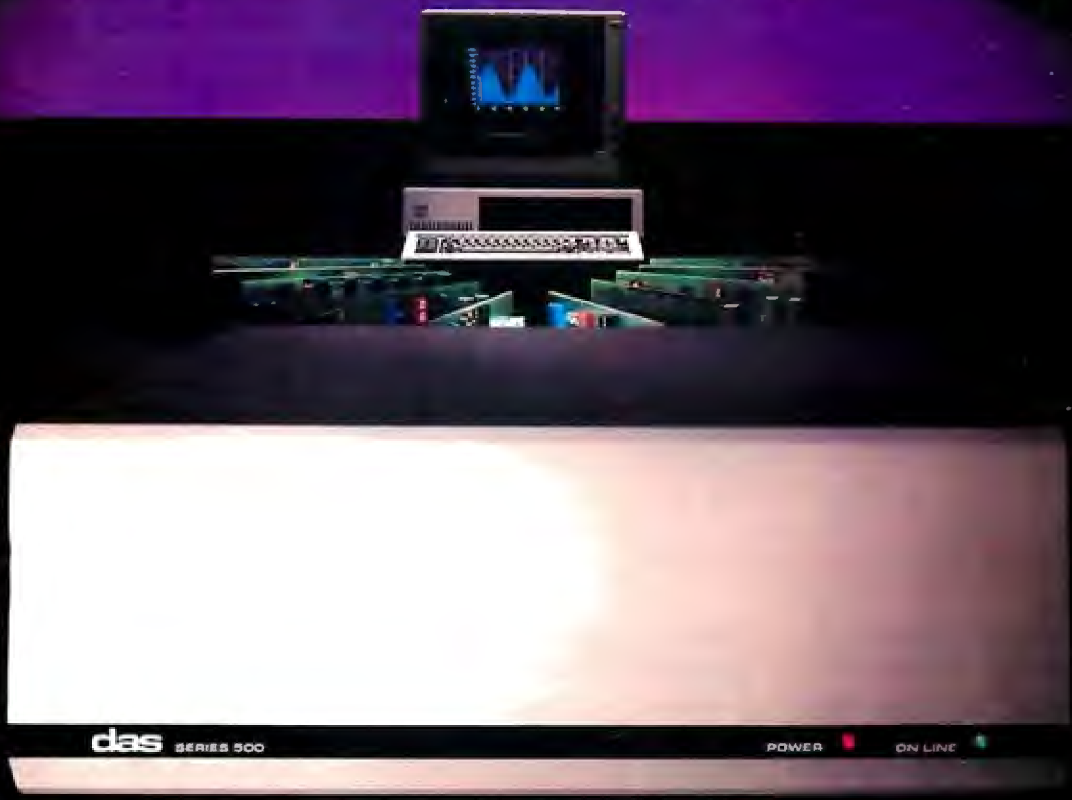

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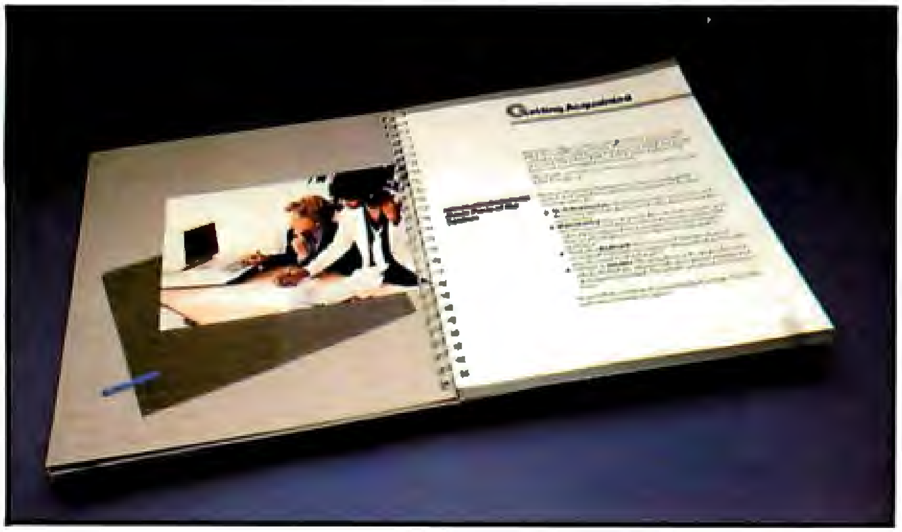

Photo 9: *A look at the* Apple IIe Owner's Manual. *The manuals provided with the Apple IIe set new standards of quality by being comprehensive, very friendly, and by containing numerous color photos to illustrate the text.*

the various computer languages, how to add components to your system, and what to do when you have problems.

This is clearly the first manual a new owner should read, and is also the only manual that is included with the Apple IIe. The new owner picks up the only manual in the box and it tells exactly what to do to get the system up and running. To avoid confusion, all other manuals are optional, and many manuals included with products are available separately. (The *Apple IIe Owner's Manual* is shown in photo 9.)

The *Apple IIe Reference Manual* is an optional manual worth noting. It provides a complete technical description of the machine, and its operation, in detail sufficient to satisfy almost anyone. It provides descriptions of the hardware and special features, instructions for using the monitor, timing diagrams and pinouts of the custom ICs and ROMs, and a complete set of schematics. No self-respecting programmer or experimenter should be without this manual. Apple also provides other manuals, including rewritten Applesoft and DOS manuals and reference manuals for the Apple IIe and the 80-column boards; see the "At a Glance" text box on page 70.

Conclusions

As you can probably tell, I was impressed with the Apple IIe. The people at Apple Computer had their act together when they designed this machine and it really shows.

I am disappointed that the 80-column cards are not as inexpensive as they were rumored to be; other vendors will probably design less expensive ones. However, with the new keyboard and 80-column display, the Apple IIe can handle just about any task.

The manuals with the system are superb. They are friendly, easy to read, and comprehensive, setting a new standard for the industry to meet.

Applewriter IIe and Quickfile IIe are well-written, useful programs that will find favor with people who wish to use their Apple IIe for word processing and information filing. With these two programs and a spreadsheet (like Visicalc), you could satisfy virtually all your computing needs.

I was most impressed with the balance struck between compatibility and new features, and the obvious care that went into the design. Congratulations, Apple Computer, you've produced another winner. ■

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An Interview with Wayne Rosing, Bruce Daniels, and Larry Tesler

A behind-the-scenes look at the development of Apple's Lisa.

Chris Morgan
Gregg Williams, Senior Editor
Phil Lemmons, West Coast Editor

Of the more than 90 members of the Apple engineering staff who participated in the Lisa project, Wayne Rosing, Bruce Daniels, and Larry Tesler are three of those who were most responsible for its final form. Rosing, formerly of the Digital Equipment Company, oversaw hardware development until Lisa went into pilot manufacture and then assumed responsibility for technical management of the entire Lisa project. Daniels and Tesler were responsible for Lisa's systems software and applications software, respectively. Chris Morgan, senior editor Gregg Williams, and West Coast editor Phil Lemmons interviewed the three at Apple's headquarters in Cupertino, California, last October.

BYTE: Tell us how you staffed the Lisa project.

Tesler: In software, we drew mostly experienced people from other companies and very few people straight out of school. Even the ones we took out of school generally had lots of job experience. In fact, one time I surveyed the applications group and found an average of nine years' work experience in software. When we looked at résumés, we tried to find people with several years of experience in development. We made exceptions if someone had specialized in something we were interested in or was a top student who also had good summer experience. We wanted an experienced team because what we've been doing is a very major software effort. It's very complex, and there's such a large body of software to crank out and make reliable that it takes experienced people.

BYTE: When did you do the hiring?

Tesler: The project went through phases. There was some design and some implementation when the project first started two and a half years ago, but we hired most of our software people about two years ago. In three months, we hired most of the software staff, and then they spent several months learning about the machine and designing their particular parts of the software. The bulk of the programming started about a year and a half ago.

We had to spend quite a long time just building a team—people who had a common view and could work together. We drew people from different companies with completely different backgrounds and tried to do something that nobody in this group had ever done. Some of us had done parts of it before. We were developing everything in parallel: the hardware, the operating system, the applications, the manuals, the details of the user interface. We did have a sort of fundamental philosophy, but having to do everything at once means you're never sure when you're going to get what you need from the person who does whatever you need next.

Daniels: I think communication is the key there. If you have that many things going in parallel, you spend a lot of time communicating so each of you knows what the other's doing and can depend on each other.

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Tesler: It took a while to work out those channels. It was rough at the beginning, but it's pretty easy now. Our progress was gradual. I think I'd call it team-building. Some of the things were hard to do in an organization that's thrown together like this. But once you've got a team built, it's a valuable asset. Of course, we were doing technical work all along, but in a sense we spent a year building the team and a year building the product. Now when we build something else, we can do it without the team-building step.

BYTE: What about project security?

Rosing: We tried to be as secure as we could without creating a discouraging atmosphere for people to work in. Within the group there has always been total information transfer, and we've kept lots of machines available. People have been able to take machines home with them. There was always the risk of losing a Lisa in a burglary, but we had a rule that the floppy disk had to be kept separate from the machine. We felt it was worth risking a theft to gain the increased productivity of people working at home. We've been very fortunate; we haven't lost one machine.

BYTE: How did you schedule the project?

Tesler: People made estimates, but it was difficult. All the estimates were conditional—"If the hardware is here by a certain date and the operating system is frozen and I have the user-interface definition and I can get some assistance from people who have the right sort of experience, then I can do it in this many months." But none of the ifs were ever really possible. People were really hesitant to make a firm date because there were so many contingencies. We did come up with schedules all the time, but they were myths.

Daniels: Getting Lisa to market has been a dream, a goal that we all have. Although we're willing to make compromises to get Lisa out expeditiously, the dream of what we're trying to achieve is the major thing.

Rosing: We had this dream of what we wanted to do, and I think over

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time we recognized that we couldn't achieve some of the goals. We'll have to take care of them later. We've taken the attitude that Lisa is going to be good and we're not going to sacrifice the integrity of the product for scheduling. We wanted to make a very balanced set of decisions, and so everything, as I say, just started to come together. The floppy disk works well, the mouse works well, the hardware works well, the software is beginning to come, and now we're cranking to get this first release out. But we won't let it be compromised because of scheduling.

Daniels: Part of the difficulty was that both the user interface and the internals—the architecture—of the software are revolutionary. Getting that architecture designed and built was a big scheduling problem. Once we'd done that, we'd built the foundation. Now building the applications is much smoother and has been much easier for us to predict.

Tesler: We didn't know if some of the things we started would work at all, like the way the dot-matrix printer is used and even the way the letter-quality printer is used to print the graphics.

Daniels: No one had ever done that before.

Tesler: Theoretically, it ought to be possible, but it had never been done, and the manufacturer of the printer didn't believe it could be done. It had to be possible in order for this product to do what we wanted, but no one could predict how long it was going to take. When we hired the printer people we told them to do it in two months. It took them a year and a half, but they did it. And then the high-density disk drives are new technology to Apple. A lot of the concepts in there had never been tried before. That was one of the biggest risks. And Apple not only built disk drives for the first time but built *revolutionary* disk drives.

BYTE: What makes them revolutionary?

Rosing: One of the major things we did was to vary the speed of the disk as you change the track position, so the drives keep constant area density, and that gives them a greater capacity. Second, we used microstepping algorithms on the stepper motor so that if a head gets off track because of changes in humidity and temperature, the intelligent controller can hunt and find the track. So we have much better interchangeability, with much higher density, and we're getting approximately 50 to 60 percent more data on that disk by good systems engineering. Some of the competitive units have a greater capacity, but we think the error rate ultimately suffers. We wouldn't tolerate a serious error-rate problem.

BYTE: How does the error rate compare with double-sided double-density disks?

Rosing: As for hard-error rates, we're talking about 10^{-12}, and that occurs after so many bits that it's hard to measure. But we're quite delighted that the measurements are impossible to take. Basically that means the errors are low.

BYTE: Did you work more than 40-hour weeks?

Tesler: Each engineer set his or her own schedule. Some engineers work something like Monday through Friday from nine to five. Others work all day at the office, then go home and work all night there. And what an individual engineer does may vary from time to time.

Daniels: These people have pride. They set their own milestones and they want to meet them, so they'll put in extra work to do that.

Tesler: We decided a long time ago that since the project would obviously go on for more than a few months—a couple of years—we couldn't have this constant pressure on everybody, because people would just crack.

BYTE: As individual designers, do you feel that your signature is on that machine?

Tesler: I think that's true of everybody in the group. Even people

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who have been with us for only a few months have something in the Lisa that they can look at and say, "That was my idea; that's my code." It's really a group effort. Even marketing got involved in the design effort in various ways, particularly in user-interface issues, product design, packaging, and the style of the manuals. The whole division really got involved.

BYTE: When did you decide to incorporate all the fundamental applications into the system software?

Daniels: At the very beginning. Some applications weren't decided until later, but the integration, the way it all fit together, was a goal from the very beginning.

Rosing: As a matter of fact, we cut out a few more things because we just didn't feel we could manage a project that large. Then we added a couple things back in as we became more comfortable with the development cycle. But we've basically been operating on the same goal for the past two years, with very little change of direction.

BYTE: What was the sequence in the early days? Did you decide what the project had to look like to the end user, and then what software was required, and then. . .

Daniels: Then hardware. In fact, we spent the first six months hammering out the user-interface docket. We had that completely specified before we really started the applications. I think the key to success here is to know where you're going before you start.

Tesler: The hardware, the operating system, and the applications were all developed somewhat in parallel, but there was a definite cause and effect. The people who designed the hardware had to make decisions, for example, about whether the disk drive should have a door that you flip open or a button to push, that kind of thing. The designers focused on that aspect of the user interface even before the rest of the user interface. They didn't want the user to be able to accidentally pull out a disk when it was being written on or something. So some decisions were made even before the hardware was designed. There have also been hardware revisions. The first Lisa hardware was here when I came, over two years ago. It's gone through several. . . how many revisions since then?

Rosing: About four. Each one's been an iteration. We discovered a few things in the early hardware that wouldn't work well. We just took them out because we couldn't do them properly. The rest has mostly been a matter of fine-tuning Lisa so that it's very manufacturable and very reliable.

Tesler: Each time they go through a cycle, the people working on user interface get another crack at it—"Since you're going to revise the hardware anyway, why don't you. . . ?" Or the people doing the operating system say, "The memory-management unit needs to be more general, and since you're redesigning the hardware anyway. . . " So we were able to get in some hardware revisions. Also, that keyboard you saw yesterday is not the final one. After user testing, and because of needing to support the European market, we determined that we really needed a couple more keys on the keyboard, so we made a major change in the keyboard layout.

Rosing: One of the things about this project that's different is that, more than any other I've been associated with, there's a continuous loop for dealing with user issues. We've gone to the software and that has implied a hardware change. We synthesized a lot of different disciplines. The power-off button used to be a traditional button on the back of the machine, but we didn't want to encourage users to turn off their machines that way because if they left a document open, they would lose it.

BYTE: Do you expect to find a little initial resistance to the fact that the machine doesn't actually turn off when you push a button? Do you think people are going to say, "Well, I know I can leave it alone now, but I want to make sure it turns off"?

Rosing: Right. It does feel a little funny at first, but after a few times you begin to have confidence that the thing does turn itself off.

BYTE: When you finally got the user-interface specified, did you have a brief description of it that everybody knew by heart?

Daniels: It was about a 35-page document.

BYTE: Thirty-five pages of specifications?

Tesler: We have something called the User-Interface Standard, and it consisted of those things which would be common to all applications. Also, the year after that document was published some revisions and some changes were made, and as we built applications we found that they had even more in common than we envisioned. Then we would adopt those things as part of the standard.

Daniels: Another thing we've done is user tests—taking our ideas and bringing in naive users and sitting them down and seeing what their impressions are. That has caused some changes, and I think that's all shown in the quality.

BYTE: Where did you get your naive users?

Tesler: Various places—the bulk of them were new Apple employees. We had a screening process. New Apple employees go through an orientation the first Monday morning they're here. We handed out a questionnaire to the new employees about their previous experience with computers, word processors, video games, and that sort of thing, and then what kind of work they did. Someone in our training department screened all those vitae. I'd go in and say I needed three user test subjects this week who have no word-processing experience but who are secretaries or accounting people to test out our Lisa Calc. She'd go through and pick out some candidates and I'd pick the ones I wanted, based on their experience for whatever test I was trying to run. We had about 50 tests this year in engineering to test out the software.

BYTE: The fact that you responded to the tests speaks well for the end product. The changes in the keyboard, for instance. How recently did you decide to change the keyboard for the final time?

Tesler: There were several changes. Those from the user tests had to do with changing the numeric pad so it had the arrow keys on it so you could move around in the Lisa Calc table. Those tests were run around January [1982], I think.

Rosing: January, and in March we decided to make the change.

Tesler: That was just key-cap legends that had changed. The other change has to do with the number of keys on the keyboard and was primarily for the benefit of international sales, although it did improve the user interface in terms of the positioning of the Enter key and the Extended Character option key, which gives you extended character sets. Those were all done around the same time.

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Rosing: The interesting thing is that we were at the stage in the program where the decision to make even what sounds like a simple change takes six months to percolate through because it's not a simple engineering change—it's manufacturing, tooling, documentation.

Daniels: We made one legend change in June or July—the Apple key. When was that?

Tesler: July, and it's just now showing up.

BYTE: A legend change?

Tesler: You saw two keys that said Command on them. The new version has only one, and instead of saying Command it has a picture of an apple on it. The reason is that the key's used as a shortcut to choose a menu command. If you look at a menu, on the right you'll see this little apple symbol and a letter. If you hold down the Apple key and the letter, you get the command. We couldn't find any way to symbolize the Command key that would fit nicely in a menu and be recognizable to people. We tried and tried. Finally we decided that the apple looked nice and had a nice sound to it—"Apple X," "Apple R"—and it keeps Apple in the mind of the user instead of "control" or something else. It's a symbol that everybody using this machine will recognize instantly, so we decided to put it on the key as well as on the screen. To finish the artwork in time to get the machines to test users in time to get responses, and so on, the change had to be in by a certain date. The decision was made only hours before the deadline.

BYTE: Are there going to be two Command keys without legends on them?

Tesler: No, only one. We studied IBM and DEC and other keyboards and found that they all have just a single Command or Control key on the left-hand side. We also really wanted to put an Enter key on the main keyboard because we would like to be able to offer a configuration in which an alphabetic keyboard and a numeric keyboard are independent—for, say, a company that does only word processing. Word processors don't need the Clear function, but they do need the Enter function, so we wanted to be able to have the Enter key on the main keyboard; that way, even people without a numeric keypad can hit Enter. Again, on IBM and DEC keyboards the Enter key is standard; on many of those keyboards, that's the standard position for the Enter key. So we decided to be more like other companies. The Enter key also gives us the option of removing the numeric keypad without losing an important function. And then the option keys were put on the side of those, and there we decided we did need two option keys, left and right, because they're used very much like shift keys for typing, and in Europe it would be very important to be able to touch-type for-

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[1] For comparison purposes, typical professional configurations consist of 16-Bit 8088 Processor, 128K RAM with Parity, Dual 320K 5-inch Floppies, DMA and Interrupt Controller, Dual RS-232 Serial Ports, Centronics Parallel Port and Dumb Computer Terminal or Equivalent.

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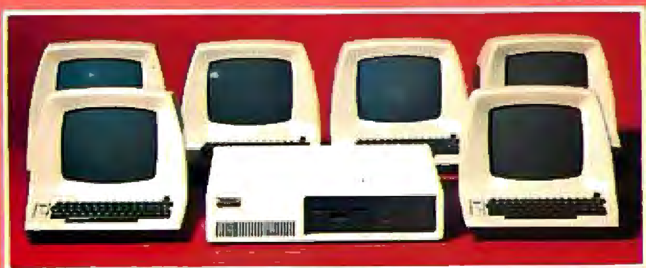

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eign alphabets for international correspondence, mathematical symbols, and other special characters. So there were some trade-offs. We didn't want to just keep jamming two of every key on the keyboard, so we decided what the priorities were and ended up being fairly close to the industry standard. We have one Apple key, one Enter key, and two Option keys.

BYTE: The user-interface design seems to have been difficult.

Tesler: That was the hard thing that affected the most people. A lot of software and hardware engineering issues were very difficult, but they affected only a few people. Interface issues affected half the division because Training, Publications, Marketing, and the software person implementing the application all had an opinion. People like us who were overviewing all the applications had opinions, in-between managers had opinions, kibitzers on the side had opinions, too. Not everybody can talk about what gate to use in some circuit or what routine to use in some program, but everybody can talk about the user interface. So we had to accommodate all of these things. And it turned out that good ideas and good criticisms came from everywhere. We had to come up with some objective way to decide. That's why we established the methodology which involved user testing. We had a procedure for proposing changes, reviewing the changes, narrowing it down to a few choices, with certain criteria like consistency and parsimony. And then we actually implemented two or three of the various ways and tested them on users, and that's how we made the decisions. Sometimes we found that everybody was wrong. We had a couple of real beauties where the users couldn't use any of the versions that were given to them and they would immediately say, "Why don't you just do it this way?" and that was obviously the way to do it. So sometimes we got the ideas from our user tests, and as soon as we heard the idea we all thought, "Why didn't we think of that?" Then we did it that way.

BYTE: Bruce, could you say something about the software architecture?

Daniels: There's an operating system underneath that we built ourselves because we felt that the ones that were out there didn't quite meet our needs.

BYTE: What does yours do that others don't?

Daniels: It's not just what it does, but what it doesn't do. Some other operating systems are basically timesharing systems like Unix that have a lot of features that we don't need, and why take up extra space for that? We wanted a system that the user didn't have to be experienced to understand, and it had to be very reliable. It had to maintain the user's data and keep it there. It also had to

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support things like graphics, the windows that we have on the screen, the mouse, and so forth. We didn't really find an operating system that met our needs, so we felt we had to go build our own. We built the other features on top of this—the support for the windows, the support for graphics, the support for multiple fonts, the support for printing. It's really quite a rich architecture. At least half of the software is in this foundation software.

BYTE: How large is that in bytes? How much code is in that foundation software?

Daniels: Well, source code is something like 10 megabytes.

Tesler: Object code is about half a megabyte.

BYTE: That's what's there before you put the application programs in—half a megabyte?

Daniels: Yes.

BYTE: After you specified the user interface, what list of hardware requirements did you come up with?

Rosing: Well, the main list that was specifically user interface would be the bit-mapped graphics display and the resolution of approximately 700 pixels across in the horizontal dimension, the mouse, and the doorless disk drives with the eject button rather than an eject handle. They determined a lot of the hardware design. We had other user-interface considerations, though. We wanted to make the system very easy for its users to service—I presume you've seen it break apart. Servicing really is simple. It took a moderate amount of extra product cost to get that feature in there. And that's a part of the even more global user interface, how people perceive the whole system.

BYTE: Why did you choose the 68000 microprocessor and what alternatives did you consider?

Daniels: We thought its architecture was very broad and strong and would take us through the '80s, and we wanted that. We wanted something to support the graphics, and we thought that processor gave us what we needed then. The 68000 was a bit of a gamble because it was very young when we got on it. We were getting one sample at a time from the local Motorola engineer here.

BYTE: Do you think the 68000 will be the dominant processor in the next few years? Is it going to overcome the 8088, the 8086?

Rosing: I would speculate that for high-end applications with very computer-intensive, graphics-intensive needs, the 68000 will become dominant.

Daniels: But the 8086 has such an installed base going already, I think that alone would carry it. . .

Tesler: You mean numbers of actual units with the 68000 in it, or the number of different products?

BYTE: Both of those questions.

Tesler: Well, we're putting 68000s in the units we'll sell, so that will mean more units with 68000s. We expect to sell a lot of machines.

BYTE: You've got a 68000 machine with a lot of memory in there, and not too much special-purpose hardware. Why did you decide to do it that way instead of using some versatile hardware chips, like the NEC 7220, for video display?

Daniels: We're very much boosters of bit-mapped graphics, and in fact hardware support for bit-mapped graphics is pretty small. All you need is sort of a shift register. We thought the flexibility that would give us in graphics and the things we could do in user interface with bit-mapped graphics was well worth the price.

BYTE: But doesn't the 7220 have bit-mapped graphics itself?

Rosing: Well, there were a couple of practical considerations. The NEC 7220 didn't exist when we designed Lisa, although we knew it was planned. The second consideration was that the 7220 cost more than the TTL [transistor-transistor logic] hardware needed to implement the equivalent functions. And the third consideration was this: because we were able to interleave the memory and display cycles, we were able to essentially get data out of the memory at very little penalty. Using a 7220 would actually cost considerably more in terms of system

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performance. And there was one more consideration: with the 7220, you can't access the display memory bank when the chip is refreshing the CRT, and that limits the time you can access it to about 10 percent of what we have, which would drastically affect performance. We can access memory any time. For equivalent performance, we would have to use two 7220s, and that would push the cost and the "real estate" beyond what we have.

BYTE: On the other hand, software doesn't get written overnight. . . there's a certain cost to that. You know, this is very software-intensive.

Rosing: Most of the software that supports the graphics took three years to write, but no hardware in the world can duplicate what that software does.

BYTE: Really? The software is faster than the hardware?

Rosing: No, not always faster.

BYTE: Its functionality is greater?

Tesler: Yes. The graphics package lets us draw circles, rectangles, ovals, and rectangles with rounded corners. It also automatically handles clipping on nonrectangular boundaries. If you have one object over another, you can draw the one behind without splashing the pixels on top of the one that's in front. That's a . . .

BYTE: A software revolution?

Tesler: A very unusual capability, which no one else has in that general form. The other implementations are all either very, very expensive hardware—the $100,000 class—or in software, which isn't really that general and performs much much worse. There's nothing in the same class as our software as far as capability and speed. Of course, there is graphics software that's faster and hardware that's faster, but it doesn't have anywhere near this capability.

BYTE: Do you have a Xerox Star here that you work with?

Tesler: No, we didn't have one here. We went to the NCC when the Star was announced and looked at it. And in fact it did have an immediate impact. A few months after looking at it we made some changes to our user interface based on ideas that we got from it. For example, the desktop manager we had before was completely different; it didn't use icons at all, and we never liked it very much. We decided to change ours to the icon base. That was probably the only thing we got from the Star, I think. Most of our Xerox inspiration was Smalltalk rather than Star.

BYTE: What does Lisa have that the Star doesn't have?

Tesler: We're talking about graphics capability. You originally asked why we didn't use graphics hardware. Our graphics primitives in software are more general than the Star's, so they perform better. We have a faster and more general ability to draw on the screen a picture of multiple graphical objects in different shapes, to have one window that uncovers another, and to repaint just the parts that are uncovered.

Daniels: Look at the desktop managers of the Star and Lisa. With the Star, you can only put them at fixed places on the screen so you know they don't ever overlap. On ours, you can put them any place you want. It's that generality that allows us to have arbitrarily shaped things and covering each other up and . . .

BYTE: Documents or forms, shapes, or anything. . .

Daniels: Yes.

Tesler: Right. We have curves in it. Everything in the Star, you'll notice, is really rectangular, and our things can have curved edges and that sort of thing.

BYTE: Another hardware question: How many microprocessors are in the machine, what are they, and what do they do?

Rosing: Let's see. One to scan the keyboard, in the keyboard housing proper; a second one that receives the

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keyboard commands and keys up mouse events; the 6504 that controls two floppy disks; a Z8 microprocessor in the hard-disk controller—it's an intelligent controller; and then, of course, the 68000. That's five.

Tesler: Almost every major chip manufacturer except for one.

Rosing: And with only one exception all our I/O (input/output) cards have microprocessors.

BYTE: You say that the magnetic read/write head in the disk drive is microprocessor-controlled in order to let it be more sensitive to variations in the alignment. Is that the 6504?

Rosing: Yes.

BYTE: What is the microprocessor that handles the keyboard and the mouse?

Rosing: That's a National COPS. We tried to pick the processor that we felt was best for each particular job.

BYTE: The memory is 64K-byte chips?

Rosing: Yes, 64K chips.

Tesler: On the memory we have parity and. . .

BYTE: What part of the memory is video memory?

Daniels: Some area in the main memory can be the video.

Tesler: Any area at all. In fact, if you noticed yesterday in the demonstration, when we're developing software, we need debugging information to be displayed for the programmer, but we don't want it to come out on the same screen that the user is seeing, so we had this magic toggle we were hitting that flipped between two screens. There are really two different areas of memory with a bit map in each. The software can switch between the two to display each in turn.

BYTE: But they're within the main memory?

Tesler: Yes, absolutely. Anywhere in memory. Take any number of consecutive bytes and say that's the bit map.

BYTE: Is anything else in main memory, or is the rest of it all available to the user? Is anything else mapped to the memory?

Tesler: Oh, I see what you're saying—the shared memory. Shared memory with I/O is not main memory. The I/O memory is in the I/O cards.

Rosing: It's not in the memory, but it's accessed like main memory, from the 68000 bus.

Tesler: It's in the address space, but it's not in those 64K chips.

BYTE: A certain address is really an I/O port, is that right?

Rosing: Yes; it's the top physical address of the 68000.

BYTE: Did you consider voice as part of the user interface?

Rosing: Yes. We looked at it pretty hard and at one time in the early system we actually had a CVSD-based voice subsystem in the computer, and we took it out because we didn't feel it achieved the quality we wanted to have associated with this system.

BYTE: What does CVSD mean?

Rosing: Continuously Variable Slope Delta modulation. It's much easier to say alphabet soup. We've thought about voice; it's part of our network architecture and will appear in the future, but only when we feel the technology's right so we can be proud of what we offer.

BYTE: That's both input and output?

Rosing: Right. We look at voice as being three problems. There's store and forward, which is just moving voice messages around, like a glorified answering machine. Second is text to voice; and third, of course, is voice recognition, or voice to text. The last one's the hardest of all, but we look at voice technology as something we have to approach in a unified way.

BYTE: What about the programmable serial ports? What chip is used there?

Rosing: They use the Zilog SIO. That was one of the last major changes we made in the hardware design. We did it because we had two high-speed ports with less board space, and the Zilog SIO chip supports asyn-

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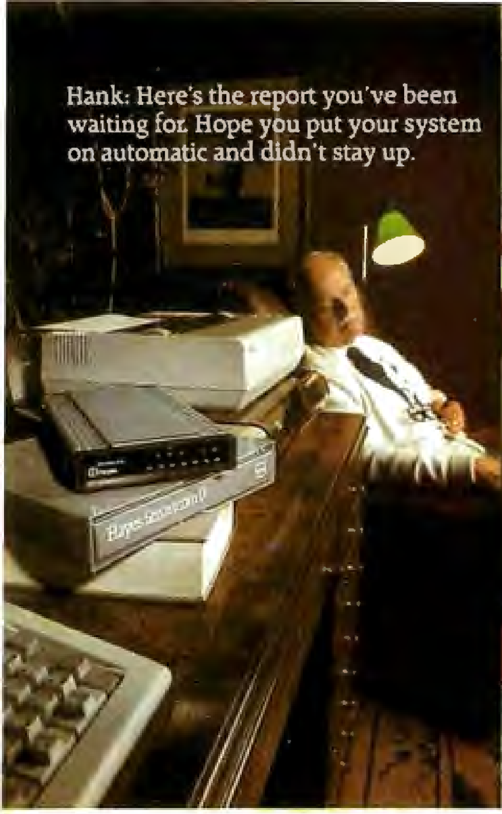

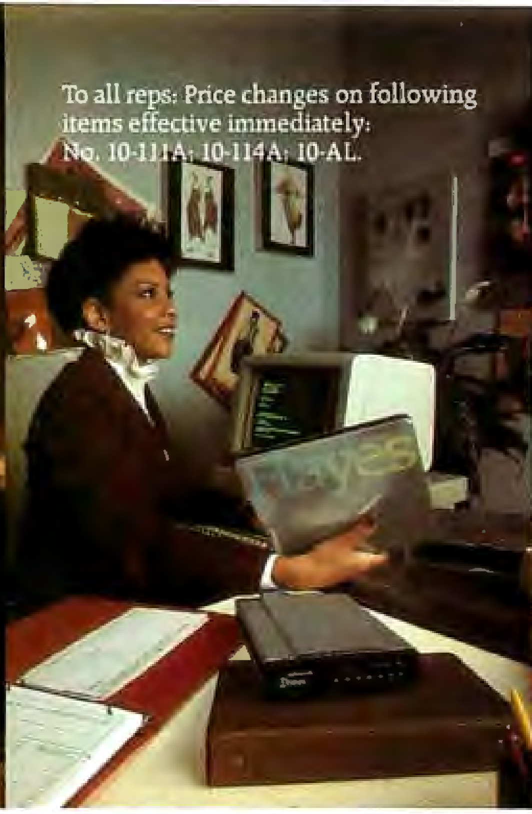

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BYTE: Both serial ports can be bisynchronous?

Rosing: Yes; they can be programmed any way.

BYTE: And can this SIO function as a UART?

Rosing: Yes. A UART/USART combination.

BYTE: When did you know that you were going to have half a megabyte as standard memory? When did you know how much you were going to need?

Daniels: It's always been a backward sort of thing. We had the capability for a full megabyte in the machine, and it was more a case of how much memory we needed to achieve our goal.

Tesler: The sales force wanted it to be 128K; the programmers wanted a megabyte. We negotiated.

Rosing: Since we were writing the code we got the megabyte.

Tesler: So the hardware people made it as big as they could in the address space, and then after some testing of the system we determined that half a megabyte was a reasonable compromise of cost and performance.

BYTE: Do you expect the standard memory on other manufacturers' machines to jump dramatically after the appearance of Lisa?

Tesler: Well, apart from its impact on cost, I don't think the amount of memory is a critical factor in deciding what machine you want to buy. If you're an end user, you should be buying a machine based on what it does for you, how easy it is for you to learn, how easy it is to use. Whether it has 12 bytes or it has 12 megabytes doesn't really matter to the end user, which is our marketplace. We're not selling the machine primarily to programmers who might care about that. End users have no idea which systems have more memory or less memory or one megabyte or one hundred thousand bytes. If other manufacturers are trying to match Apple, they should try to match us on ease of use and functionality and things like that. If they can do it in a small amount of memory, more power to them.

BYTE: Doesn't it matter when you're doing something like dictionary software or when you want to read a dictionary into memory fast and proofread a document very fast?

Tesler: Yes, there are certain functions where it definitely makes a difference. We have that in our Lisa Calc. In order to do rapid recalculation, the whole matrix really should be in resident memory, so we spent a lot of time coming up with a data structure that packed that data as tight as possible so that it would get as many cells as possible into memory, no matter what size memory there was.

BYTE: Your version of BASIC will use more than 64K?

Daniels: Oh, yes. We could have put less memory in it, but the performance would have been unacceptable. Unfortunately, some companies advertise machines that have less memory than anyone would ever reasonably buy. We haven't tried to do that here.

BYTE: You didn't use less memory and fewer disk drives than would really be effective, and so on?

Daniels: Yes, and I think when you look at the typical configurations that people buy of other machines, the cost is really not that different from the kind of costs we're talking about for Lisa. If the other machines get loaded up with disks and memory and the other kinds of things you want to run, then their prices will be comparable.

BYTE: When you decided you had to have hard-copy graphic output that accurately represented the quality of the screen graphics, what choices did you consider before you did this amazing adaptation of a $600-$700 printer?

Circle 35 on inquiry card.

BYTE Interview

Rosing: A wide range of options were being discussed, all the way from thermal printers to laser printers. We tried to identify what's critical in the marketplace. We thought there were two printers of first priority: a personal printer and one with letter quality. At the same time our sister division, the Apple II-III division, was evaluating the same two sets of printers. So we teamed up and did a survey of virtually all the printers that were available from every manufacturer who would have the volume capability to serve our needs. We did an extensive test and put about eight dot-matrix printers through their paces with really tough software. Quite a few of them just fell right off the table—it was clear that the quality wasn't there. Certain vendors were also much more responsive to fixing problems. So it really boiled down to two printers. Then, as we developed our printer software, the one we're using now—the C. Itoh—just far and away stood out as having the best mechanical design. You could put the dots where you wanted them repeatedly, and that's what we needed more than anything else in the world—good mechanical design.

Rosing: And a good price. Same for the letter-quality printer.

BYTE: The printer you are using is from C. Itoh, but it's your own ROM and your own systems software that drives the printer through the ROM.

Rosing: Correct.

BYTE: What else can you tell us about the printer, especially the dot-matrix?

Daniels: Mechanically it's just a raster device.

Tesler: A character generator is built into it; it has some capabilities. It has a single type style that can be stretched horizontally and vertically as it's printed, and it has what they call a graphics mode. They thought that would be used lightly, but it's what we use almost exclusively. And even within the graphics mode, there are two resolutions, low and high. High resolution is a lot slower. We wanted to offer the user all these choices.

BYTE: So this is a custom design for you. . . custom changes?

Tesler: Custom changes I would say, yes.

BYTE: Did you say it sometimes prints out in character mode? I thought all of its printing when you were controlling it was using the highest resolution.

Daniels: I think all the stuff you saw was done at high resolution.

BYTE: For speed you can go to a different mode?

Tesler: Yes; we're planning to offer the customer a way to get a quick draft using the character generator. Characters won't look quite the way they will in the final version, but you can get output in a hurry.

Rosing: The printer will have three different speeds and three different quality levels.

BYTE: Do you have an idea where you're going next?

Rosing: We have what feels like ten years' worth of backlog. We have a pretty good idea what we're going to do for the next few years.

BYTE: What's that?

Rosing: The thrust is to expand the level of integration within the applications and to add facilities to make it easier for more applications to be written outside of Apple.

BYTE: Those facilities are the development toolkit?

Rosing: Yes. The development toolkit is a key thing. And for a large part of the marketplace, adding network applications and data communications is very important. Last but not least is adding really serious database functionality to the system. If you add all that up, it's as big a task or bigger than what we've just done.

Daniels: In fact, almost as important as the team building that we've gone through is building up this foundation that we've used to create the six applications we've now built. The foundation is an amazing application machine. We and others outside Apple can build applications that are just amazing now, because no one has to rebuild the foundation. It's already there, in place, and we really hope to leverage off that in the future. ■

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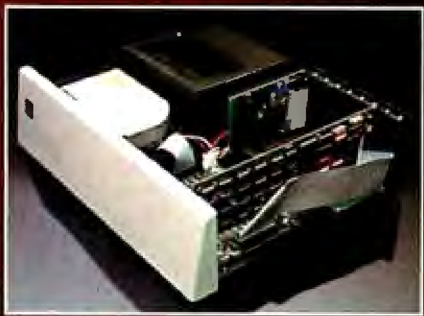

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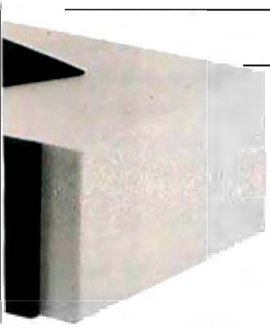

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The Enhanced VIC-20

Part 1: Adding a Reset Switch

Joel Swank
12550 SW Colony #3
Beaverton, OR 97005

Most microprocessor chips have an input pin called Reset. When an electrical zero or ground is applied to this pin, the microprocessor clears all internal registers and starts a preselected sequence of initialization instructions. That's how a microcomputer begins operation when you turn it on. Most microcomputers also have a Reset switch that enables the operator to apply the zero signal to the Reset pin to restart the computer. Unfortunately, the Commodore VIC-20 does not.

The VIC has a restore function that is activated by pressing the Stop/Run and Restore keys at the same time, but it doesn't use the 6502 microprocessor's Reset line. Instead, the Restore key is connected to a 6522 VIA (versatile interface adapter) that is programmed to interrupt the 6502 microprocessor each time you press the Restore key. The 6522 is connected to the 6502's NMI (nonmaskable interrupt) line. When the VIA interrupts the microprocessor, the program being executed stops and the VIC NMI interrupt-handling routine takes control. This routine checks to see if the Stop/Run key is depressed and, if it is, executes the warm-start routine. If the Stop/Run key is not depressed, the original program continues. In normal operation, this method of resetting the VIC works fine. When a program runs astray, you just press Stop/Run and Restore to recover. Any BASIC program in memory is preserved, and all parameters (screen color, sound, input/output devices, etc.) are reset to default values.

Editor's Note

*The VIC-20 is one of the new breed of low-cost computers that offer a surprising amount of computing power for the money. But its low cost means that it lacks some of the features we've come to take for granted. In this series of articles, Joel Swank will "enhance" the VIC-20 and hence increase the utility of this very interesting computer. . . .*S.J.W.

For the restore function to work, the VIA must be programmed properly. If the errant program has inserted random data into the VIA registers, the restore function will not work. There's another problem: the 6502 can enter a state in which the NMI has no effect. In this "hung" state, the 6502 performs no operations. You rarely encounter it when you use BASIC programs, but if you try to develop any machine-language subroutines, it could happen often. In both of the above cases the restore function does nothing. The only way to recover is to turn the VIC off and back on again, thereby erasing any data or programs that are in memory. A Reset switch can reinitialize the VIC without turning it off while preserving anything in memory.

Installing the Switch

You can implement a Reset switch for the VIC by adding two wires and a switch. Figure 1 shows the schematic diagram for the VIC Reset circuit. Normally, the 555 integrated circuit (IC) timer on the VIC board is used to generate a 3-second low pulse on the Reset line at power-up. The switch serves to temporarily connect pin 2 of the 555 (the trigger input) to the ground line. That causes the 555 to repeat the pulse, which completely resets the VIC system without losing the data in memory. (Note: making this modification to the VIC will invalidate your warranty, so you might want to wait until it has expired.)

The Reset circuit requires one normally open SPST (single-pole, single-throw) push-button switch and two 6-inch lengths of stranded insulated hookup wire. To install the circuit, you'll need a 25-watt or smaller soldering iron. Do not use a 150-watt soldering gun; it will destroy your VIC's printed-circuit (PC) board. Be sure to use only rosin core solder. You'll need a pair of wire cutter/strippers and a pair of small needle-nose pliers. To mount the

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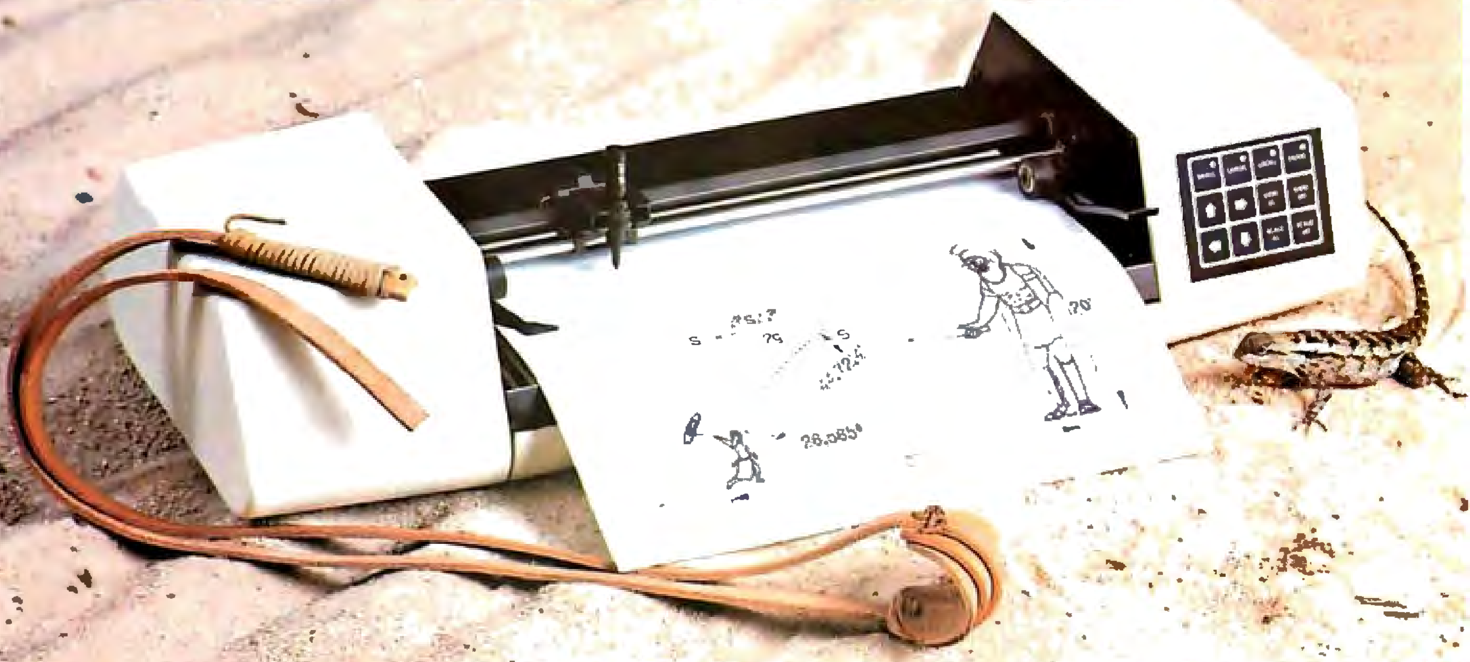

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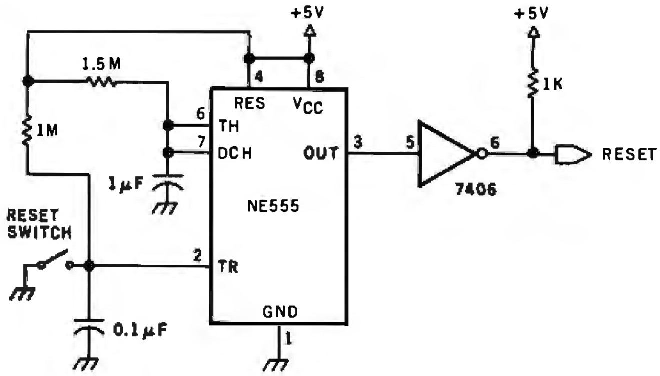

Figure 1: *A circuit diagram for the Reset switch, which has been added between pins 1 and 2 of the 555 IC timer.*

switch in the case, you'll need a ¼-inch electric drill and drill bits. A small vise to hold the switch while soldering would be handy. You will also need a small Phillips screwdriver to disassemble the VIC.

First disconnect the power cord and any peripherals that are connected to the VIC. Then turn the VIC upside down and remove the three Phillips screws in the bottom front of the case. Turn the VIC back over and lift the top front of the case. It should separate from the bottom and hinge on some hooks at the rear of the case. You will see two sets of wires that connect the top and bottom of the case; these connect the main PC board in the bottom of the case to the keyboard in the top. The group of 18 wires on the left is for the keyboard. The wires must be disconnected at the connector on the PC board. Gently work loose this connector to reveal a row of square posts. The two wires on the right are for the power LED (light-emitting diode). They must also be disconnected from a connector on the PC board. When both sets of wires are disconnected, remove the top of the case and put it aside.

Let's take a look at the VIC board. Two versions are currently in use. The original version, made in Japan, was produced under an FCC waiver that allows it to emit substantial RFI (radio-frequency interference). A small printed notice over the game input/output (I/O) port states this waiver. The newer VICs, which are produced in the United States, have sufficient shielding to meet FCC regulations. Their PC boards are also arranged differently. I have one of the older models, so I'll approach it first.

On the older versions of the VIC, the right side of the PC board is almost completely taken up by the power supply and heat sink. On the far right are the connectors for the power cord and the game I/O. At the right rear is the housing for the expansion slot. The left side is taken up by the ICs that make up the VIC computer. The two 40-pin ICs in the left rear corner are the two 6522 VIAs that the VIC uses to communicate with external devices. Just in front of them are the two 24-pin ROMs (read-only memories), which contain the machine-language routines that make up the VIC control program and BASIC. In front of them is the 6502 microprocessor that controls the

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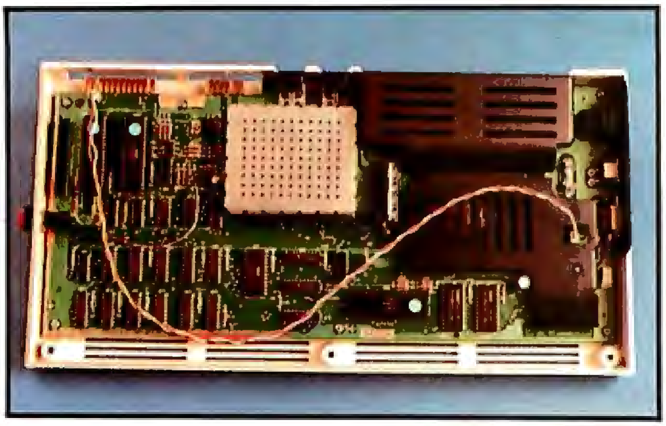

Photo 1: *The VIC-20 circuit board. The Reset switch, shown at left, has already been installed in the American version. (Photos by John M. Hannan.)*

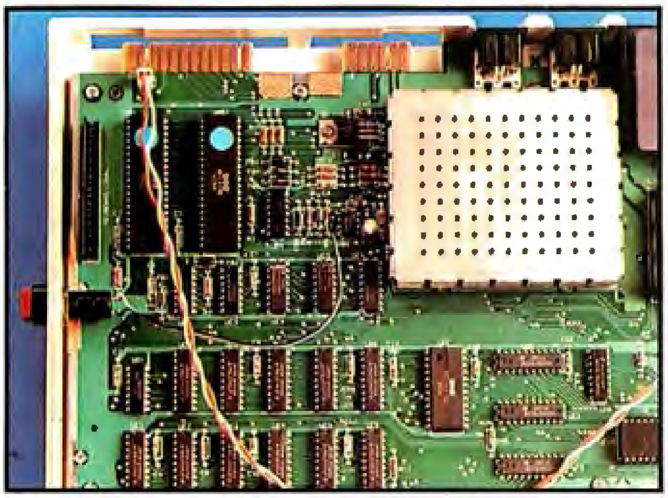

Photo 2: *A close-up of the VIC-20 circuit board. The Reset switch is connected to pins 1 and 2 of the 555 IC timer next to the lower left-hand corner of the perforated metal box.*

entire system. At the rear center is the 24-pin ROM that contains the VIC character-set patterns and the 40-pin 6560 video-interface chip (hence VIC) that controls the output to the TV. In front of the 6560 are the ten 2114 RAMs (random-access read/write memories) that make up the VIC's 5K-byte standard memory. The rest of the ICs on the board are the TTL (transistor-transistor logic) chips that perform the address decoding and interface between the larger ICs.

Photo 1 shows the newer version of the VIC, which has the power supply, expansion slot, and game I/O on the right side. It has additional metal shielding over the power supply as well. The ICs on the new version are rearranged. The 6502 microprocessor and the two program ROMs are located in the right front just below the power supply. The RAMs are located in the front left in two rows. The character-set ROM is just to the right of the RAMs. The 6522 VIAs are located in the left rear corner. The 6560 and the rest of the TV circuitry can be found in the center rear covered by a metal box. The 555 timer is located at the left of this metal box.

You will install the Reset switch at the center of the far left end. To the left of the perforated metal box is the 555 timer (see photo 2). With only eight pins, it is the smallest IC on the board. Connecting the Reset switch involves soldering wires to pins 1 and 2 of this IC. The 555 has a dot beside pin 1. The pins are numbered counterclockwise from pin 1.

Before you make any connections, you must take the PC board out of its case. Remove the screws in the corners of the board, the two screws along the rear edge, and the screw along the front edge. The old version also has a black screw in the front center of the black-metal heat sink. Do not remove the two screws along the right edge. Once you've removed these seven or eight screws, the PC board should lift easily out of its case. If the area you're working in has any static electricity, make sure you discharge yourself by touching a metal object—a filing cabinet or table, say—before touching the PC board. Static electricity can destroy the delicate ICs on the VIC PC board.

Place the PC board on a flat surface to install the switch. Strip about ⅛ inch of insulation off each end of the two 6-inch lengths of wire. Twist together the strands of the four exposed ends and tin them by melting solder into the strands—that makes them easier to solder to the board and the switch. Next, solder one end of each wire to one of the connections on the switch. Solder the other end of one of the wires to pin 2 of the 555 IC. Solder the other wire to pin 1 of the 555. When you solder the wires to the pins, get the connections hot enough to melt the solder, but be careful not to get them too hot. Excess heat can damage parts and cause traces to lift from the board. The key is to work as fast as possible.

After you've made all the solder connections, you'll be ready to prepare the case for mounting the switch. You'll have to drill a hole through the left side of the case large enough to accommodate the neck of the switch. Because the VIC case is about ¼ inch thick, you may have to countersink the hole (i.e., make it funnel-shaped) so that enough of the neck of the switch will fit through to fasten it. Locate the hole high enough from the bottom of the case so that the switch will not touch the PC board and close enough to the 555 so the wires will reach. Drill the proper size hole. If you need to countersink, use the point of a larger drill bit to partially increase the size of the hole from the inside of the case. After drilling the hole, make sure that the switch fits properly. Return the PC board to the case and reinstall the seven or eight screws that hold the PC board. Then insert the switch into its hole and fasten it securely. Reattach the two cables from the top half of the case. The cable on the left, for the keyboard, is keyed and will install in only one direction. The polarity of the LED cable on the right does not matter. Place the hooks in their slots at the rear of the case and gently close it. If the case is slightly warped, you may have to press down on the rear to get the hooks to engage properly. After you've closed the case, examine it on all sides to be sure that it has no gaps. Turn it over and reinstall the

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Listing 1: *The Reset program, which will reset the first link field and end-of-program pointers. Starting at line 25, use the POKE command to enter the program.*

```
0001  0000               ;
0002  0000               ;
0003  0000               ;    PROGRAM TO RESTORE THE BASIC END
0004  0000               ;    OF PROGRAM POINTER.
0005  0000               ;
0006  0000               ;    CALL WITH SYS 828
0007  0000               ;
0008  0000               CHAIN   =$C533          ;VIC LINE LINK CALCULATOR
0009  0000               ;
0010  0000                       *=$33C          ;ASSEMBLE IN TAPE BUFFER

0011  033C  20 33 C5             JSR CHAIN       ;FIND LAST LINK
0012  033F  18                   CLC
0013  0340  A5 22                LDA $22         ;ADD TWO TO GET
0014  0342  69 02                ADC #2          ;END OF PROGRAM
0015  0344  85 2D                STA $2D         ;AND SAVE IN END POINTER
0016  0346  A5 23                LDA $23         ;ADD ZERO TO HI BYTE
0017  0348  69 00                ADC #0          ;IN CASE OF CARRY
0018  034A  85 2E                STA $2E         ;SAVE IT
0019  034C  60                   RTS             ;RETURN TO VIC
0020  034D               ;
0021  034D               ;
0022  034D               ;    POKE THE FOLLOWING DECIMAL VALUES INTO MEMORY
0023  034D               ;    STARTING AT 828 TO USE THE PROGRAM
0024  034D               ;
0025  034D               ;POKE 828,32
0026  034D               ;POKE 829,51
0027  034D               ;POKE 830,197
0028  034D               ;POKE 831,24
0029  034D               ;POKE 832,165
0030  034D               ;POKE 833,34
0031  034D               ;POKE 834,105
0032  034D               ;POKE 835,2
0033  034D               ;POKE 836,133
0034  034D               ;POKE 837,45
0035  034D               ;POKE 838,165
0036  034D               ;POKE 839,35
0037  034D               ;POKE 840,105
0038  034D               ;POKE 841,0
0039  034D               ;POKE 842,133
0040  034D               ;POKE 843,46
0041  034D               ;POKE 844,96
0042  034D               ;
0043  034D                       .END
0044  034D                ERRORS= 0000
```

three screws in the bottom. You now have a Reset switch for your VIC.

Memory Pointers

You can use the Reset switch to recover when Stop/Run and Restore have no effect. Reset does not erase a BASIC program, but it does change two pointers in memory that VIC needs to find the program. One of the pointers that is altered is the link field in the first line of the BASIC program. Each line of a VIC BASIC program has a pointer to the next line. Reset clears the link in the first line so that the VIC thinks there are no statements in memory. Reset also changes the pointer to the end of the program. Both of these pointers must be restored to their proper values for the VIC to recognize the program that is in memory.

The easiest way to restore these values is to use the PEEK command to examine them *before* you run the program and then write them down in case you need to use Reset. Then after you reset you can use the POKE command to restore them and execute the BASIC CLR command to reset the other BASIC pointers. Of course, chances are that when you have to use Reset you will not have thought to do this. It's possible to find the correct values for these pointers after the VIC has been reset.

On a standard VIC the first link field is located at memory locations 4097 and 4098 (1001 and 1002 hexadecimal). It is a 2-byte pointer to the beginning of the second line of the program. The end-of-program pointer is at locations 45 and 46 (2D and 2E). Finding the end of the program involves following the chain of BASIC statement links to the end of the program. Fortunately, there's a machine-language subroutine in the VIC ROM that will reset the first link and find the end of the program. To help in executing this subroutine I wrote the Reset program shown in listing 1. The program calls the VIC ROM subroutine that recalculates the VIC statement links and leaves the last pointer in a temporary memory area. It

then increments this pointer by two and stores the result in locations 45 and 46 (2D and 2E). To use the Reset program, you must first enter it into an unused area of memory by using the POKE command. As shown in listing 1, it resides in the VIC tape buffer at location 828 (33C), but it is relocatable and could be located in any spot you are sure will not be used. Use the POKE command to enter the decimal value given in the listing (starting at line 25) into memory beginning at location 828. Next enter a nonzero value into the higher-order byte location of the link field with the command POKE 4098,1. That lets the VIC ROM subroutine know that a program is in memory. Call the program with the BASIC SYS command SYS 828. Now initialize the rest of the BASIC pointers with a CLR command. The BASIC program is now fully restored and you can LIST it or SAVE it on tape.

Note that you must not use any BASIC variables during the above procedure. Doing so will wipe out part of the BASIC program. And if you're using an expanded VIC, the location of the first link field is different. If you have only a 3K-byte expansion board or a Commodore Super Expander plugged in, the higher-order byte of the link is located at 1026 (402). If you have one or more 8K-byte expansion modules, the higher-order byte of the link is at 4610 (1202). You can still use the above procedure to find the correct link value by substituting the appropriate address. If you have changed the pointer to the end of BASIC memory at locations 55 and 56 (37 and 38), Reset will restore it to the default value.

The VIC Reset switch is a handy addition to the VIC-20. It can save you hours of retyping a program. Using Reset instead of the on/off switch will also save wear and tear on your VIC.■

BYTE's Bits

Public-Domain Apple Graphics Routines

One reason for the Apple II's popularity is the large amount of public-domain software available for it. Most public-domain software is rather modest stuff, but someone occasionally donates an impressive piece of software that is easily good enough to be sold commercially. Such a piece of software (obviously a labor of love that reflects much work and talent) is David Shapiro's Dr. Cat's Grafix Disk. This is an Apple II floppy disk running under the DOS 3.3 operating system that gives the user a 5K-byte package of high-resolution Apple graphics routines, the source code for the assembly-language routines (in Apple DOS Tool Kit format), some documentation, and a lot of enjoyable demonstration programs.

David sees Cat-Grafix, as he calls them, as an alternative to the high-resolution drawing routines provided by Applesoft. The package has 25 major routines, each of which can be called from BASIC or entered via an optional set of ampersand routines (e.g., &HIRES). The routines include both color and black-and-white versions of subroutines that plot points, draw lines, outline or fill boxes and circles, scroll the high-resolution screen, and draw characters from a user-defined character set onto the high-resolution screen.

The disk and associated software are in the public domain and can be used as part of another program (commercial or otherwise) if credit is given to Cat-Grafix. The disk is currently being distributed through Apple user groups and can be copied without limitation. If you cannot get this disk through these channels, it can be ordered from:

David Shapiro
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Please send an Apple disk, a check for $8, and a stamped, self-addressed return envelope with sufficient postage and cardboard protection for the disk.

I think that Cat-Grafix is one of the most impressive sets of graphics routines for the Apple that I have ever seen, and the price is certainly right. David is to be commended for his decision to give this software away. I hope that his efforts will persuade other hobbyists to share their work.

Gregg Williams
Senior Editor ■

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As our civilization grows more complex, the need for standards increases at an amazing rate. Without thinking in terms of standards, we are accustomed to asking for a specific weight of oil for our car, film of varying speeds for our cameras, tires of a certain size, and certain kinds of electric light bulbs, electric sockets, extension cords, etc. Standards are vital to our daily lives. As consumers, we have become dependent upon standards and would not tolerate the inconvenience incurred by a lack of standards.

Standards are such an integral part of our daily lives that we are often oblivious to their existence and therefore do not always appreciate their value. As we understand the role played by standards in our daily lives, it becomes easier to understand why a need for standards arises. When this need in a particular area becomes acute, the next logical step is to convene a committee interested in the subject to develop a standard.

Standards organizations exist to provide a framework so that standards that represent a consensus can be developed and approved.

Much of this material has been adapted from The World of EDP Standards, *3rd edition, by R. D. Prigge, M. F. Hill, and J. L. Walkowicz. (Blue Bell, PA: Sperry Univac Corporation, 1978). Used by arrangement with Sperry Univac.*

History

In the early part of our century, the general need for standards was fairly widespread, and as a result, several organizations were founded to develop standards in a variety of areas. Therefore, when the first suggestions were made that standards should be established in the field of computers and information processing, there already existed mature and well-established organizations available to accept that responsibility. On the international scene, the International Organization for Standardization (ISO) authorized the formation of Technical Committee 97 (Computers and Information Processing) and Technical Committee 95 (Office Machines). These two committees have now merged into Technical Committee 97 (Information Processing Systems). In the United States, the American National Standards Institute (ANSI) assigned to the Business Equipment Manufacturers Association (now the Computer and Business Equipment Manufacturers Association, or CBEMA) the responsibility for forming the corresponding American National Standards Committees X3 and X4, which have since merged into Committee X3 (Information Processing Systems). X3 now has responsibility for all of ANSI's computer-related standards (see figure 1 for a chart of the X3 organization).

Meanwhile in Europe, the European Computer Manufacturers Association (ECMA) was formed, and by mid-1961, the standardization effort for computers and information processing was well underway.

Objectives

While the names and relationships of these organizations can be confusing, the objectives of all the international and national standards bodies are so similar that they can be thought of as carbon copies of each other. Basically these objectives are development, promulgation, and establishment of standards; coordination of standards development; and exchange of information.

At the technical level the objective is the development of a standard for a specific product or process.

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Membership and Finance

The membership base of standards-making bodies varies somewhat, but in general, at the international level, the members represent nations. At the national level, individual members represent interests of consumers, producers, and general-interest groups.

Membership in standards organizations is restricted in the sense that each organization establishes categories and balance for membership but is open-ended in respect to the number of members. In the ISO, membership is restricted to the standards organization most representative of each nation. ANSI represents the United States in ISO, and therefore, no other standards organization based in the United States can hold membership. (Other standards organizations are subtly restrictive on the basis of technical interest, product produced, or similar categories.)

Although many international and national organizations derive their operating revenue from membership dues and the sale of standards, others are wholly or partially supported by their governments. Several national standards organizations have extended their activities to include a certification program, which contributes to their income. Most of the organizations important to computer standards are self-sustaining nonprofit organizations.

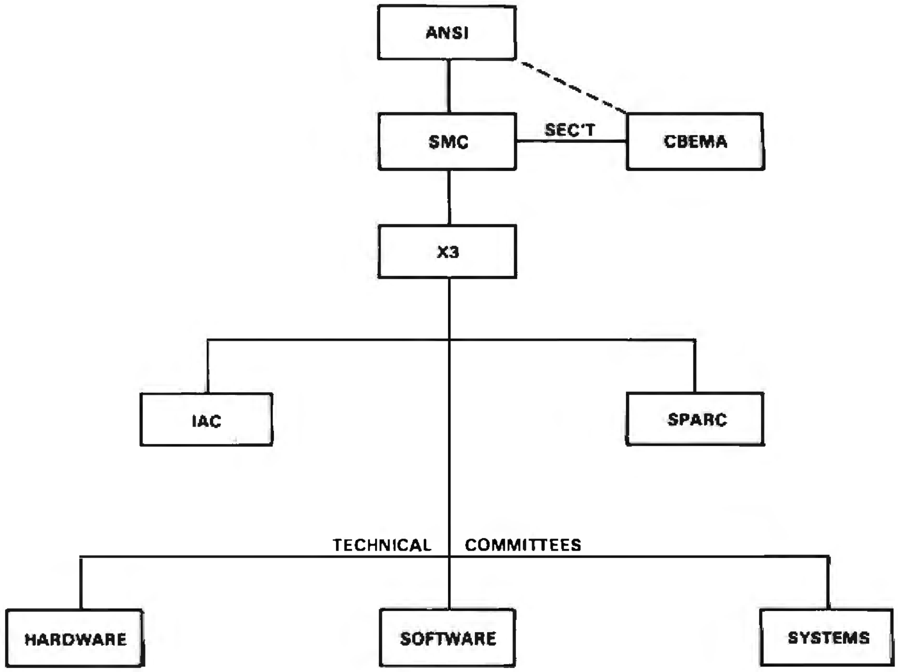

Figure 1: *Structure of the American National Standards Committee X3 for Information Processing Systems. The abbreviations stand for the following: ANSI, American National Standards Institute; SMC, Standards Management Committee; CBEMA, Computer and Business Equipment Manufacturers Association (the secretariat to X3); IAC, International Advisory Council; and SPARC, Standards Planning and Requirements Committee.*

Technical Committees

Within a standardization organization, technical committees are chartered to develop standards in an assigned range of interest. Because this charter generally covers a broad technical area, a technical committee may work simultaneously on several overlapping or independent technical areas within its assigned responsibility. A technical committee may also need to establish liaisons with technical committees of other standards organizations or within the same parent organization.

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SC1	VOCABULARY	0	0	P		0	P		P		0	0		P	P*	P		0	0			0	0	P		0		P		0	0	P		0	P	P		0			P	P	P		0
SC2	CHARACTER SETS	0	0	P	0	0	P		P		P	0		0	P*	P		0	0			0	P	P		P		0		0	0	P		0	P	P	P	0			P	P	0		0
SC5	PROG. LANGUAGES	P	P	P		0	P		P		0	0		P	P	P		P	0		P	0	P	P		P		P		P	0	P		0	P	P	P				P	P*	0		0
SC6	DATA COMMUNICATIONS	U	0	P		0	P		P		0	P		P	P	P	0	P	0			0	P	P		P		0		0	0	P		0	P	P	0				P	P*	P		0
SC7	DOCUMENTATION	0	0	P		0	P		0		0	P		0	P	P	0	U	0			0	P	P		P		0			0	P		0	P	P*	0				P	0	0		0
SC8	NUMERICAL CONTROL	0	0	P		0	0	0	0		0	0		0	P*	P	0	0	0		0	0	P	P		0		0		P	0	P		0	P	P	P				P	P			0
SC9	PL/NUMERICAL CONTROL	0		P			0		0					0	P*	P		P	0				P	P		0		0		0	0	P			P	0	P				P	P	P		0
SC10	MAGNETIC DISKS	0				P	0		P		P			0	P	P*		0	0				P	P		P		0		0	0	0				0	P				P	P	P		0
SC11	FLEXIBLE MAG. MEDIA	0		0		0	0		0		P			0	P	P		0	0				P	P		P		0		P	0					0	P				P	P*	P		0
SC12	INSTRUMENTATION TAPE	0		0			0		0		0			0	P	P		0	0				0	P		0		0			0	0				0	0				P	P*	P		0
SC13	INTERCONNECTION	0	0				0		0		P	0		0	P	P*		0	0				P	P		P		0		0	0					P	0				P	P	P		0
SC14	DATA ELEMENTS	0		P		0	P		0		0	0		0	P	P		0	0			0	0	P		0		0			0	0			P	P	0				P	P*	0		0
SC15	LABELLING	0					0		0			0		0	0	P		0				0	P	P		P		0								P	P				P*	P	0		0
SC16	OPEN SYSTEMS	P	P	P		0	P		0		P	P		P	P	P		P	0		0		P	P		P		P		P				0	0	P	0				P	P*	P		
SC17	IO/CREDIT CARDS	P		P		0	P		0		0	0		P	P	P		0					P	P				0			0				P	P	P				P	P*			
SC18	TEXT PREP. & INTERCHANGE						P		0		P	P		P	P	P		0					P	P		P								0		P					P	P*			
SC19	OFFICE EQ. & SUPPLIES	0					0		0				0	P	P	P		0					P*	P		0									0	P	P				P	P			

NOTE: All data as of 82 06 15 P=PRINCIPAL 0-OBSERVER P*= SECRETARIAT

Figure 2: *The ISO/TC 97 is the technical committee for information systems. The member countries belong to one or more of the various standards committees (SC) under the technical committee. Each member country has the option of participating in a principal or an observer role. Additionally, some members may serve as secretariat of a standards committee.*

organizational structure similar to that of the parent organization and have a quota of administrative and advisory groups to supervise the progress of the technical work.

Most of the developed countries take an active part in the development of standards. Some elect to monitor the international development work, which is then evaluated in terms of their national requirements. Australia and Denmark are examples of this type of participation. It is also common practice for some national organizations to adopt the International Standards developed by the ISO Technical Committees (see figure 2 for a list of the member countries in ISO Technical Committee 97).

Development of a Standard

Standards development is based upon cooperation and *consensus* of the parties involved regarding technical content. This may require many changes in wording to effect a compromise, as well as many material additions or deletions. The ultimate objective is to produce a standard for which consensus can be achieved.

The philosophy of consensus imposes a responsibility upon the organizations within which standards can be initiated, developed, and approved: the organizations must develop a process, methods, and operating procedures that will guarantee that a consensus has been reached.

In the United States, ANSI recognizes only three methods for the development of evidence of consensus for approval of American National Standards: the Accredited-Organization Method, the Canvass Method, and the Standards-Committee Method. All methods have the same objective, i.e., to develop evidence of consensus of interested parties for approval of a proposed standard. Any individual or any organization may propose a standard for approval and, in so doing, may specify any one of the three methods.

Accredited-Organization Method

Any organization involved in standards work may seek accreditation from ANSI. As an accredited organization, it may submit proposed American National Standards to ANSI for approval.

To be accredited, an organization must have a procedure for development of consensus comparable to that required under the Standards Committee Method.

When the proposed standard has been approved within the accredited organization, it is sent to ANSI for approval as an American National Standard.

Canvass Method

When a standards-making organization or any other responsible organization has existing or draft standards it wants to have considered

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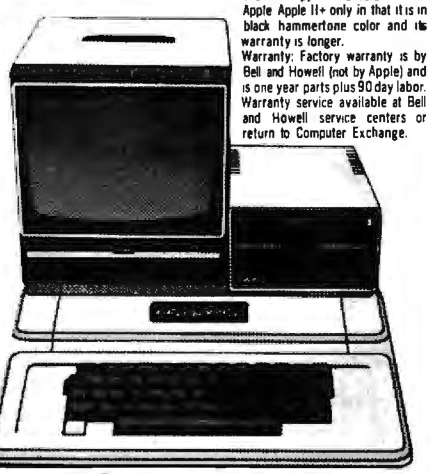

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Standards Are Volatile

You might think that an official standard is as stable as a mountain. Most standards are in fact more stable than Mount St. Helens but not as stable as Gibraltar. ANSI brings up standards for review every five years, when they may be reaffirmed, revised, or withdrawn. If the responsible committee does not act, the standard automatically dies. Sunset laws appeared in standardization before they appeared in government.

Revisions to the editorial content of the standard specification are the most common; technical changes are more rare and must be treated as if a new standard were in development, with all the necessary meetings, documents, etc.

The constant review process protects both computer-product vendors and users from technological stagnation caused by fixed standards. But consequently, the standard's name must carry a date, which becomes very significant if changes are made. For instance, FORTRAN programmers must be aware of the changes made between the 1966 FORTRAN standard and the 1977 revision of the language (American National Standard X3.9-1978).

Because major changes in a standard might prove to be detrimental to both industry and consumers by making items obsolete, some standards are stabilized through the process of registration. *When a standard is registered, as for instance the ASCII (American National Standard Code for Information Interchange) character set, an entry is made in the broadly circulated standards registers. When changes are made to the character set standard (as happened in 1977 and may happen again in 1984), the new entries will be placed in the same standards registers while the original entry remains unchanged. In this way, several versions of a standard can exist at the same time. Using this method helps to avoid repeating the entire standardization process when there is a need to make changes.*

as American National Standards, it can use the Canvass Method. In this event, the group takes a canvass or mail poll of all organizations that are known to have concern for and competence in the subject.

The organization proposing the standard becomes the sponsor and is responsible for preparing the canvass list. Generally, a six months' time limit is placed upon responses to the poll.

When the canvass ballot period closes, the sponsoring organization must submit all pertinent documentation to the standards-approving organization. This documentation includes the standard being proposed, the canvass list, the comments received, and the sponsor's responses to adverse comments. For example, these materials would be sent to ANSI, and futher processing as an American National Standard proceeds. The programming language Ada has recently progressed through this method.

Standards Committee Method

The Standards Committee Method is the one best known to the computing industry. It is used when one or more organizations have developed or are developing standards on the same or related subjects.

The method described here is the ANSI version. However, the fundamental principles are identical to those at the international and local levels. As an example, the factors applied to the decision to form a standards committee are the same in ANSI as in ISO. Additionally, the ANSI responsibilities in establishing a Standards Committee, watching its progress, and acting upon its output are identical to those of the comparable ISO councils.

The Standards Committee Method consists of a secretariat (administrative-support group) and a standards committee embodying a balanced representation of consumers, producers, and general interests. In many cases, a sponsor may also be involved.

The terms secretariat and sponsor are often used synonymously, but each has a distinct place in the standardization process. The *secretariat* plays an important role in the efficient functioning of the standards committee. While a secretariat is always associated with a standards committee, a sponsor need not be. The secretariat organizes and appoints officers to the standards committee and generally handles all of the administrative work for the standards committee. The relationships of standards organizations and secretariats can be confusing at times, as each can fulfill several roles. As examples, CBEMA was authorized by ANSI to act as the secretariat for American National Standards Committee (ANSC) X3, and ANSI itself holds several ISO secretariats, among which is that for ISO/TC 97.

A *sponsor*, as defined by ANSI, is "an organization or group which assumes responsibility for development and publication of its standard and subsequently submits it to the institute for approval under any of the methods covered in these procedures." As an example, the American Society for Testing and Materials acts as a sponsor of ASTM standards when these are proposed as American National Standards. By this definition, CBEMA cannot be a sponsor because it does not develop its own standards.

Standardization Process

Regardless of the method used to submit a proposed standard, the objective of the approval process is to confirm that consensus has been reached. Within this process, four requirements must be met: all substantially concerned parties must have an opportunity to express their views, and these views must be considered; significant conflicts with other American National Standards must be resolved; consideration must be given to existing national and international standards; and evidence of compliance with ANSI procedure must be shown.

The process to accomplish all of this occurs in three phases.

1. Planning: A standard is proposed, and a judgment is made as to its value to the industry. A committee is authorized to accomplish the

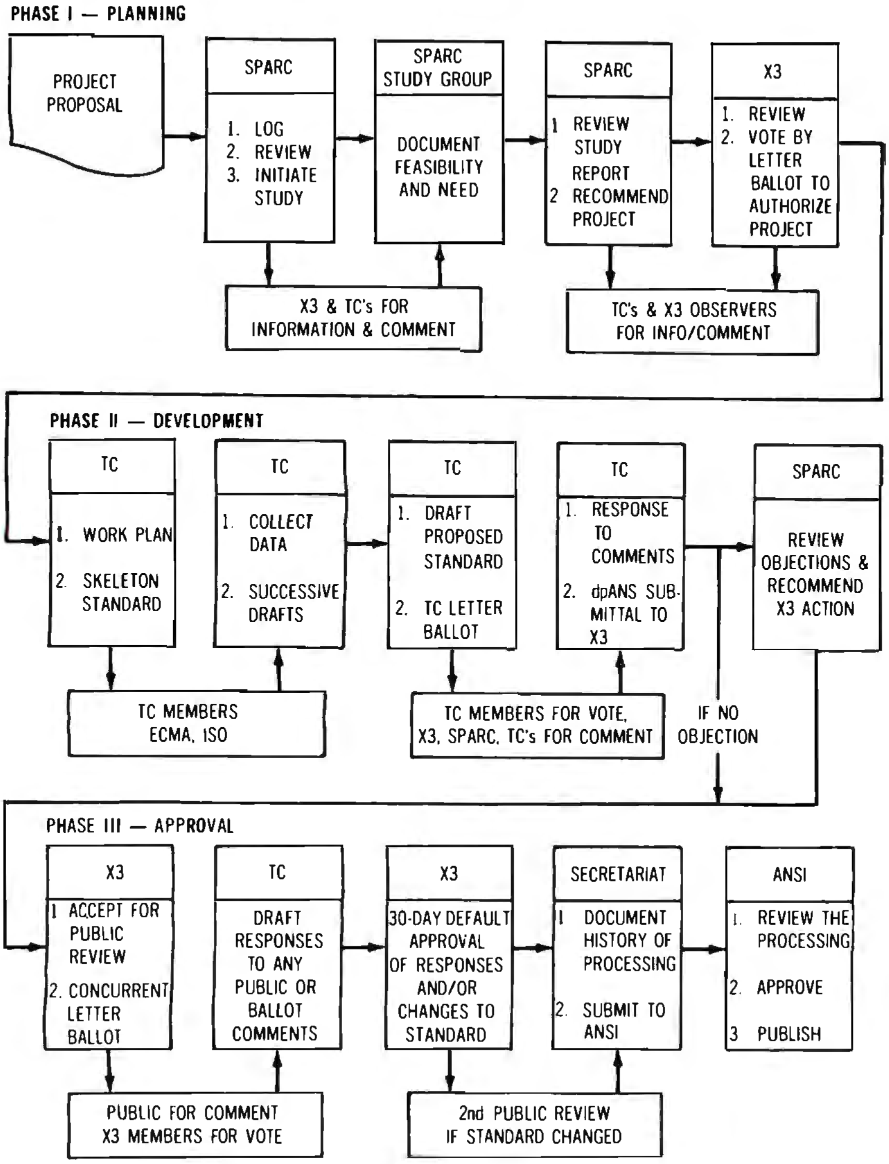

Figure 3: *The standardization process is divided into three stages: planning, development, and approval. This flowchart depicts the milestones in each stage, beginning with the project proposal to SPARC (Standards Planning and Requirements Committee of ANSC X3), through the appropriate technical committees (TC) and ANSC X3 (American National Standards Committee for Information Processing Systems), culminating with submission to the secretariat and finally to ANSI.*

work, and a public announcement is issued to that effect.

2. Development: A committee is formed (or assigned) to develop the standard or standards. When work is completed, the proposed standard is transmitted to the approving body.
3. Approval: Approval is obtained through the hierarchical structure of the approving body, and the standard is published.

See figure 3 for an example of these phases in the ANSC X3. To satisfy the commitment to consensus, each phase includes requirements for balanced representation, distribution of information, and approvals. If this is a national standard effort, the liaison and joint participation required for developing an international standard are also found in each phase.

Planning Phase

Any standardization organization may consider a request to establish a standards committee for a particular subject. The request is forwarded to a technically oriented advisory authority within the standardization organization. In ANSI, the Executive Standards Council assigns the subject to a Standards Management Board.

In evaluating the request for initiation of a standards committee, the foremost consideration is that those concerned with the subject have an opportunity to express their views. For this purpose a general conference may be convened, a poll may be taken to determine interest in the subject, or a research study may be undertaken by an ad hoc study group.

When the decision has been made to form a standards committee, appropriate notices are issued to the press and interested parties are encouraged to participate. The Standards Management Board then appoints a secretariat for the committee.

Development Phase

The work of the standards-development committee culminates in the transmittal of a proposed standard to the cognizant authority. This is preceded by a ballot to verify that consensus has been reached. If only one subject was assigned to the committee, the committee ceases to hold meetings but remains ready to process the comments generated during the approval phase of the proposed standard. It should be noted here that if any changes must be made in the technical content as a result of a ballot, the proposed standard is returned to the standards-development committee.

Approval Phase

The approval phase begins when the secretariat receives the proposed standard with the request that it be processed as a national or international standard. The secretariat first determines that all the required documentation has been submitted and then distributes the document for review prior to taking a formal ballot. If comments are received during the balloting process, these are forwarded to the development committee for resolution, and the proposed standard may then be returned to the secretariat for review. The nature of the comments (substantive or editorial) determines whether the next step will be further changes or transmittal to the next higher level of authority.

The proposed standard now enters the stage where processing will be completed to make it a national or international standard. From this point on, no decisions are made on the technical content; the total emphasis is on the evidence of consensus. When the existence of consensus has been validated, the standard-development cycle is complete. The proposed standard is then published in its entirety, or a notice is published indicating that the standard is available.

Operating Procedures

An understanding of the operating procedures of various standards organizations provides one of the best avenues to an understanding of the total process of standardization. It is here that you can best appreciate the checks and balances that constitute the development of a standard and come to understand the slow, laborious, and frequently frustrating delays, which to an outsider seem unwarranted but which are part of the process.

Basic to the process of standardization are the ballot procedures and member involvement. Both of these are indispensable to achieving consensus.

ANSI Voting Procedures

Let's examine the important voting process in detail. The voting period for the letter ballots of a standards committee is six weeks from the date of issue. The results of the ballot remain confidential to the secretariat and the committee officers until the ballot peric closes.

When the ballot period closes, the secretary of the standards committee forwards the ballot tally to the chairman of the standards committee, who determines whether consideration of unresolved negative votes and comments shall be by correspondence or by a meeting of the standards committee or subcommittee involved.

(Often, committee members vote "no" on a given ballot because of minor objections to either the proposed standard or its specifying document. A simple clarifying statement in the standard can change a "no" to a "yes"; the vote is said to have been *resolved.*)

If technical changes must be made to resolve negative votes, these changes must be submitted to the standards-committee membership within the four-week period given for responses. Those who voted in the affirmative must either reaffirm their vote in the light of any substantive changes or cast a negative vote. If negative votes cannot be resolved, these must be reported to the membership of the standards committee, with the reasons given for the negative votes. Each voting member, on receipt of unresolved negative votes and comments from those balloted, must indicate whether or not this affects his original vote. The final result is recorded and reported to the secretariat and to the membership of the standards committee.

At this point, the secretariat may use its discretion as to whether the proposed standard is ready to be submitted for ANSI approval. If at least two-thirds of the standards committee members voting have approved the standard, it is mandatory that the proposed standard together with the necessary exhibits be submitted to ANSI. If this is not done by the secretariat within one calendar month of the ballot closure, one or more of the members of the standards committee may offer the proposed standard for approval.

When the proposed standard reaches ANSI it is examined by the staff to determine that the documentation required has been forwarded and that evidence of consensus exists, just as was done when the proposed standard was submitted to the secretariat for a ballot by the standards committee.

The proposed standard is now submitted to the vote of the Board of Standards Review, which requires an affirmative vote of not less than two-thirds of the full board, taken by written ballot.

Documents

The names of the standards documents will give you a clue to the stages in the standardization process. As the documents containing a proposed standard specification move through the standardization process, the changes in document names indicate the level of acceptance the standard has attained. The following names are used: Working Draft or Preliminary Draft, Proposed Draft or Proposal (proposals submitted for a technical committee ballot), Draft Standard (a Proposed Draft that has received the approval of the technical committee for publication), and Standard (a Draft Standard which has received all the necessary approvals for adoption as a national or international standard).

Member Responsibilities

All standards-committee work is accomplished by volunteers selected from the ranks of the member organizations. At the technical-committee level the individual must be technically competent in the subject and function as an independent "expert." In addition, the participant must become cognizant of all facets of the subject other than his own specific area of expertise in order to understand the viewpoints of other members. This is an essential requirement for obtaining consensus.

In addition to their professional positions within their organizations, participants must plan to spend a fixed portion of their own time on standards-committee work as well as allocate time to inform their own organizations on standards. A detailed knowledge of international protocol is essential so that a technical committee can function properly in the international environment.

International Standardization

International standards are becoming increasingly influential in world trade. Multinational companies find that differing national technical requirements have joined trade tariffs as significant factors in worldwide marketing because they may require a company to produce costly and unnecessary variants of a product. Development of international standards helps resolve these technical barriers to trade.

While it is neither desirable nor intended that international standards should be applied with the force of law, the policy of legislating by "reference to standards" is becoming more and more frequent as technology develops and trade expands. The effective implementation of the "reference-to-standards" technique requires that legislation and regulations be drafted in the form of general requirements that contain references to a standard or a group of standards, which, in turn, provide more detailed explanations of the general requirements, as well as illustrations of the means of meeting the requirements.

If all standards originated at the national level and moved in an orderly fashion to the international level in one organizational structure, few complexities would exist. However, standards originate in many areas and from many organizations and thus involve liaisons with many other organizations. The international organizations best known to the computing community are the ISO, the IEC (International Electrotechnical Commission), and the Comité Consultatif International Téléphonique at Télégraphique (CCITT) of the International Telecommunication Union (ITU).

Conclusion

International standardization provides the solution to the problems of diverse national standards, the protection of consumer interests, and the elimination of trade barriers.

Throughout history, whenever a need for a standard was recognized, the interested parties either formed or designated an organization through which the process of developing standards could take place. Now the development of standards is a vast worldwide activity that could almost be classified as an industry in itself.

Simply put, a standard is a solution to a problem. It is not too surprising then that as our problems get more complex, the process of finding a solution also increases in complexity. Thousands of individuals are involved in standardization work for the computer industry alone, and the work they do affects all of us. Perhaps the information in this article will help you better appreciate the importance of standards and the standards process to our technological world. ■

Where to Obtain Standards Information

ACM Standards Committee
Association for Computing Machinery
11 West 42nd St.
New York, NY 10036

American National Standards Institute
1430 Broadway
New York, NY 10018

Computer and Business Equipment Manufacturers Association (CBEMA)
X3 Secretariat
Suite 500
311 First St. NW
Washington, DC 20001

Electronic Industries Association
Engineering Department
2001 Eye St. NW
Washington, DC 20006

IEEE Computer Society
POB 80452
Worldway Postal Center
Los Angeles, CA 90080

IEEE Service Center
445 Hoes Lane
Piscataway, NJ 08854

Information Handling Services
Product Management Department
15 Inverness Way E
POB 1154
Englewood, CO 80150
(This is a commercial firm that compiles and distributes copies of electronics standards for a fee.)

Institute for Computer Sciences and Technology
A200 Administration
National Bureau of Standards
Washington, DC 20234

United States Department of Commerce
National Technical Information Service
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Springfield, VA 22161

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Welcome to the Standards Jungle

An in-depth look at the confusing world of computer connections.

Ian H. Witten
Computer Science Department
University of Calgary
2500 University Drive NW
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RS-232C, RS-366, RS-423A, RS-449, V.10, V.11, V.24, V.28, X.21, X.21 bis, X.26, X.27, current loop. . . Welcome to the standards jungle. All these are standards or recommendations designed to help you connect computers to terminals, modems, and computer networks. Why are there so many? What are the differences between them? The similarities? I'll attempt to guide you through this horrendous complication of standards, but first let's take a look at where these standards originated.

The standards or recommendations I'll cover come from two organizations. The standards with the RS prefix are from a United States organization, the Electronic Industries Association (EIA). These are the most widely used standards for computer equipment in North America and hence the world at this time. The standards prefixed by a V or X are from the Comité Consultatif International Téléphonique et Télégraphique (CCITT), a committee of the International Telecommunications Union, which is an agency of the United Nations. The concerns of the CCITT encompass all aspects of telecommunications worldwide. Because of sometimes conflicting factors influencing its decisions, such as special national requirements and geopolitical concerns, the CCITT makes recommendations rather than standards. Although the EIA standards and the CCITT recommendations are almost identical in many cases, they differ somewhat in wording and detail. Additionally, the CCITT has taken a separate direction from the EIA in the past few years, which I will discuss later. (A complete copy of the standards and recommendations can be purchased by writing to the respective organizations: EIA, 2001 Eye St. NW, Washington, DC 20006; and CCITT, United Nations Bookstore, United Nations Assembly Building, New York, NY 10017.)

The EIA standards are the most widely used standards for computer equipment in the world.

An RS-232C Beginning

My jungle tour starts with a whirlwind overview of the standards listed in table 1, after which I'll describe each one in greater detail. A good place to begin is with the most popular standard for connecting computers to modems and terminals, RS-232C. The official title for this complicated standard is *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Interface.* The C in RS-232C indicates that it has been revised. This standard includes much more than just the transmit-and receive-data wires you use to connect a terminal to a computer.

The RS-232C standard has four parts: electrical signal characteristics, interface mechanical characteristics, functional description of the signals, and a list of standard subsets of signals for specific interface types. The first part defines the voltages to be used and their interpretations as 0s and 1s. The second gives you the size

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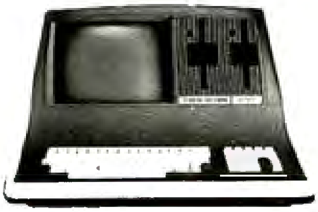

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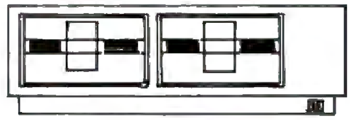

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EIA	CCITT	Approx. Date	Speed/Distance	Purpose
RS-232C	V.24, V.28	1969	20,000 bps and 50 ft.	interface specification for modem control, including electrical and mechanical characteristics and functional definitions of signals
RS-366	V.25			automatic calling unit used in conjunction with a modem to allow a computer to dial calls
RS-422A	V.11, X.27	1975	10 million bps and 40 ft 100,000 bps and 4000 ft	electrical specification only; two-wire connection for each signal
RS-423A	V.10, X.26	1975	100,000 bps and 40 ft 1000 bps and 4000 ft	electrical specification only; one-wire connection for each signal with common return wire
RS-449		1977	2 million bps using RS-422A 20,000 bps using RS-423A	interface specification for modem control, using RS-423A as electrical specification, with option of RS-422A for some wires
	X.21	1976		interface specification for data equipment to public data network, using synchronous format and digital rather than analog transmission on telephone networks
	X.21 bis	1976		modification of X.21 to allow its use with existing synchronous data equipment and analog telephone networks—essentially the same as V.24 and RS-232C
current-loop (not officially sanctioned)			10,000 bps and 1500 ft	provides send and return data paths only (no modem control)—not a proper standard—used originally for Teletype terminals and now used on many microcomputers

Table 1: *The standards jungle.*

of the plug and the disposition of the pins. The third, which I'll discuss in most detail, gives a functional description of the 21 signals which make up the RS-232C standard. The fourth part lists about 14 subsets of these 21 signals that are used in different types of modems. The CCITT recommendation, V.24, is almost identical with RS-232C; however, the electrical signal characteristics are specified separately in a companion recommendation, V.28.

When you access a computer over

telephone lines, the computer must connect to a modem or data set (*data set* is the term used instead of *modem* in Bell System literature). The computer's modem communicates through the telephone network to another modem that connects to your terminal. This configuration involves two RS-232C interfaces: one between the computer and its modem and the other between your terminal and its modem. Official terminology labels both the computer and your terminal DTEs (data terminal equipment) and labels the modems DCEs (data circuit-terminating equipment, most often some sort of data-communication equipment).

Because you often want the choice of using your terminal with a modem or directly connecting it to a computer's output port, the RS-232C standard frequently provides both connections. Strictly speaking, the RS-232C standard was never intended for connecting a DTE device directly to another DTE, and most of its signals are unnecessary in that application. When manufacturers claim that a product is RS-232C-compatible they usually mean that the equipment accepts and generates only a small fraction of the RS-232C signals and also doesn't violate any other parts of the standard.

Generally, the RS-232C standard covers such things as the protocol for answering calls and modem control for reversing the transmission direction in a half-duplex link. It does not, however, cover the requirements for autodial units. This information is provided by the companion specification, RS-366 (comparable to CCITT recommendation V.25), which defines how the computer presents the digits to be dialed to the autodialer, how the computer signals the end of the number, and what occurs when the autodialer cannot successfully complete the call.

The major drawback to RS-232C is its limited transmission distance of 50 feet. In practice, you can go considerably farther, but always at your own risk. A second disadvantage is its maximum transmission speed, although this is not usually a limitation in applications between computers and terminals. While RS-232C can operate at speeds up to 19,200 bits per second (bps), the data rate between computer and terminal is usually 9600 bps at best, and it is very difficult to transmit data even at this slower rate over the switched telephone network.

The distance restriction is not a serious disadvantage if you use modems to access a remote computer. The modems usually sit beside the computer and terminal, and the long-haul transmission takes place between them over telephone lines. In local applications, however, you often find RS-232C connecting terminals directly to computers, simply because it is obviously convenient to use the same terminal and computer interface whether or not a modem connection is used. This is where the 50-foot limit becomes restrictive. Furthermore, the RS-232C voltage levels are not particularly convenient because they aren't the same as those in standard TTL (transistor-transistor logic) and MOS (metal-oxide semiconductor) technologies now dominating computer implementations.

This means you need an additional power supply with this configuration.

Because of these problems with RS-232C, the current-loop interface, made famous by the original Teletype terminals, has come back in fashion, particularly for low-cost home computers. This interface is not a proper standard, with both 20- and 60-milliamp (mA) versions, but it usually works over distances of up to 1500 ft at rates of up to 9600 bps. Unfortunately, the current-loop interface is completely incompatible with RS-232C and requires you to use switchable, dual-standard hardware or conversion boxes. Moreover, the interface comes in two flavors: active, which actually generates the current, and passive, which either detects the current or signals by switching it on and off. The conversion boxes enable passive devices to communicate with active devices. For example, a microcomputer usually contains the active interface and a terminal has the passive one, which means you must have an active-to-active conversion to directly connect two microcomputers.

Overcoming Defects

The EIA introduced standards RS-422A, RS-423A, and RS-449 to overcome the defects of RS-232C and to incorporate and improve upon the advantages of the current-loop interface. A major change was to unbundle the joint electrical, mechanical, and functional specifications of RS-232C. Just the electrical specifications are in RS-422A and RS-423A. To allow you to transmit data at high rates, RS-422A uses two wires for each signal. This setup, known as *balanced* transmission, doubles the number of wires in the cable. RS-423A transmits at lower speeds and uses one wire as a common return path for all signals. This is called *unbalanced* transmission and is similar to the design of RS-232C. The RS-423A standard operates in both RS-232C and RS-422A environments and thus provides users of existing equipment with a migration path to move to the new RS-422A regime.

The EIA has introduced RS-449 as its intended successor to RS-232C. The standard provides a complete functional description of the signals needed for modem control, together with the mechanical specification of the plugs and sockets. The electrical specification for most signals is RS-423A, but RS-422A is also available for high-speed operation if necessary. RS-449 has a horrendous number of wires (46 as opposed to the 25 of RS-232C) in two plugs, one with 37 pins and one with 9. Fortunately, most applications don't require the signals in the 9-pin plug. Apart from its improved speed and distance specifications, RS-449 offers some minor functional enhancements over RS-232C in automatic modem testing and a provision for a standby channel, but it still does not incorporate dialing out. The success of RS-449 in the commercial market remains to be seen.

Meanwhile, the CCITT has been steering a different course. With its X.21 recommendation, introduced in

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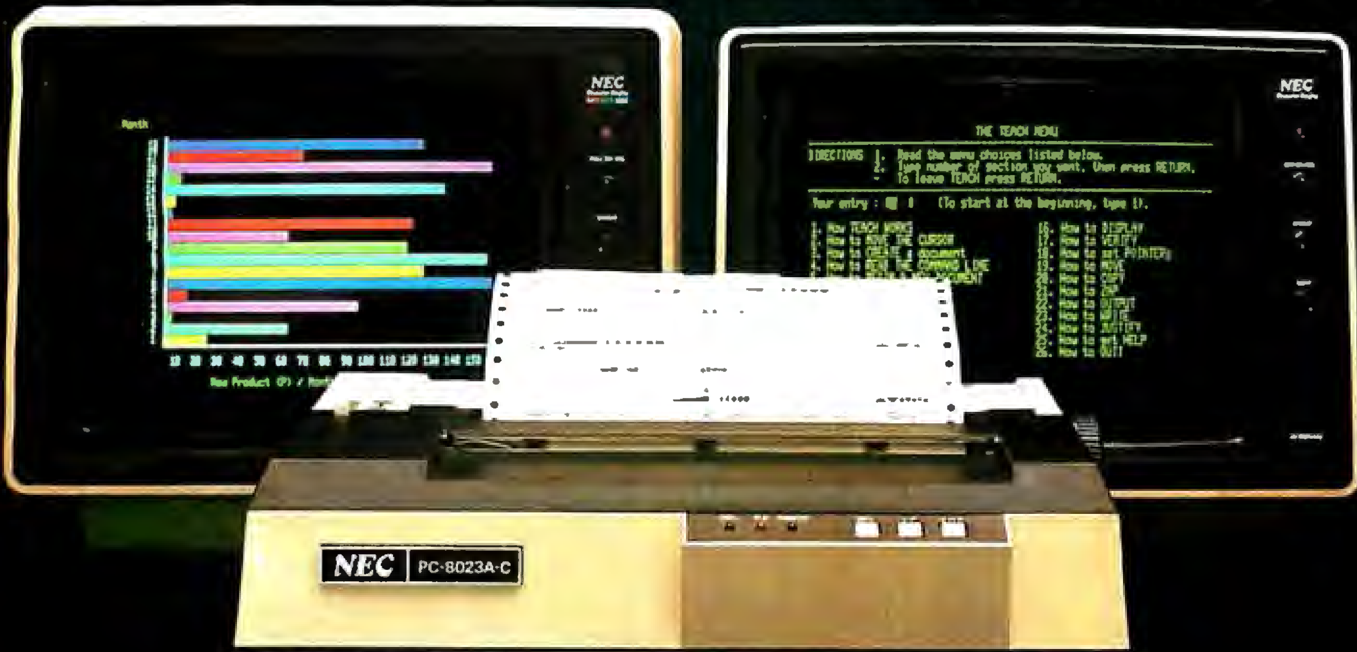

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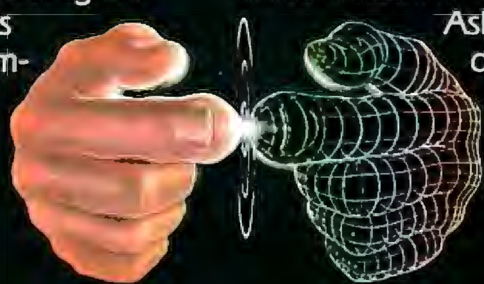

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7	AB	102	Signal Grounc	
2	BA	103	Transmitted Data	
4	CA	105	Request To Send	
20	CD	108.2	Data Terminal Ready	
23	CH	111	Data Signaling Rate Selector (DTE source)	DTE (computer interface)
24	DA		Transmitter Signal Element Timing (DTE source)	
14			Secondary Transmitted Data	
19			Secondary Request To Send	
3	BB	104	Received Data	
5	CB	106	Clear To Send	
6	CC	107	Data Set Ready	
22	CE	125	Ring Indicator	
	CF	109	Received Line Signal Detector	
	CG		Signal Quality Detector	
	CI		Data Signaling Rate Selector (DCE source)	DCE (modem or terminal)
	DB		Transmitter Signal Element Timing (DCE source)	
	DD	115	Receiver Signal Element Timing (DCE source)	
	SBB	119	Secondary Received Data	
	SCB	121	Secondary Clear To Send	
	SCF	122	Secondary Received Line Signal Detector	

Table 2: *RS-232C signals.*

1976, it is obvious that the committee looks forward to the day when direct digital connection to a digital telephone network will be possible. Then all data transmission will be synchronous, and the communication equipment will provide bit and byte timing signals. X.21 includes the protocol for making and answering calls and for sending and receiving data using full-duplex synchronous transmission. Byte-timing signals are in fact an option, which the vast majority of digital telephone exchanges will almost certainly provide. In sharp contrast to RS-449, X.21 uses only six signals. The electrical specifications are in recommendations X.26 (corresponding to EIA RS-422A) and X.27 (EIA RS-423A).

Although X.21 is defined as the lowest (or "physical") level of the international X.25 packet-switching protocol, it is far ahead of its time, for direct digital connection to public telephone networks is hardly possible now. For this reason, CCITT offers the X.21 bis recommendation as an interim measure to connect existing computer equipment to packet communication services. With this, the wheel turns full circle, for this recommendation is essentially the same as RS-232C (V.24), and sadly, its use is almost universal in packet-switching protocol today.

I have, in the tradition of all great guides, followed a circular path. To create a more detailed path through this standards jungle, let's look closer at each of the standards I have mentioned.

The RS-232C Standard

The 21 signals in RS-232C are numbered according to three systems: pin numbering used in the conventional 25-pin connector, the EIA RS-232C numbering, and the CCITT V.24 numbering (see table 2). I will explain each of the signals by providing a variety of different applications of the standard, each using progressively more signals.

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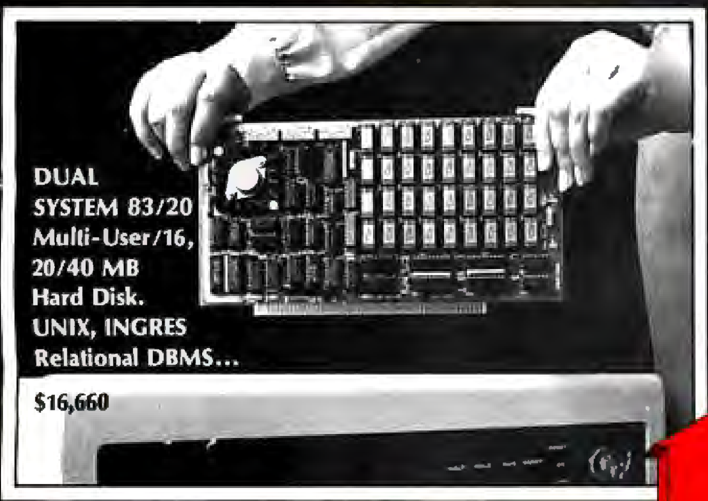

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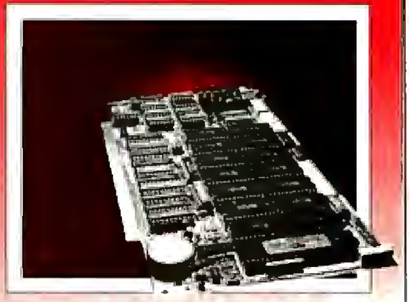

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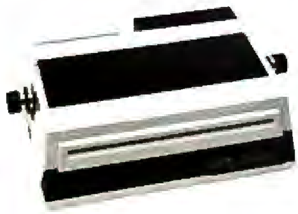

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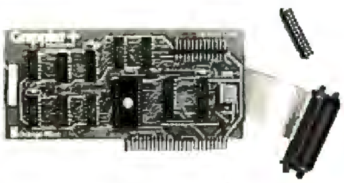

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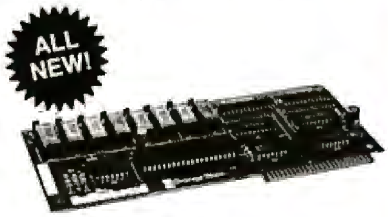

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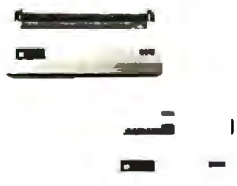

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Video Display Terminal—signals used: *Protective Ground, Signal Ground, Transmitted Data,* and *Received Data.* The Protective Ground is for safety and connects to the equipment chassis at both ends of the link. The Signal Ground establishes a common ground reference voltage for all data signals. Transmitted Data is the data path from the computer interface to the terminal, while Received Data is the path in the reverse direction. You don't need any other connections for a simple asynchronous RS-232C-compatible terminal interface.

Serial Printer—signals used: *Protective Ground, Signal Ground, Transmitted Data,* and *Data Set Ready.* Because the data connection to the printer is only in one direction, you don't need the Received Data line. However, most printers cannot accept characters continuously at an even rate. For example, a daisy-wheel letter-quality printer takes a significant time to move the print head from one position to another, and so the printing rate depends on character spacing. A Return character generally takes longer than other characters because in most cases the print head has to move farther across the paper than for other characters. This presents the problem of flow control; the printer must provide feedback to the computer interface to control the data flow. The Data Set Ready line is one way to provide the feedback.

You can use the ASCII control codes DC1 and DC4 to regulate data flow to a serial printer.

Actually, Data Set Ready has other purposes. A modem uses it to indicate that its power is on and that the modem is ready to receive data for transmission. Many software device drivers examine this signal before transmitting each output character and simply delay transmission until it is in the on state. Therefore, you can use the signal for flow control, even though it was not designed for that purpose. You can also use other lines, such as Clear To Send, for the same purpose.

Another technique for regulating data flow to a device like a serial printer is to use the ASCII (American National Standard Code for Information Interchange) control codes DC1 (device control 1, often called XON) and DC4 (often called XOFF). These codes correspond to the control characters Control-Q and Control-S respectively. Some software device drivers use them to suspend and resume output to a terminal. When you use these codes for flow control on a printer, you connect the Received Data line rather than the Data Set Ready line. The printer then transmits Control-S when its buffer is full and Control-Q when it is ready for more data.

Many printer manufacturers cater to both flow-control methods. However, in practice, significant problems can arise with each of them. When the printer is connected through a modem, there is no connection between the states of the Data Set Ready lines at the two ends of the link, and so you can't use the first method, which is meant for purely local use. The XON/XOFF protocol should work fine over a telephone connection, provided the operating system you use responds quickly to the XOFF control character. While a few extra characters don't usually matter on a video display terminal, they can mean a disastrous buffer overflow for a printer. The same result may occur due to characteristics of a terminal multiplexer, which in many cases has internal character buffers that store several characters awaiting transmission. When XOFF arrives, the data to the printer will not cease immediately, even if the operating system instantly stops sending characters. In another case, if you connect your printer to the printer port provided on some terminals, you may again see a delay in the execution of the XOFF command due to the buffering going on in that unit.

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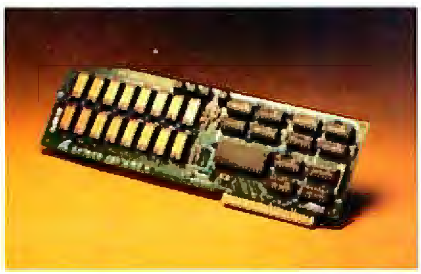

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intended for DTE-to-DTE connections. Thus it is not surprising that problems arise when the standard is used for such purposes. After all, these flow-control methods are ad hoc mechanisms tacked on to an unsuitable standard.

Full-Duplex Private-Line Modem—signals used: *Protective Ground, Signal Ground, Transmitted Data, Received Data, Received Line Signal Detector*, and (possibly) *Data Set Ready*. The Received Line Signal Detector, often called Carrier Detect, says in effect, "I hear something like a modem talking to me." You use this signal to tell the computer that someone is trying to make contact on that line. You could use it to trigger the computer to generate a log-on invitation. Data Set Ready may indicate that the modem is ready and not in voice or test mode, but this is not a common practice in North American asynchronous modems.

Half-Duplex Private-Line Modem—signals used: *Protective Ground, Signal Ground, Transmitted Data, Received Data, Request To Send, Clear To Send, Received Line Signal Detector*, and (possibly) *Data Set Ready*. Request To Send and Clear To Send control the transmission direction in the half-duplex operation. The computer generates Request To Send when it wants to transmit. The Clear To Send signal indicates that the modem is ready to receive characters for transmitting. There will be a delay—typically 200 milliseconds (ms)—between the Request To Send signal from the computer and the Clear To Send handshake, because the modem must generate the carrier waveform and allow it to stabilize. When the transmission finishes, the computer drops Request To Send, causing the modem to turn the transmitter off. To ensure that both ends of the link cooperate in choosing the direction of the transmission, you need a software protocol.

Switched Network Auto-Answer Modem—signals used: *Protective Ground, Signal Ground, Transmitted Data, Received Data, Request To Send, Clear To Send, Data Terminal Ready, Ring Indicator, Received Line Signal Detector*, and (possibly) *Data*

Set Ready. Here, the additional signals are Data Terminal Ready, which shows that the computer is ready to receive calls, and Ring Indicator, which signals that the modem has received a new call. The Ring Indicator signal goes up and down as the telephone bell rings so that the computer can answer after a specified number of rings. If the computer leaves Data Terminal Ready on, the modem answers incoming calls immediately. If it is off, the computer should turn on the signal, after the appropriate number of rings, to answer the call. At the completion of the call, the computer should turn off Data Terminal Ready to ensure that the line is disconnected. Normally this is not necessary, because the line should disconnect automatically when the calling party hangs up the phone, but it is good practice to force disconnection at both ends.

Dual-Rate Modems—extra signals used: *Data Signaling Rate Selector (DTE source)* and *Data Signaling Rate Selector (DCE source)*. Some modems allow switching between two transmission speeds. These two signals control whether the modem uses the high or low speed. Usually the modem at the calling end sets the speed for the connection. In this case, the calling computer uses the Data Signaling Rate Selector (DTE source) to determine the line speed. The calling modem signals the speed to the answering modem, which informs the called computer by setting Data Signaling Rate Selector (DCE source) appropriately.

Synchronous Modems—Extra signals used: *Signal Quality Detector, Transmitter Signal Element Timing (DTE source), Transmitter Signal Element Timing (DCE source),* and *Receiver Signal Element Timing (DCE source).* Synchronous modems provide a clock signal along with the data. In the case of received data, the modem provides the Receiver Signal Element Timing (DCE source) or the clock. For transmitted data, the modem may still provide the clock signal on Transmitter Signal Element Timing (DCE source). Or the computer equipment (DTE) may generate a timing signal instead, called Transmitter Signal Element Timing (DTE source). Synchronous modems also provide a signal which shows whether or not there is a high probability of an error in the received data (Signal Quality Detector).

Modems with Primary and Secondary Channels—extra signals used: *Secondary Transmitted Data, Secondary Received Data, Secondary Request To Send, Secondary Clear To Send,* and *Secondary Received Line Signal Detector.* Some modems provide a primary transmission channel with a high data rate (e.g., 1200 bps) and a secondary channel in the reverse direction with a much lower data rate (e.g., 75 bps). The reverse channel allows you to listen and confirm reception or to interrupt the transmitter. The channel directions can be reversed, and the above set of five signals allows you to control the secondary channel in much the same way as the primary one.

Do you know what happens when you make a call to a computer on a 300-bps full-duplex switched line?

A Scenario

The following sequence of events, illustrated in table 3, will show you what happens when you make a call to a computer on a 300-bps full-duplex switched line. To begin, the computer expects a call and so it leaves Data Terminal Ready on, which in turn sets the computer's modem ready to answer a call as soon as one is received. When this happens, the computer sees Ring Indicator (which it can ignore because Data Terminal Ready is already on) and Data Set Ready (the signal for the computer to generate Request To Send). In the preceding section, I explained Request To Send and Clear To Send in the context of half-duplex calls. In fact, full-duplex modems use them also. Request To Send commands the modem to turn on its transmitter. After a short delay, the computer sees Clear To Send and ignores it. At the other end of the line, you hear the carrier signal and either push the data button (on a data set) or put the telephone handset onto the acoustic coupler. Now your modem's transmitter turns on, producing its own carrier whistle. When the modem at the computer end hears this, it turns on Received Line Signal Detector. Upon receiving this signal, the computer begins sending data. Many operating systems, however, ignore this signal and simply wait for you to send a character to begin the log-on process.

At the end of the transmission, assume that the computer decides to terminate because you logged off. The computer turns off Request To Send, which then turns off the computer's modem carrier signal. The computer then turns off Data Terminal Ready, forcing the line to be disconnected. Meanwhile, in your modem, Received Line Signal Detector goes off and generates a warning note to you. You replace the handset, ensuring that the line disconnects from your end also. When the computer sees its Received Line Signal Detector turn off, it knows that the disconnection is complete, and so raises Data Terminal Ready in preparation for the next call.

RS-232C and RS-449: What's the Difference?

RS-232C is being superseded by a new standard, RS-449. Technically, the major differences between them result from RS-449's using improved electrical-transmission standards. To explain these improvements, I will first describe the electrical specifications of RS-232C.

An RS-232C transmitter generates a voltage of above +5 volts (V) to signal one line condition, called Space, and a voltage of below −5 V to signal the other condition, called Mark. To produce these voltages, you generally use a power supply of ±12 V. A receiver recognizes voltages of above +3 V as Spaces and voltages of below −3 V as Marks (see figure 1). When a signal changes from one condition to the other, it can spend, at most, 4 percent of a bit period (the duration of a bit: 2

Terminal	Line	Computer
		Data Terminal Ready is on in anticipation of a call
raise handset and dial		
	connect call	
		see Ring Indicator and Data Set Ready, generate Request To Send
	carrier whistle	
hear carrier (analogous to Received Line Signal Detector)		(after short delay, see Clear To Send)
push data button (see Data Set Ready light)	carrier signal	
		see Received Line Signal Detector
	—carry on communication—	
		set Request To Send off
	no tone from computer	
modem's Received Line Signal Detector goes off, modem generates warning note, replace handset		set Data Terminal Ready off, Clear To Send and Data Set Ready go off
	call disconnected	Received Line Signal Detector goes off, set Data Terminal Ready on in preparation for next call

Table 3: *The sequence of events in a 300-bps dialed call, proceeding from top to bottom.*

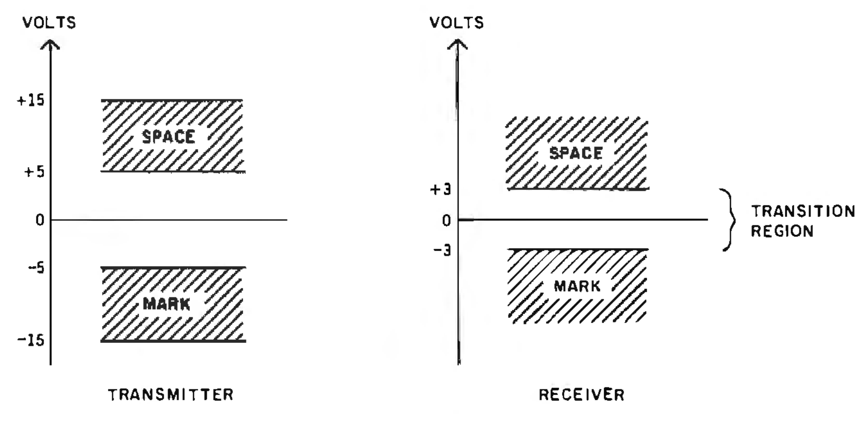

Figure 1: *RS-232C signal levels.*

microseconds at the maximum speed of 19,200 bps) in the transition region. This requirement limits the amount of stray capacitance allowable in the transmission link because capacitance smooths out sharp transitions. RS-232C specifies that the capacitance must not exceed 2500 picofarads (pF); and, because ordinary cables have a capacitance of 40 or 50 pF per foot, RS-232C limits cables to 50 feet.

A second difficulty of RS-232C is its grounding arrangements with two separate lines: Protective Ground and Signal Ground. Unfortunately the standard does not state clearly how these signals are to be used. In many implementations, the Protective Ground is simply not connected.

Grounding for distributed analog systems is a notoriously difficult subject. To give you a simple idea of the problems that could occur, imagine an RS-232C link between two pieces of equipment where Protective Ground is not connected but where Signal Ground is connected to the earth at both ends (this is quite a common arrangement). Different ground potentials at the ends of the link cause a ground current to flow through the Signal Ground wire. The inevitable resistance in this wire insures that a potential difference between the Signal Grounds exists that could, if large enough, cause the data to be received incorrectly.

The obvious way to overcome ground potential differences between the transmitter and the receiver is to send the signal differentially on two wires. The difference between the voltages on the wires determines whether a Mark or a Space is read. This is how RS-422A works, and you may recall that this technique is known as balanced transmission. Figure 2 shows an RS-422A signal, carried on a twisted pair of wires. A balanced transmission would use two of these signals.

Of course, you can regard even RS-232C as transmitting a signal differentially, with the difference being between the signal-wire voltage and the ground-wire voltage. What makes this approach inferior is that the ground wire actually connects to the

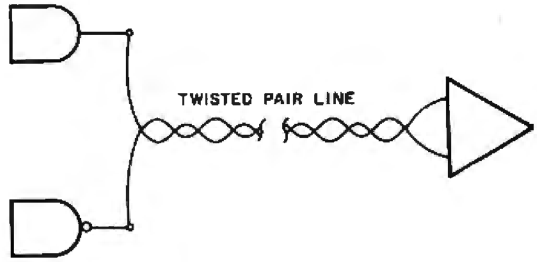

Figure 2: *An RS-422A signal.*

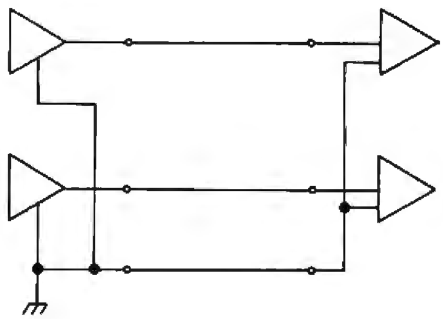

Figure 3: *Two RS-423A signals.*

ground at each end. Then if the ground potentials differ, the ground wire carries a substantial current. The amount of the current depends on the ground-potential difference and the electrical resistance of the ground wire. This current makes the potential of the ground wire different at each end. The RS-422A grounding requirements are much less critical than those of the RS-232C because the standard does not use ground as a voltage reference. Therefore, the use of the Signal Ground wire, which connects the grounds at each end of the link, is optional.

The third major difference between RS-422A and RS-232C is the transition region between Mark and Space states. This is only 400 millivolts (mV) in RS-422A, whereas it is 6 V in RS-232C. With the elimination of the ground-potential problem, the use of such a narrow region becomes possible. If the difference signal between the two wires is positive and more than 200 mV, the receiver reads a Mark, while if it is negative and more than 200 mV, the receiver reads a Space. This approach allows suitable transmitters and receivers to be implemented with just the normal ±5-V power supply.

Because of the much smaller transition region, RS-422A transmitters will not drive RS-232C receivers correctly. This incompatability poses such a serious disadvantage that the EIA introduced the RS-423A standard, which you can use with both RS-449 and RS-232C. This standard is not just an interim measure, however, for RS-423A does not use two wires for each signal as RS-422A does and thus is more economical. You can see two RS-423A signals in figure 3. Each direction uses a common return path that connects to ground at one end of the link only, the transmitter end. The receiver judges whether a Mark or Space is present by examining whether the signal wire is negative or positive with respect to the common return. Because this return path does not connect to ground in the receiver, the

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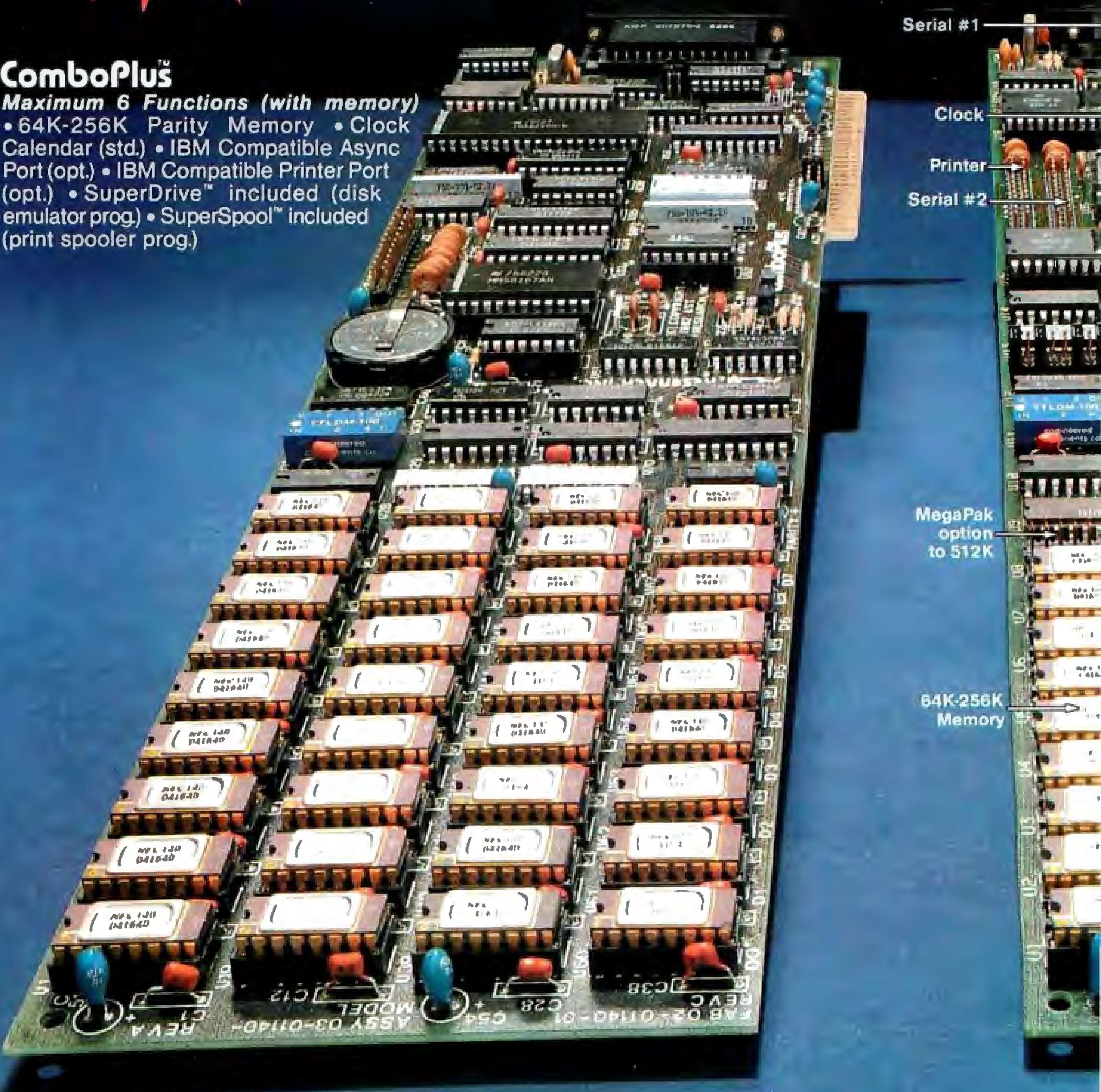

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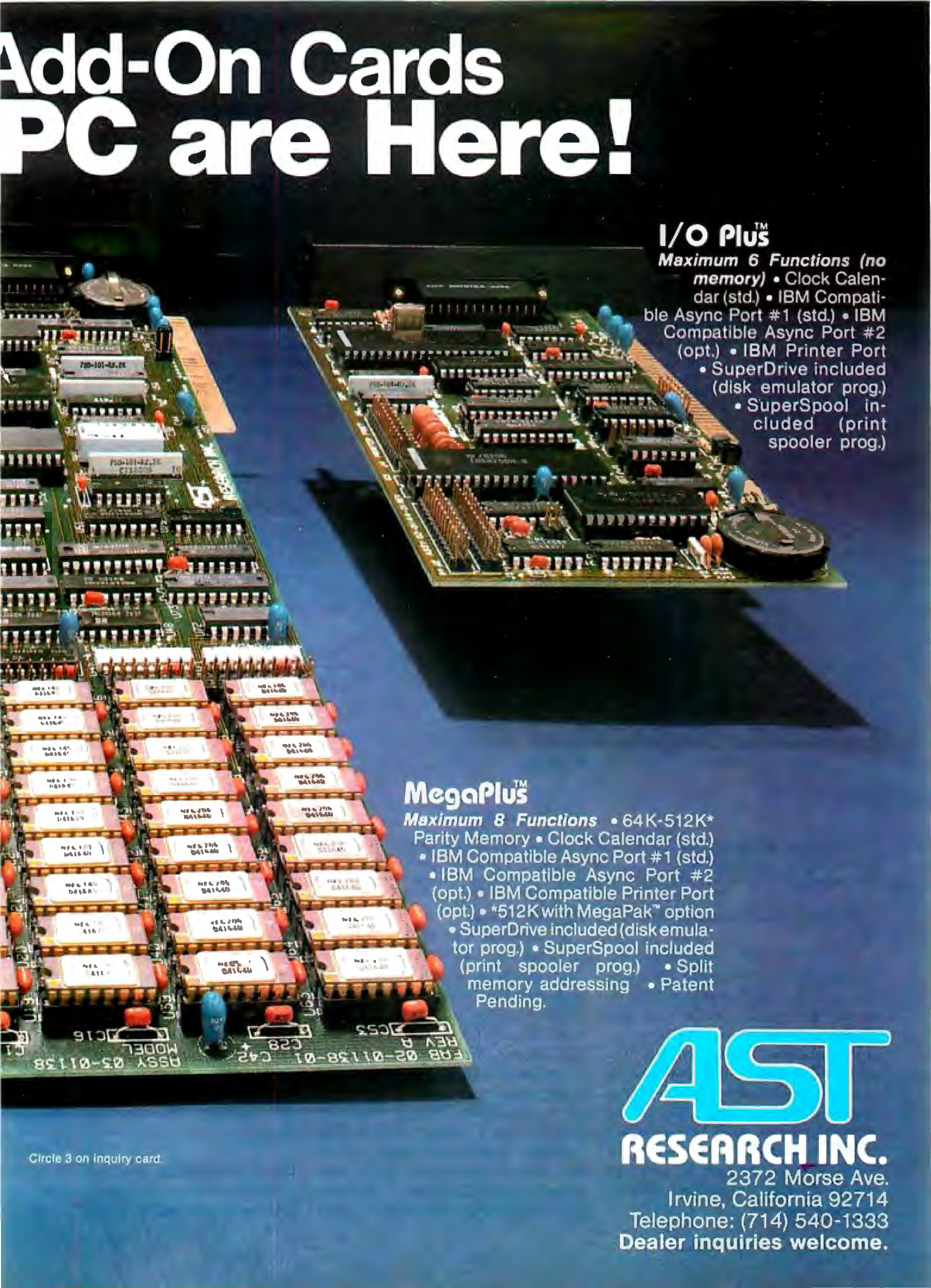
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37/37 9/9	SC	Signal Common		
37/20 9/6	RC	Receive Common		
37/28	IS	Terminal In Service		
37/15	IC	Incoming Call	CE	Ring Indicator
* 37/12 37/30	TR	Terminal Ready	CD	Data Terminal Ready
* 37/11 37/29	DM	Data Mode	CC	Data Set Ready
* 37/4 37/22	SD	Send Data	BA	Transmitted Data
* 37/6 37/24	RD	Receive Data	BB	Received Data
* 37/17 37/35	TT	Terminal Timing	DA	Transmitter Signal Element Timing (DTE source)
* 37/5 37/23	ST	Send Timing	DB	Transmitter Signal Element Timing (DCE source)
* 37/8 37/26	RT	Receive Timing	DD	Receiver Signal Element Timing
* 37/7 37/25	RS	Request To Send	CA	Request To Send
* 37/9 37/27	CS	Clear To Send	CB	Clear To Send
* 37/13 37/31	RR	Receiver Ready	CF	Received Line Signal Detector
37/33	SQ	Signal Quality	CG	Signal Quality Detector
37/34	NS	New Signal		
37/16	SF	Select Frequency		
also 37/16	SR	Signaling Rate Selector	CH	Data Signal Rate Selector (DTE source)
37/2	SI	Signaling Rate Indicator	CI	Data Signal Rate Selector (DCE source)
9/3	SSD	Secondary Send Data	SBA	Secondary Transmitted Data
9/4	SRD	Secondary Receive Data	SBB	Secondary Received Data
9/7	SRS	Secondary Request To Send	SCA	Secondary Request To Send
9/8	SCS	Secondary Clear To Send	SCB	Secondary Clear To Send
9/2	SRR	Secondary Receiver Ready	SCF	Secondary Received Line Signal Detector
37/10	LL	Local Loopback		
37/14	RL	Remote Loopback		
37/18	TM	Test Mode		
37/32	SS	Select Standby		
37/36	SB	Standby Indicator		

number of signals in list	30
less number of signals which share a pin	−1
number of extra pins for balanced-line signals	+10
duplicate grounds/commons (one for each cable)	+3
cable shields	+2
spare pins	+2
total pins:	46

Table 4: *RS-449 signals and their RS-232Cd analogs. Signals marked with an asterisk (*) use RS-422A for higher-speed links; all other signals use RS-423A.*

problem of ground currents does not arise.

For an RS-423A transmitter, the voltage difference between the signal line and the common return must be at least 4 V, positive for a Space and negative for a Mark. This gives an 8-V transition region—enough for RS-232C receivers—but also presents the same power-supply problem that occurs with the RS-232C. Because the RS-423A receiver must be as sensitive to the same 400-mV transition region as an RS-422A receiver is, you can use an RS-422A transmitter with an RS-423A receiver.

RS-449 Signals

It's obvious that RS-449 provides few functional advantages over RS-232C except those stemming from the new electrical transmission methods. Table 4 shows all RS-449 signals, together with the corresponding RS-232C signals. Notice the similarity between the new and old standards. The major differences are in the grounding arrangements (Signal Common and Receive Common) and testing facilities. Apart from these, only a few miscellaneous signals have been added. All signals shown in the table use the RS-423A transmission standard except the 10 asterisked ones, which may optionally use the RS-422A for higher-speed links. (Two wires are specified for each of these.) The signals are divided between a 37-pin and a 9-pin connector, and the ground and common signals are transmitted separately for each cable. Many applications will not need the smaller cable, for it only contains signals relevant to the secondary channel.

The Current-Loop Interface

Now that I have described the electrical specifications for RS-232C, it is

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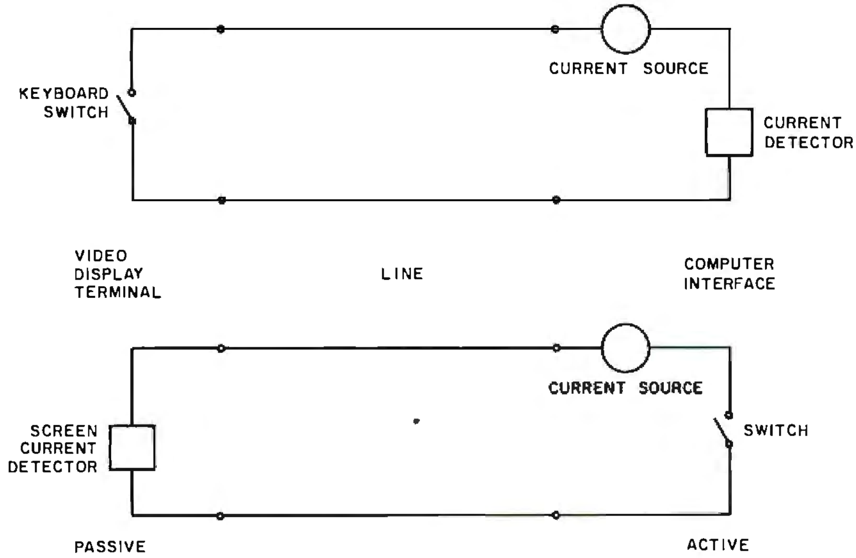


Figure 4: *Computer-to-terminal interface using current loops.*

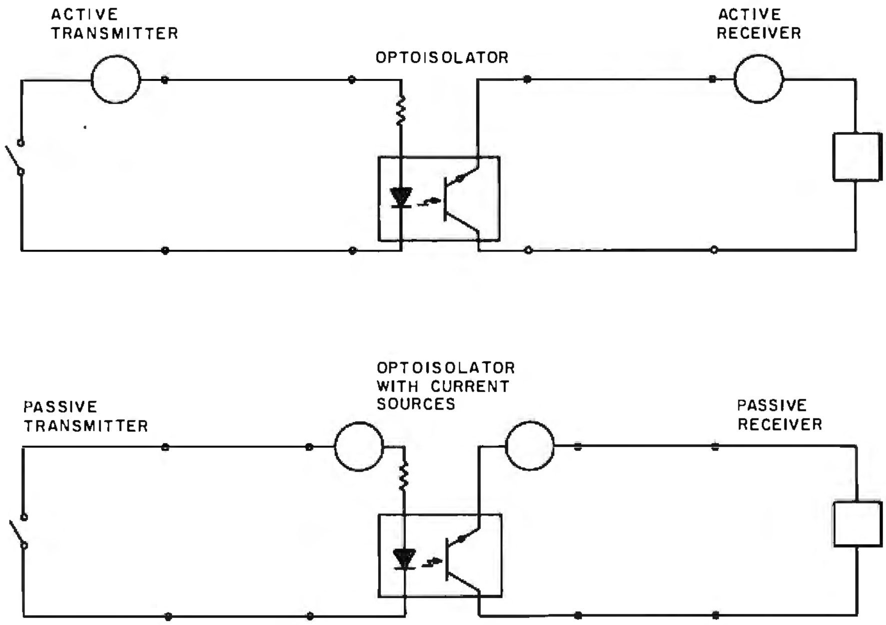


Figure 5: *Active-to-active and passive-to-passive converters.*

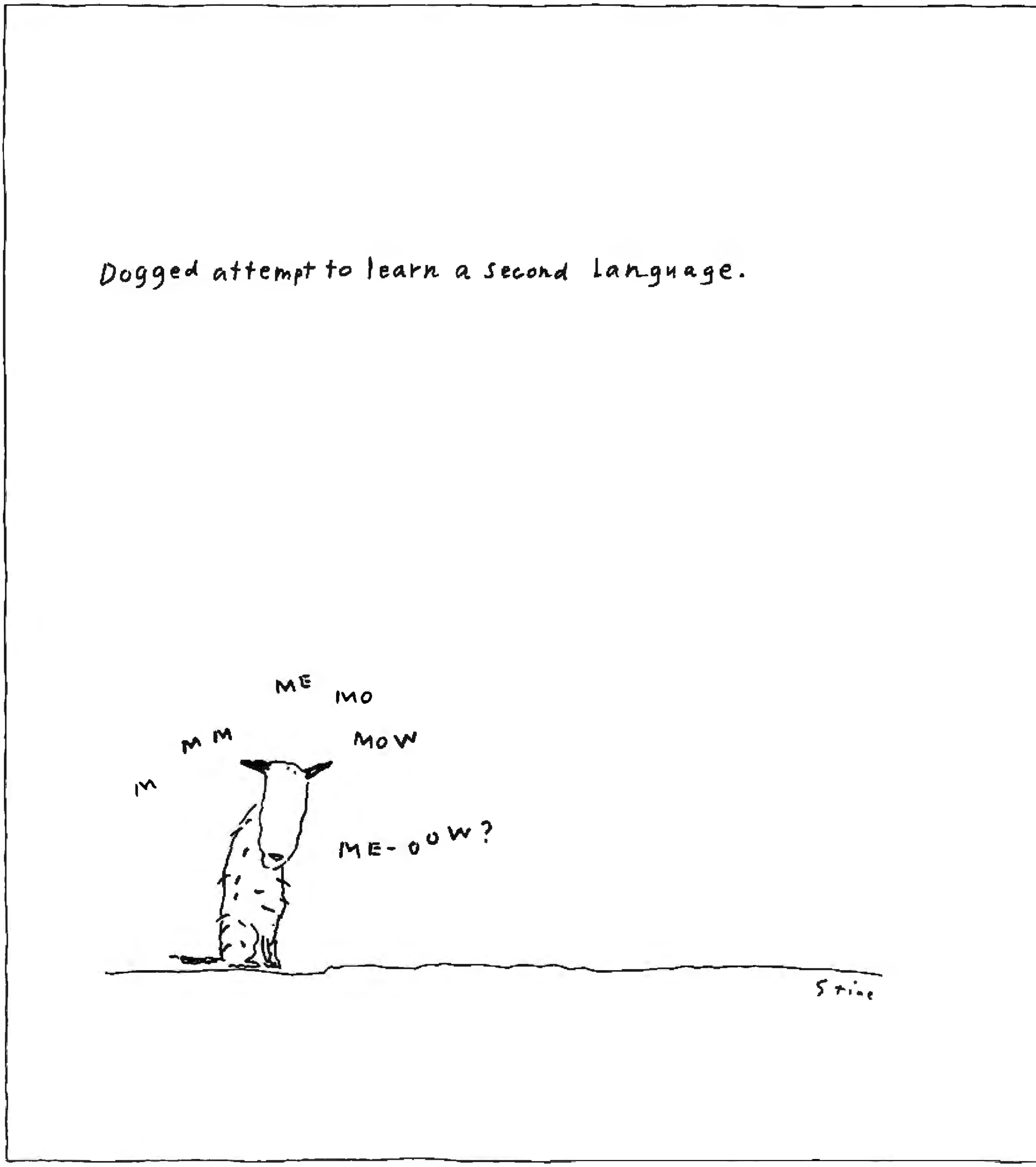
worth looking at the current-loop interface in more detail. Although this interface does not represent a proper standard, many low-cost microcomputer systems are using current loop because it eliminates the need for special power supplies. The current-loop interface is not a modem interface, as RS-232C and RS-449 are. It generally contains just the transmit- and receive-data signals. However, it can drive signals at reasonable speeds over respectable distances (9600 bps over 1500 feet), which makes it useful for directly connecting terminals to computers.

The idea of the current loop is to switch a current on and off. The active side of the line generates the current, while the passive side switches or detects it. Either the receiver or transmitter can be active. This gives you four possibilities: Active Receiver, Active Transmitter, Passive Receiver, and Passive Transmitter. Because of the convenience of locating the power supply at just one end of the link (usually the computer), you will find all four of these signals in a single computer-to-terminal connection. You can see this arrangement in figure 4.

Unfortunately, this convention introduces the need for active-to-active and passive-to-passive converters. It is obvious that each link must have one active component (otherwise there is no current to switch), and it is also true that a link may have only one active component, at least in most implementations. Hence, if you want to connect a passive terminal directly to another passive terminal, you must put a passive-to-passive converter in between. Similarly, if you want to connect an active computer to an active computer, you will need an active-to-active converter. These converters are easy to implement and are shown in figure 5. The optoisolator provides complete electric isolation between the two sides, thus eliminating any problems with ground potential differences. The active-to-active converter does not even need a power supply, although the passive-to-passive must have one to generate the current.

Automatic Calling Units

None of the standards examined so far support the automatic placement of calls by a computer. RS-232C and RS-449 provide specifications for answering calls, but not for dialing. For this there is another standard, RS-366 (CCITT V.25) for automatic calling units. Making a telephone call can be quite complicated, although most of us are so used to it that we don't think about the complexity. The computer must be able to determine whether the line is free, figuratively take the phone off the hook, await the dial tone, present the telephone number, and detect and decipher the various audio signals that the telephone network uses to indicate the status of a call (the dial tone, the busy tone, the ringing tone, and the number-unavailable tone).



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202	Call Request	
206	NB1	
207	NB2	DTE (computer interface)
208	NB4	
209	NB8	
211	Digit Present	
203	Data Line Occupied	
204	Distant Station Connected	DCE (automatic calling unit)
205	Abandon Call	
210	Present Next Digit	
213	Power Indicator	

Table 5: *The signals used by RS-366 and V.25 automatic calling units.*

Digit Code	NB8	NB4	NB2	NB1
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
EON	1	1	0	0
SEP	1	1	0	1

Table 6: *Number codes for automatic calling units. In the last four columns a 0 stands for on and a 1 stands for off.*

The signals for the automatic-calling-unit standard are listed in table 5. Data Line Occupied tells the computer if someone is already on the line. After checking that the line is free, the computer indicates that it wants to place a call by using Call Request. This effectively takes the phone off the hook. When the automatic calling unit hears the dial tone, it signals with Present Next Digit. Each digit is a binary-coded decimal as shown in table 6. The computer generates the next digit and signals its presence with Digit Present. Shortly afterwards, it again sees Present Next Digit, which indicates that the calling unit is ready for another digit. The sequence continues until the end of the number is reached, which the computer indicates with the EON (end of number) code. The computer can use another code, SEP (separator), in the case when there might be a second dial tone, as when calling out through a private branch exchange (PBX). Often you have to wait for a dial tone, dial 9, and then wait for a second dial tone from the main exchange. SEP indicates to the calling unit that a second dial tone is expected. The calling unit then waits until that tone is received before asking the computer for another digit.

When the end of the number is reached, the calling unit waits for the called party to answer and then signals Distant Station Connected. Otherwise, if the number is unavailable or busy, it signals Abandon Call.

Moving into the Digital World

The overwhelming complexity of these standards is symptomatic of the fact that we are asking the analog telephone network to serve a purpose for which it was never designed. No one foresaw automatic placement and answering of calls by computers when the first phone was installed.

Today, the telephone network is slowly moving into the digital era, an advancement complicated by the staggering investment that the telephone companies have in existing equipment. In anticipation of widespread direct digital connection to the telephone network, CCITT is offering a new, cleaned-up recommendation specifically designed for the digital telephone exchange. It is X.21, and the minimum line speed is likely to be 56,000 bps, the data rate needed to encode voice to telephone quality. Just imagine the impact this will have on your home use of remote computers or information networks like the Source.

The X.21 standard uses only eight lines (see table 7). The computer sends data to the modem on the Transport line and data moves in the reverse direction on the Receive line. Control and Indication provide control channels in the two directions. The X.21 modem generates a bit-rate clock and possibly a byte-synchronization signal. The last two wires give a voltage reference and ground connection.

Although Control and Indication are control wires, most of the controlling information actually uses the Transport and Receive lines. The computer changes the state of Control when it wants to place a call, just as you lift the handset off the telephone when you want to dial. To terminate the call, the computer changes Control back to the idle state. Similarly, the modem changes the state of Indication when the remote telephone is answered and changes it back if it shuts down. All the dialing information travels on the Transport line and all the information about tones comes back on the Receive wire.

The major advantage of X.21 over RS-232C and RS-449 is that the X.21 signals are encoded in serial digital form. For example, when a dial tone is received, a continuous sequence of ASCII "+" characters is sent to the computer on the Receive wire. In

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Ga	DTE Common Return	
R	Receive	
I	Indication	DCE (X.21 modem)
S	Signal (bit timing)	
B	Byte Timing (optional)	
G	Ground	

Table 7: *Signals used in the X.21 data-communications standard.*

Calling Computer	X.21 Modem	Telephone Network
turn Control on (pick up handset)		
	wait for dial tone	
		dial tone comes
	signal dial tone with ASCII "+ + + ..." on Receive line	
send phone number on Transport line		
	dial the call	
		remote phone rings
	send call progress signal on Receive line	
		remote phone is picked up
	turn Indication on	
	—communication on Transport and Receive—	
turn Control off (put down handset)		
	turn Indication off to acknowledge	
		line becomes disconnected

Table 8: *The sequence of events in an X.21 call, with time running from top to bottom.*

effect, this is a digital dial tone. The computer dials the number by transmitting it as a series of ASCII characters on the Transport line, a bit at a time. This method is much more convenient for the computer than having a parallel connection for the digits because today software is much cheaper than parallel output ports. After dialing the call, the computer receives call-progress signals from the modem on the Receive wire. These signals indicate such call states as number busy, access barred, and network congestion. Table 8 shows an example of the X.21 standard in operation. Notice that the Control and Indication lines change state only once per call; the main control information is sent on Transport and Receive.

The Future

The telephone network is rapidly becoming more complicated. The computer technology in the telephone exchange increases your options for interaction with the telephone system. For example, on an advanced exchange, if you get a busy signal, you can place the call again by issuing a repeat-last-call command. Alternatively, you can store that last number you called for future reference and free the phone for other calls. Another option, short-code dialing, allows you to associate short codes with commonly dialed numbers. You can also bar both incoming and outgoing calls. A diversion service allows you to direct all incoming calls to another telephone either immediately or if the number is busy.

By using serial digital coding instead of dedicated wires for special functions, X.21 provides a sound basis for building such services into computer communication. A short-code-dialing or repeat-last-call facility would be extremely useful, for example, to reconnect a call every time you complete a line of typing at the terminal. If the line could be disconnected while you are typing, long distance calls would be much cheaper. Of course, this would also depend on the tariff policies of the telecommunication carriers. Using X.21 could allow many of the advantages of packet-switching without the associated complexity. Imagine the possibilities of setting up a three-party call between computers! You can't do this now because you still need operator intervention, but the new exchanges will allow you to do it yourself. Possibilities like these show us where the future is, and with the X.21 data-communication standard, we may have found the path out of the standards jungle. ■

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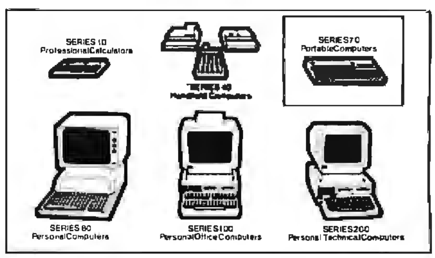

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Power supply: 3 AA NiCad batteries (AC adapter/charger included)
Liquid-crystal display: 32-character window on 96-character line

A Proposed Floppy-Disk Format Standard

ANSI considers a format that would make floppy disks interchangeable.

Chuck Card
2192 Buckboard Circle
Warrington, PA 18976

A few things in the microcomputer world are interchangeable. For example, certain printers, modems, and BASIC programs can be used on a fairly large number of systems. Floppy disks, unfortunately, are not in this group. (And if for some reason you find that hard to believe, look for any evidence of interchangeable disks in the ads of this issue of BYTE. But please don't do it now; just take my word for it.) When you choose a particular microcomputer, you also choose the disk format you'll have to live with for as long as you own the computer. Fortunately, most major software is available in several formats. But, when you want to send something on a disk to friends, will they be able to read it?

Think of all the software you've wanted but couldn't get in the format you needed for your computer. No, I am not talking about the 6502 code you can't execute on your Z80 (or the other way around). I'm talking about those things that your processor may be able to handle, but your disk-drive controller cannot.

And if you think this disk incompatibility is a problem for users, think about what this means for independent software vendors. If you take a look at an old issue of BYTE, you will find, in double-page ads, a list of the disk formats one software distributor has been willing to generate for its customers. That distributor doesn't advertise like that anymore, but things have not improved.

Obviously, a standard disk format is needed. But, unfortunately, none was being offered. Thus, in an effort to at least get the ball rolling, I submitted a standard-disk-format proposal of my own to the American National Standards Committee for Information Processing Systems (Committee X3; part of the American National Standards Institute, or ANSI). In this article, I will give a brief description of that proposed format and will suggest how you as a computer user can help determine what the final adopted standard will be.

First, let's establish what we mean by disk formats. Are we talking about text or command files? The answer is either. We are interested in the fact that the files in the various systems are not compatible. Or worse, the files themselves are quite compatible but the disks are not.

But how can that be? Aren't most disks recorded according to the same standards? Indeed, they are. The problem is that the recording standards deal only with such topics as tracks and the way bits are defined on the storage medium, plus the physical characteristics of the medium itself.

What has been proposed is a disk format standard for disk directories and general file organization flexible enough to accommodate further development and evolution. After lots of study of the various disk formats currently available, I found that there is a common feature to some of these formats, a pattern that many of you have undoubtedly noticed.

About the Author

Chuck Card is a member of the Standards Planning and Requirements Committee of the American National Standards Institute Committee X3 (Information Processing Systems).

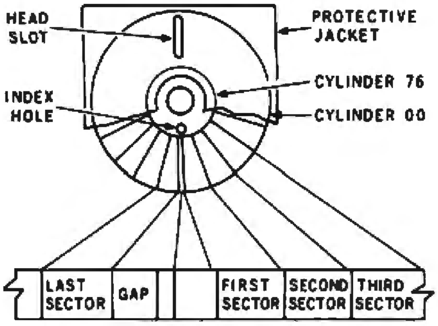

Figure 1: *A diagram of a typical formatted 8-inch floppy disk.*

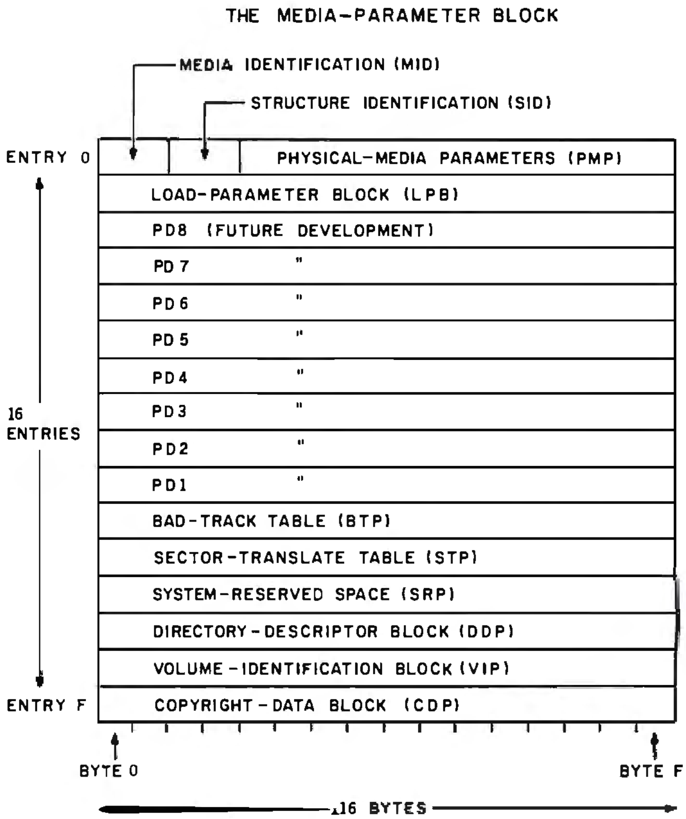

Figure 2: *A diagram of the media-parameter block (MPB), the 256 bytes of the first sector of the proposed standard disk format. The information in this sector describes how the rest of the disk is formatted. Each block contains specific information or points to the area of the disk that has that information.*

	Bit	Field	Mnemonic
Byte 02	0	Physical-media-parameter table	PMP
	1	Load-parameter block	LPB
	2	Copyright-data block	CDP
	3	Volume-identification block	VIP
	4	Directory-descriptor block	DDP
	5	System-reserved space	SRP
	6	Sector-translate table	STP
	7	Bad-track table	BTP
Byte 03	0	Reserved for future standardization	
	1	"	
	2	"	
	3	"	
	4	"	
	5	"	
	6	"	
	7	"	

Table 1: *Bytes 2 and 3 of the media-parameter block form the structure identification (SID). These bits signify which of the pointer fields in the MPB are active.*

The Media-Parameter Block

Although notable exceptions exist, most disks seem to have a mystical sector on cylinder 0 (or track 0). It falls under the first read/write head and is the first data recorded on the track (sector 1). If the terms cylinder, head, and sector are confusing, look at figure 1.

Almost all disk drives read this *home sector* the same way. My proposal is to place certain standard information in this sector, information that will explain how the rest of the disk is formatted. Fortunately, most disk controllers can be programmed to read and write disks in more than one way. Thus it would be possible for one of these disk controllers to read the home sector and then be programmed to read the rest of the disk. In the home sector will be information on such things as the recording technique, the number of bytes in each sector, how many cylinders, heads, sectors per track, and so on. This information would in effect tell the disk drive how to read the rest of the disk.

That covers the physical issues. What about considerations such as the load block, which some systems use? The proposal deals with that as well as the interlace formula, copyright notices, bad-track tables, system-reserved space, volume identifiers, and the directory description. While these are not all required, the place to find them can be identified without wasting storage space if they are not present.

If you refer to figure 2 you will see a proposed layout for the 256 characters of the home sector, or as we call it, the media-parameter block (MPB). The first two bytes (bytes 0 and 1) are for identifying the media from a software-supplier point of view. This is jargon for saying that these bytes are arbitrary but important.

The next two bytes (bytes 2 and 3) make up the structure identification

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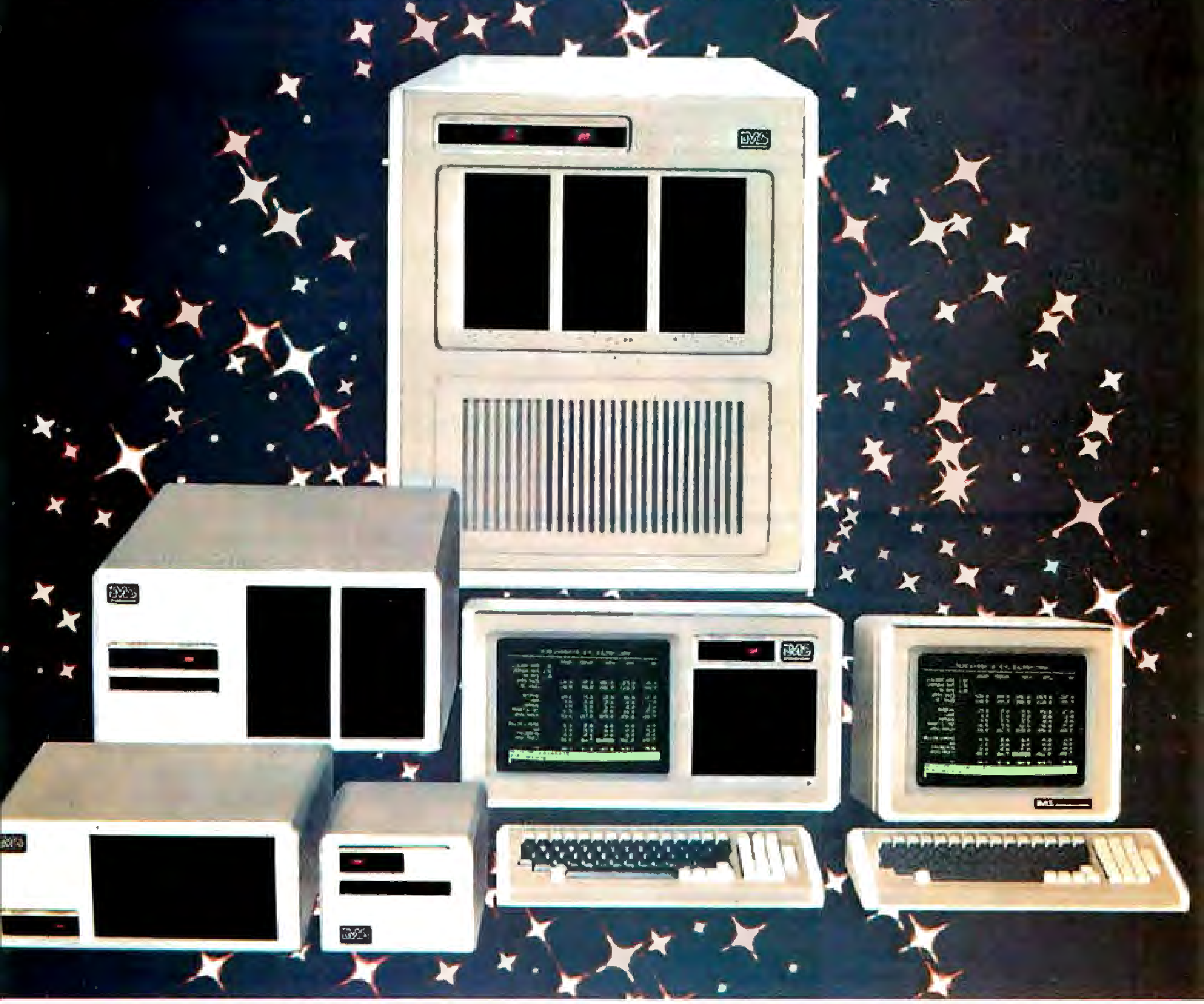

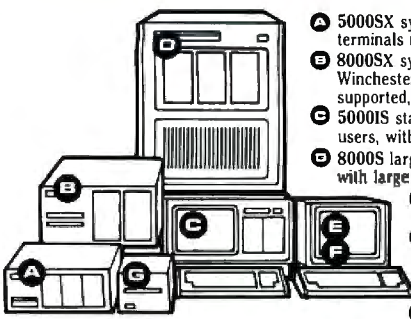

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Mnemonic	Description	Byte(s) Location
PSS	Physical sector size in bytes (16-bit value)	04, 05
PCC	Physical cylinder count (16-bit value)	06, 07
HCT	Number of heads per cylinder	08
PST	Number of sectors per track	09
RFT	Recording-format table 01 = FM 02 = MFM 03 = MMFM	0A
TAS	Track-access sequence 00 = Cylinder (Increment head count before advancing cylinder count.) 01 = Side A (Increment cylinder count before advancing head count to highest cylinder, then decrement cylinder count after incrementing head count; CP/M format.) 02 = Side B (Increment cylinder count before advancing head count to highest cylinder, then return to cylinder 0 and advance cylinder count after incrementing to new head.)	0B
RES	Reserved for future standardization	0C through 0F

Table 2: *A description of the bytes in the physical-media-parameter table (PMP) in figure 2.*

Mnemonic	Description	Byte(s) Location
CST	Starting cylinder for load area	10, 11
HST	Starting head for load area	12
SST	Starting sector for load area	13
CEN	Ending cylinder of load area	14, 15
HEN	Ending head of load area	16
SEN	Ending sector of load area	17
SID	System identification (two bytes requiring registration) Byte 18 Byte 19 00 00 = 8080 01 00 = Z80 02 00 = 6800 03 00 = 68000 04 00 = 8086 05 00 = Z8000	18, 19
SIC	System configuration (two bytes requiring registration for variables on SID)	1A, 1B
LFI	Load-format indicator (one byte for indication of load format) 00 = Sequential: begin at start cylinder, head, and sector; load at start of system memory 01 = Sequential with load addressing at first locations of start cylinder, head, and sector (see load-element descriptor)	1C
LFQ	Load-format qualifier (one byte of system-dependent load qualifier used as a check for load condition)	1D
LFR	Load-format reserve (reserved for future standardization)	1E, 1F

Table 3: *A description of the bytes that make up the load-parameter block (LPB) in figure 2.*

(SID). Each bit indicates whether one of several blocks or tables are active. Each "1" bit means that the corresponding pointer field for that block is in use for its appointed purpose. The layouts of bytes 2 and 3 are given in table 1. The exact purpose of the bits in byte 3 has not yet been determined, but they are reserved in case the media-parameter block should ever grow to 512 bytes.

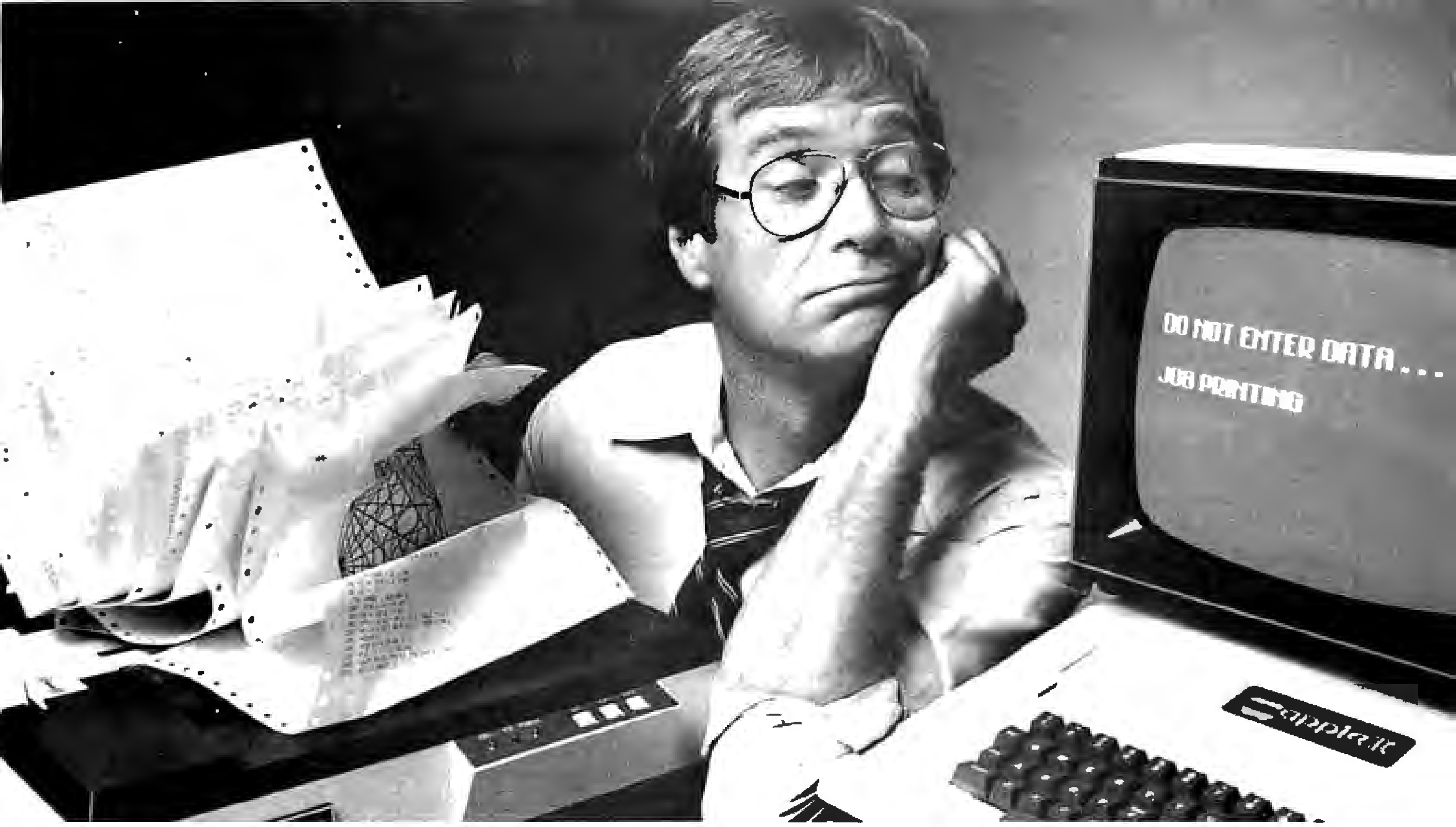
Table 2 describes the bytes in the physical-media-parameter table (PMP) in figure 2. If you examine these bytes closely, you can see that a huge disk can be accommodated. No, I haven't seen any new product announcements; this is just a little groundwork to handle all those rumors coming out of Silicon Valley.

The load-parameter block, while not always needed, has some features we haven't seen on disks previously (see table 3). These are typical of the new features that seem to come out of the woodwork when a new standard is designed. In particular, your attention is called to the SID byte in table 3. That byte contains information on the type of microprocessor that is expected to execute the code in the load block. This information will help prevent you from trying to execute 6502 code on your 8088.

Also noteworthy is an accommodation for new formats (that is, new for microcomputers) such as relocatable object code. Yes indeed, the proposed standard is trying to look as far ahead as is practical.

Those among you who have used Unix may be wondering about the chained directories of that system. They would be easy to add. The directory in this new proposal could serve as the root directory for a series of subdirectories. From then on, it is just a matter of designating a file for each subdirectory. The directory-descriptor block in figure 2 would describe the root directory and the individual fields in it.

I am purposely avoiding giving more details here. This format is just a proposal, and other people have written papers about features that have not yet been adequately discussed. I would hate to see any of you go write code and then find that there



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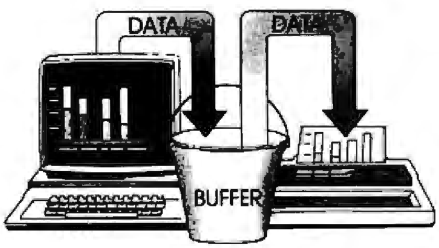

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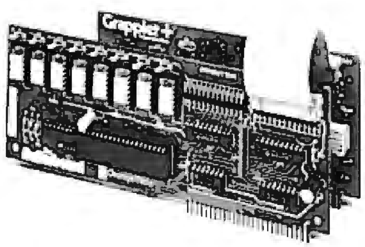

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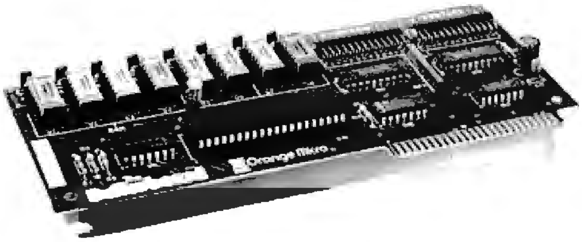

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had been changes. In this article, I am just nailing down the concepts; the actual bit-fiddling is yet to come.

Other Proposals

Other disk-format proposals have been suggested, but these proposals always seemed to be lurking off in the distance. After a long wait (some may say too long), I was asked to take the issue in hand and write my own proposal. Certain things undoubtedly were left out. Things like "my secret sauce key" that some suppliers use to copy-protect their disks are not directly referenced, but that does not preclude them. Standardizing them, however, might make the software pirate's job a little bit too easy.

One proposal that surfaced as this article was written comes from the National Bureau of Standards and has its origin in Europe in the International Organization for Standardization (ISO, Committee TC97/SC15). From what I have seen, that proposal is not completely incompatible with what has been described here. If the ISO proposal were slightly modified, it could be added to my proposal, thus supplying my proposal with even more optional formats. I hope the two efforts can be merged into a single cohesive standard.

You might think this whole thing is a bit fantastic. For such a standard to be developed, all of the major software developers would have to agree on it. And why would the big suppliers all of a sudden get involved in working together on a standard? My guess is that some of the older established companies are more standards-oriented than some of the start-up ventures that have formed the foundation of the microcomputer field. These older companies, such as IBM, Sperry Univac, Xerox, and Digital Equipment Corporation, see that they have a need to interchange disks just as you and I do. Moreover, they have huge investments in systems that use structures rather different from those used on personal computers. With this new standard, it would be possible to link these different structures with each other and with microcomputers.

Also, some microcomputer companies, such as Digital Research, Morrow, and Osborne, have shown interest in a standard disk format. My proposed format is not the same as the CP/M operating system or its cousins, but it is similar. And I can foresee products that will bridge the gap between these formats.

I hear that Version 3.0 of CP/M will be upon us by the time this appears in print, and it will take into account things that have been available to those who use other operating systems (for example, the Flex system on the 6800 and 6809 systems). What features might Version 3.0 include? How about date stamps to indicate when a directory entry was created? What about permission codes for shared access? This latter feature may not be very exciting for anybody not in a multiuser situation. But a lot of us have often dealt with that situation and see the shared-access problem. The supplier of CP/M, Digital Research, feels the need for multiuser and networking versions of its systems. Strangely, however, these issues did not seem to come up earlier when people had to share one disk on the single-user systems.

Other Disks

You may have noticed that I have been talking about disks in general rather than just the flexible disk cartridges we know as floppies. Why? Software suppliers and users have been pushing hard for compatibility between all types of storage media. Many people want the new hard-disk cartridges to work with software as if they were just large versions of their black-enveloped cousins. It would be rather foolish to invent new structures for no compelling reason.

Similarly, many suppliers and users want to get the less-than-5¼-inch disks under control before we see them explode all over us. We should be able to use the format proposed here on these new 3- to 3½-inch disks. So far, the technologies that have been proposed for these disks have been compatible with our proposal.

By adding extensions in the future, we should be able to use this format for a long time. I intended that the format serve as a guide for all of the newly emerging exotic disks we are reading about. This would be similar to the way the Shugart media interface has been adopted as a guide for all floppy-disk-drive manufacturers. Otherwise, more chaos will follow. We hope that the suppliers and developers of these new devices will let us know about any special needs they may have.

But what about the piracy problem? Wouldn't such a standard make it worse? Ours is an interesting industry. If you make things challenging, the software pirate will take the challenge. A former boss often reminded me that "you can't make a good contract with a crook." I have always taken that to mean that goodwill is as important as good locks. We can offset the piracy matter more by careful pricing strategies and by developing goodwill with consumers than with all the tricks in the barrel. Of course, the data itself can always be encrypted. But I don't want to trigger another discussion on that here.

Another phenomenon sneaking up on us is networking. Public networks and computer-based message systems (CBMS) are with us today, and many of us regularly use them. These systems will require some type of storage medium if copies are to be made of messages. But should these messages be stored in the form the host computer uses or one that the addressee can read? This is a good question. Under the new proposal, these formats would be compatible.

Getting Involved

Now, what can you as an individual user do to push for quick development of a standard for disk formats? For one thing, you can write to me. I promise to reply to everyone who writes, and I also promise to deliver your opinion to the project team that is being formed to solve this problem. I have been dubbed the convener or initial chairperson of the committee assigned to develop the new floppy-disk standard. That gives me a good chance to see that your opinions are heard.

How else can you help? If you or your employer can stand the cost, your direct participation is possible. An annual fee of $150 handles the cost of getting you registered on the committee. You can even designate someone as an alternate for yourself on that same $150 fee. Being on the committee will also involve about 15 percent of your time, and you will annually incur travel costs for about four meetings of three days' duration each, invariably held on the other side of the continent from wherever you live. That expensive? Yes. How can anybody afford it? They are expecting eventual commensurate benefits.

My point is that you are not excluded from participating. All that is necessary is patience, interest, demonstrated ability, patience again, the ability to attend the various meetings, and yet more patience. And I am not teasing you about the amount of patience required. Standards are consensus documents, and that implies getting people with many differing opinions to agree. Can you imagine getting the adherents of some exotic threaded interpreter to agree with the BASIC crowd? Oh, you could imagine that. Then add a Pascal fan to the mix and stir in an assembly-code devotee. Can you imagine the scenario? I see it quite often.

Now for the bad news. When can we expect to see a disk-format standard? Mid-1985 is the current estimate. (Are you still there?) But as consumers you should be able to detect some effects of this work by the end of this summer. How? Software suppliers, at least the ones most involved, will start anticipating the standard. You will probably even see some eager ads proclaiming adherence to the standard while the standard itself will not yet have been drafted, let alone approved.

Why did it take so long to get a proposal? My feeling is that it was the result of a mistaken notion that the ANSI activities were only for the large mainframe computers. Frankly, some people in the mainframe computer field do indeed feel that way. I feel they shouldn't, but this is a free country. Similarly, a few microcomputer specialists around are opposed to standards. Why? Standards will let others connect to their products. For good reasons they might not want to allow that. I mentioned goodwill before. Goodwill is subjective. When trust goes away, group efforts do not succeed. Microcomputer users and mainframe users are merely on two sides of one computer industry. We must work to develop trust and goodwill. Both sides have a great deal to learn from each other.

Standards do not come about just for the fun of it or to irritate the affected parties. A standard is merely one possible solution to a recurring problem, but it should be a solution developed by consensus of the concerned parties. Some problems, of course, are bigger than others. It took quite a while before this one was seen as a problem. When this disk-format standard is behind us, we will wonder why we ever needed to discuss the matter in the first place.

Let me hear your needs for the interchange of disks. Unfortunately, of course, I will not be able to accept your information *on a disk* (unless, of course, you happen to send it on a 5¼-inch Flex2 disk for my 6800 system). But I hope, with your help, this situation will not last too much longer. ■

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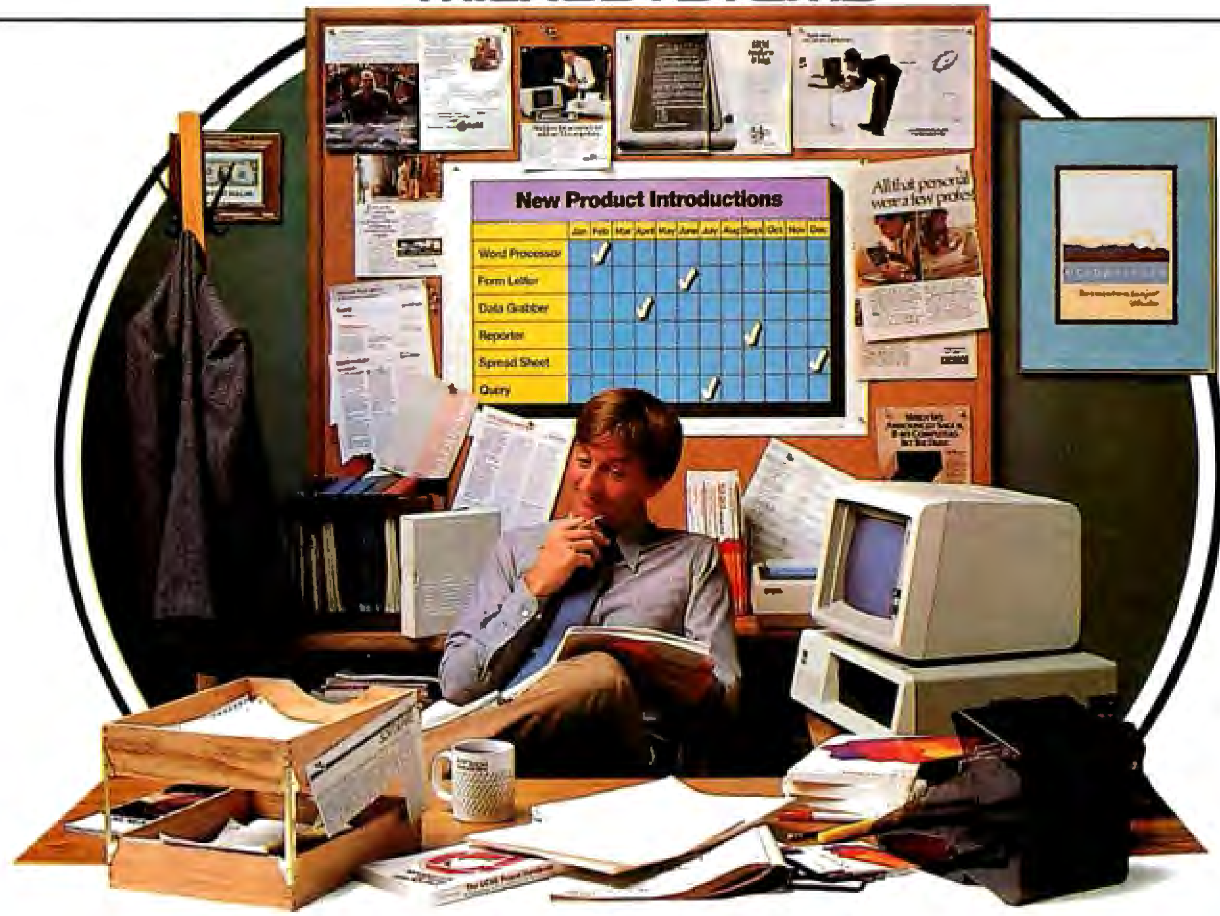

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The Proposed ANSI BASIC Standard

The committee asks for your opinion.

Ronald Anderson
2122 Riverside Ave.
Minneapolis, MN 55454

Last June, BYTE published an article by Thomas Kurtz outlining the new proposed standard for the BASIC language (see "On the Way to Standard BASIC," June 1982 BYTE, page 182). It was the first article to describe the new proposal of the ANSI (American National Standards Institute) BASIC Committee, also called the X3J2 subcommittee. The proposed BASIC standard now must go before two other ANSI committees, X3 and SPARC (Standards Planning and Requirements Committee), before entering a formal period of public review. Committee approval is expected in early 1983, at which time the 120-day public review will begin.

At the end of this review period, the various ANSI committees will study the public feedback and decide whether or not to make revisions to the proposed standard and whether or not to recommend final approval. The ANSI X3J2 committee is currently scheduled to meet again in July 1983 for this purpose.

Anticipating the process whereby anyone can register complaints or cheers, the Association for Computing Machinery (ACM) is informally collecting comments from members and from the public. ACM is represented on the ANSI X3 committee by John A. N. Lee, and before he casts a final vote on the standard, he needs input from the membership, which currently numbers more than 60,000, and others.

Acceptance of a proposed standard by ACM is by no means automatic.

Acceptance of a proposed standard by ACM is by no means automatic. For example, ACM voted against approval of the proposed Ada standard because most of the letters from members were very negative.

Because I am chairman of the ACM Special Interest Group on Computer Uses in Education (SIGCUE), I was appointed to coordinate the public-review process of BASIC standards for ACM. I am collecting letters and pooling comments as they arrive.

A number of letters have come in, and in addition, a public forum on the subject was held at the annual meetings of the ACM in Dallas on October 27, 1982. This forum offered the public an opportunity for discussion following presentations by several members of the ANSI BASIC Committee, including Carlyle Phillips of Texas Instruments and Thomas Kurtz of Dartmouth College.

ANSI BASIC versus ANSI Minimal BASIC

The ANSI BASIC (X3J2) Committee has been working on a standard for eight years. During this prolonged effort, the members produced an earlier proposal, which was officially adopted in 1978. But that standard is a minimal subset and for that reason was called Minimal BASIC. Now that X3J2 is recommending another standard BASIC, some semantic confusion has developed. The current proposed version includes extensions far beyond most existing implementations of BASIC, yet X3J2 is simply calling it BASIC, not Extended

About the Author
Ronald Anderson is chairman of the ACM Special Interest Group on Computer Uses in Education and an associate professor at the University of Minnesota.

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BASIC. Unfortunately, at the same time, some people refer to Minimal BASIC as ANSI BASIC, which strictly speaking it isn't.

To further confound communication, the ANSI BASIC proposal contains several major "optional" components, namely, graphics, editing, fixed decimals, and real-time commands. Therefore, it will not be possible to conform to the standard without having a computer equipped with graphics capabilities. Consequently, programs and implementations of ANSI BASIC that do or do not employ optional components may differ substantially, making program interchange difficult.

Positive Reactions

Before describing the negative comments and proposed revisions, I will summarize the comments favorable to the proposed standard. (I want to emphasize that these are preliminary comments, and a full summary will not be forthcoming until the spring or summer of 1983).

We have received several comments that are vague but supportive: for example, "it's about time," and "excellent." Other reactions were more specific. Philip Bouchard, Senior Programmer at the Minnesota Educational Computing Consortium, said, "I have long had a wish list (for BASIC). . . . At the top of my list are control structures, independent subroutines, and multiple-character variable names. For these features alone, the new standard is well worthwhile."

Most educators have been enthusiastic, largely because of the structured orientation of the new ANSI BASIC, which includes the following control structures:

```
IF. . .THEN. . .ELSE. . .END IF
DO UNTIL. . .LOOP
DO WHILE. . .LOOP
DO. . .EXIT DO. . .LOOP
SELECT. . .CASE. . .CASE. . .END SELECT
```

In addition, the user can enter external subroutines with a CALL statement. Line numbers can still be used, but under the new standard, programs can be written easily without the use of any internal line numbers. In fact, the version of ANSI BASIC that Dartmouth College is now developing does not even allow line numbers.

The graphics features of the proposed standard BASIC have received a cautious welcome from the educational computing community. While consensus on the need for more graphics exists, some teachers prefer turtle graphics as used in Logo languages. Others are skeptical about the success of a useful graphics standard in BASIC when the graphics hardware for existing microcomputers varies so much.

The proposed BASIC standard is especially welcomed by high school teachers who do not want to switch from BASIC to Pascal in their programming classes. An example of the problems currently faced by educators is the fury created by the announcement of the College Board AP (Advanced Placement) test in computer science because it is based upon Pascal. The College Board committee for computer science has said, however, that if there were a common version of BASIC in a structured form, an AP test could be developed for BASIC as well. If ANSI BASIC or a structured variation were to be widely implemented on educationally popular microcomputers, the language would probably become extremely popular in programming classrooms.

Negative Reactions

Not all educators are happy with the new BASIC proposal. Alfred Bork of the University of California, Irvine, exclaimed, "Why would one want to revise an old creaky language when there are better languages around?" His greatest objection to the ANSI BASIC proposal is the omission of data-type declarations. Professor Kurtz's response was that, first of all, without data typing it is much easier to write programs and, second, if BASIC had data typing, it would be indistinguishable from other languages such as FORTRAN. In some instances, simplicity has been the criterion guiding the formulation of the latest attempt to standardize BASIC.

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Ironically, one of the most common complaints about the newly proposed ANSI BASIC is that it is so complex (because it incorporates all standard features and some optional ones) that its implementation on an actual microcomputer will be extremely difficult without a very large memory and faster microprocessor operating speeds. If this is true, it may be some time before ANSI BASIC interpreters will be available for small computers.

The only contemporary implementation of BASIC that comes close to the proposed ANSI BASIC standard is the new VAX BASIC from Digital Equipment Corporation. Until an extensive BASIC such as that proposed by X3J2 is up and running on a small-scale microcomputer, many persons will continue to doubt the viability of the proposed ANSI BASIC.

A few technical criticisms have been registered. For example, one programmer complained about the replacement of ON ERROR GOTO with WHEN EXCEPTION USE, which he perceives as semantically more cumbersome.

Another technical comment came from a BASIC product specialist at Data General (see "Letters" column, October 1982 BYTE, page 18). He pointed out how a DIM statement can be bypassed inadvertently in a program. When bypassed, arrays cannot be used to test conformity to the bounds defined by the array dimension. A minor addition to the standard could solve the problem.

Despite the apparent comprehensiveness of the ANSI BASIC proposal, several people asked that the standard go even further. One comment was, "Why can't a disk-exchange format be established for 5¼-inch disks? The committee will say this is out of their territory, but why have a language standard if I have to keyboard the program into each new microcomputer I have to run it on? . . . A software format standard is the answer."

Another expansionist request was for a more powerful editor and consistent operating-system protocols. The proposed standard has an optional editing subsystem; however, it is limited and does not even specify normal text-editing functions such as character inserts and deletes. If every BASIC environment had identical syntax for editing commands as well as for operating-system commands, computing in a multimachine context would be considerably more user-friendly.

Philosophy of a Standard

The underlying philosophy of the proposed BASIC standard seems slightly different from that of other languages, such as FORTRAN, in that numerous extras are defined as *optional modules* rather than as *miscellaneous extensions*. Their inclusion in the official standard implies that they are desirable but not essential. Confusion may result because every implementation will almost certainly be a partial implementation, and conformity to the standard will be less meaningful because each implementer must also specify the optional features of his or her version of BASIC as well as the departures from the core standard. This is a major criticism of the proposed ANSI BASIC in that it may not solve software-incompatibility problems. With so many features defined as optional, it may be difficult to encourage programmers to clearly demarcate optional and nonstandard commands within a program.

Professor Kurtz replies that the major goal of the new ANSI BASIC is student interchange, not program interchange. "We want students," he argued, "to be able to use what they've learned elsewhere and, without total retraining, continue their learning experiences." To the extent that this philosophy is shared, it would be more appropriate to call the standard a model rather than a rule by which to measure conformity.

Several companies (e.g., Digital Equipment Corporation and Hewlett-Packard) have committed themselves to adding new BASIC features in the spirit of the proposed ANSI standard. The new VAX-11 BASIC Version 2.0 contains most of the proposed features. Dartmouth College is implementing the ANSI standard but adding extensions and deviations (e.g., line numbers are not allowed as statement identifiers). These projects show that having an ANSI BASIC standard is feasible, but they also forecast a continuation of diversity among BASIC implementations.

The new standard appears to be more loosely defined than most other language standards; however, the intended purpose seems not so much to produce uniformity among versions of BASIC as to steer BASIC implementers toward a common target and thus increase the chances that any given BASIC program will be usable with different versions of BASIC. ■

What's Your Opinion?

To date only a few reactions have been heard. Far more grass-roots opinions are needed. If you are reading this before the summer of 1983, you still have time to influence the verdict on ANSI BASIC. Send your comments to the author of this article so that they can be pooled and channeled into the decision process.

Copies of the "Draft Proposed Standard for BASIC" are available from X3 Secretariat, CBEMA, 311 First St., NW, Suite 500, Washington, DC 20001.

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NAPLPS: A New Standard for Text and Graphics

Part 1: Introduction, History, and Structure

A close look at an important and controversial new communications standard.

Jim Fleming
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Indianapolis, IN 46220

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Hatboro, PA 19040

Personal computers have a great deal in common. Several of them use the same microprocessor. Most have the same language in read-only memory (BASIC). And all use more or less the same keyboard. But there is a tremendous variation in the ways various computers handle graphics.

In order to mass-produce graphics software or to mass-distribute graphics information (as in videotex and teletext), a standard for graphics information is needed.

The North American Presentation-Level-Protocol Syntax (NAPLPS, or "nap-lips") is a method for encoding visual information in a standard and compact manner, which can then be exchanged among people using a variety of different computer systems. Like the well-established American Standard Code for Information Interchange (ASCII), NAPLPS is a set of rules and conventions describing how data bytes of information should be formatted, as well as a set of guidelines describing what should be displayed when properly formatted data bytes are received by a terminal.

About the Authors

Jim Fleming and William Frezza are members of the ANSI X3L2 Committee on Character Sets and Coding. Mr. Fleming is also working on Chemical Bank's Pronto home-banking project.

Unlike ASCII, however, the major emphasis in NAPLPS is on the communication of information in a two-dimensional graphics format. Graphics and textual information can be represented in a variety of modes, colors, and styles. Facilities are also provided that allow a terminal user to interact with the two-dimensional visual display in an extremely free-form manner.

NAPLPS also includes a method for minimizing the amount of information that must be sent over communications lines. Techniques are provided that allow extensions to be added to NAPLPS at some future time without affecting existing features.

The basic concept of NAPLPS can be illustrated by the cartoon in figure 1 on page 204. It shows a robot artist being fed a stream of commands that are used to paint a picture. At the robot's disposal are pens of various colors, spray paints, character templates, and all the other items found in an art studio.

With various commands, we can direct the robot's arm to any area of the canvas we desire. We can instruct the robot to use any of several standard colors, or we can tell it to create a new color from the existing ones. When text is needed, the robot selects the proper-size template for the desired letters, grabs a can of spray paint, places the template on the canvas, and paints a character.

The goal of this system is that the beauty and complexity of a picture should be limited only by the imagination and skillfulness of the person (or program) creating the commands being fed to the robot.

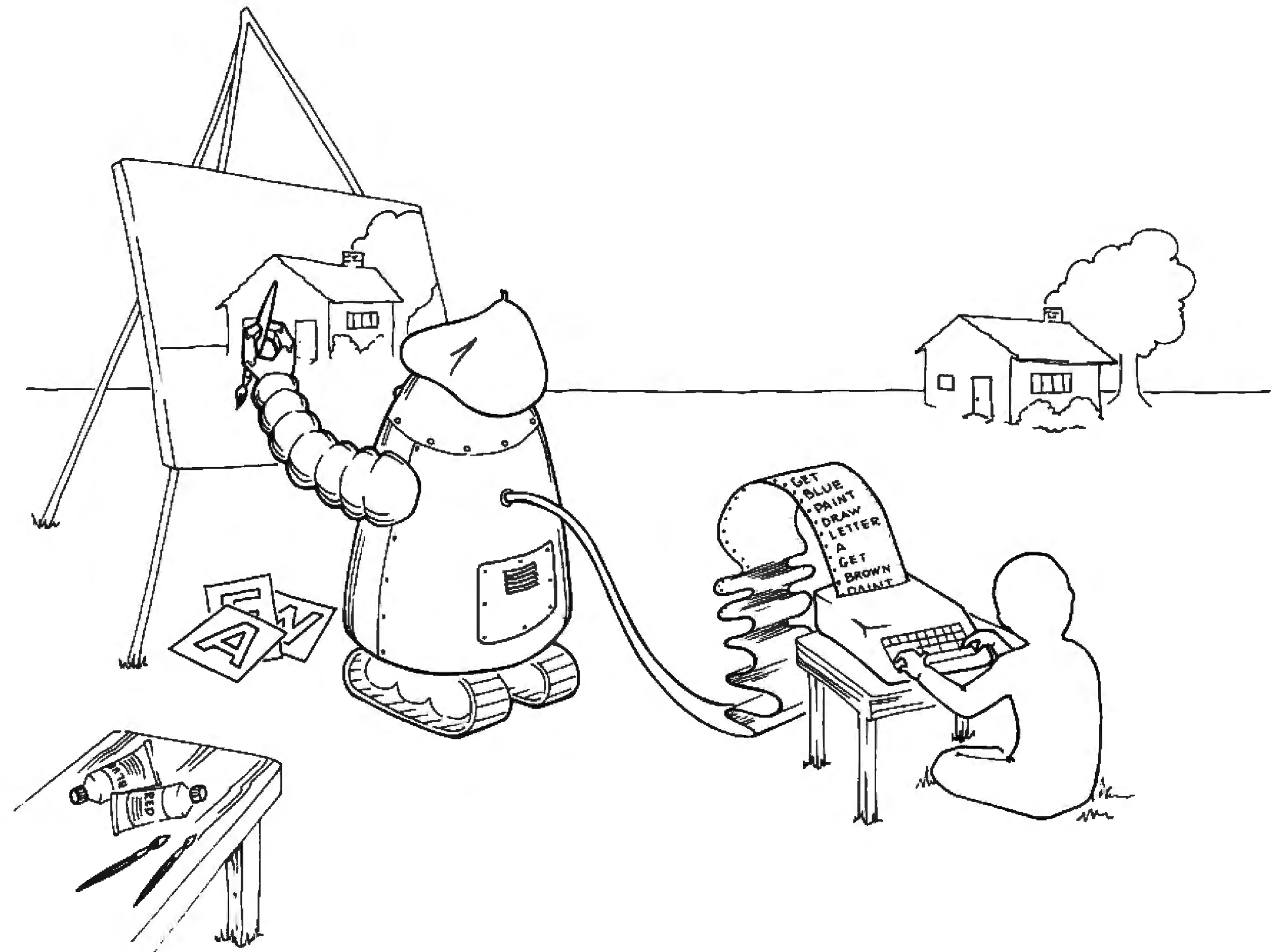

Figure 1: *A stylized representation of how the NAPLPS system works. The programmer or artist creates a list of graphics commands, e.g., "get red pen," "draw a circle." The robot (or NAPLPS decoder) then interprets these commands and uses various drawing instruments such as pens, brushes, rulers, and compasses to draw on the canvas (display screen). If a text character is specified, the robot uses an appropriate template for that character.*

This article is the first in a series of articles on NAPLPS. In this part, we give an overall perspective of NAPLPS, describing its history and background, as well as its structure and major features. In subsequent parts, we will cover the basic text and graphics features of NAPLPS from a bit and byte perspective, describe some of its more advanced features, and explore the future of NAPLPS with an emphasis on personal computers, local and regional area networks, and distributed processing.

History and Background

NAPLPS has its roots in videotex, a much-discussed system of large host computers and low-cost, user-friendly graphics terminals. Because of the large potential market for these terminals, many groups around the world have been designing such systems for use in homes, offices, and public areas. As shown in figure 2 on page 206, a basic videotex system consists of a host computer with a database of information, a communication network, and a terminal. The terminal users request information from the database, and the desired information is sent back to the terminal, where it is interpreted and displayed.

Unfortunately, all the experimental systems designed around the world used different coding schemes. As is the case with most languages, the various coding schemes had different strengths and weaknesses. Some were more efficient than others; some were more easily decoded by terminals; some preserved the "conceptual" content of the information; and some were tailored to particular hardware configurations.

At the time NAPLPS was developed, videotex coding schemes could be divided into two major groups. In one group were schemes that were similar to the approach used in the British Prestel system, which was the first videotex effort in the world. The other group of schemes is best represented by the Telidon system developed in Canada as an alternative to the Prestel system. As is the case with many developments in the computer field, being first does not imply being the best.

Table 1 on page 210 compares Prestel-like systems and Telidon-like systems. Without going into all the

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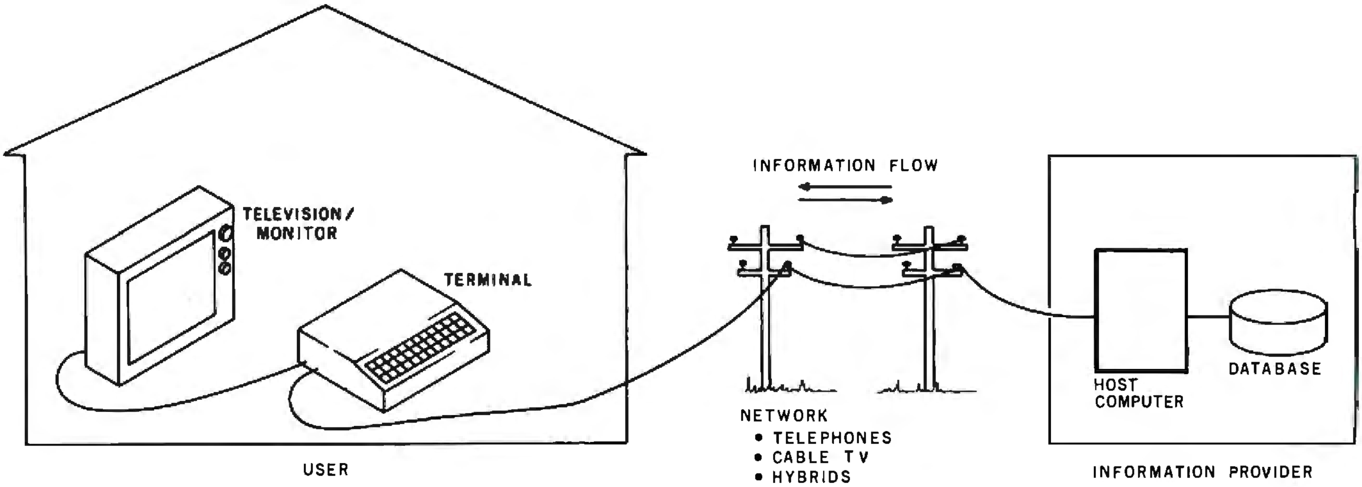

Figure 2: *A diagram of a typical videotex system. Videotex is defined here as two-way communication of textual and graphical information between a low-cost, user-friendly terminal and a large, central host computer. Communication can be by telephone lines, television cables, or a hybrid system using a broadcast television channel for information sent from the host computer and using telephone lines for information sent from the terminal.*

technical, emotional, and political history, suffice it to say that NAPLPS was designed using Telidon-like systems as a base.

In May 1981, AT&T created a bit of commotion by releasing documentation for a new Telidon-like scheme called PLP (Presentation-Level Protocol) at the Videotex '81 conference in Toronto. Since that time, continuous efforts have been underway in various standards groups to adopt PLP.

NAPLPS is a standard version of PLP that resulted from a joint effort by the American National Standards Institute (ANSI) and the Canadian Standards Association (CSA). Copies of the draft proposed NAPLPS standard (document #BSRX3.110-198X) can be obtained from CBEMA (Computer and Business Equipment Manufacturers Association, X3 Secretariat, Suite 500, 311 First St., NW, Washington, DC 20001).

This series of articles will provide an overview of the features of NAPLPS. The specific details and examples presented in these articles are not meant to form a complete NAPLPS specification. Anyone interested in doing development work using NAPLPS should obtain a copy of the ANSI document.

Layered Protocols

Modern communication systems are designed in a *layered* or *modular* manner to help prevent extensive system redesign when parts of a system are changed. Layering achieves many of the advantages found in good structured system design. By isolating functions in various layers, we can proceed to standardize and imple-

Text continued on page 210

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Characteristic	Prestel-like Systems	Telidon-like Systems	Comment
Video-display hardware dependence	Very much	Very little	This is the main advantage of NAPLPS. It is not based on special circuits or architectures.
Image complexity	Poor	Excellent	There is no comparison. It would be like trying to compare 8-mm home movies to 35-mm theater films.
Easily decoded by terminals	Yes	No	Prestel wins this one. Unfortunately, most things in life that are easy are not worth much.
Requires microprocessor terminal	No	Yes	Many thought this was an advantage and an objective worth achieving. Maybe they don't know how to program microprocessors.
Works with printers, plotters, etc.	No	Yes	While some were asking "Why?," others were saying "Why not?"
Memory intensive	No	Yes	Prestel wins again. Now that 16K bits are cheaper than 4K, this hardly seems a victory.
Preserves "conceptual" content information	No	Yes	Most are still trying to figure out what this means and why it is useful.
Can be extended for years	No	Yes	This certainly can be disputed. Time will be the judge.
Sensitive to errors in the communication channel	Less	More	A valid point but hardly an issue for a level-6 protocol.
Cost	Low	????	The true bottom line in some people's books. But how much did a personal computer cost 10 years ago?

Table 1: *A comparison of two types of graphics encoding systems for use in videotex applications: Prestel-like systems and Telidon-like systems. NAPLPS is one of the latter.*

ment a system for one layer without regard to details of other layers. Because layering is an abstract and sometimes confusing topic, we will use a simple example of communication between two people to illustrate the concept.

As shown in figure 3 on page 212, when two people converse, their basic goal is to communicate ideas to each other with as much understanding as possible. We shall regard these ideas themselves as the first level or layer of communication. This level, which may be considered the highest or most abstract, will be called the *conceptual* level.

In order for people to communicate these ideas, they must choose a language—say, English—as a set of rules for *presenting* the ideas. And with English come all the rules concerning grammar, sentence structure, and so on. We shall include English as part of a second level of communication that we shall call the *logical* level. The ideas from the upper level would have to be expressed in this logical level before a transfer could take place between the two people.

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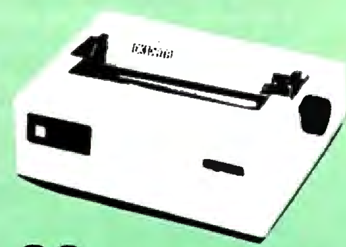

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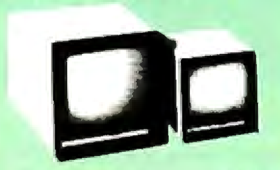

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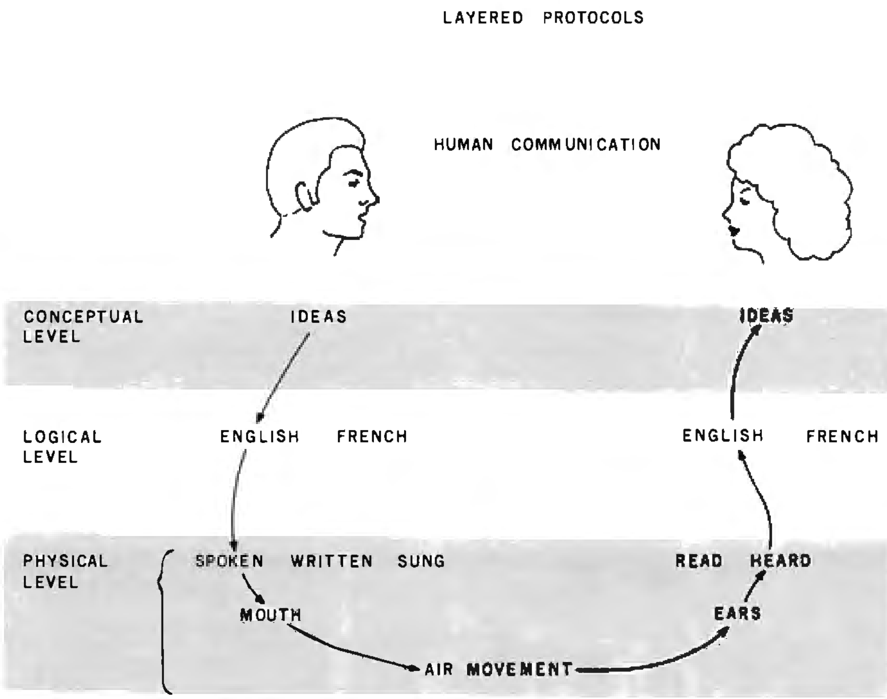

Figure 3: *A diagram showing how communication can be divided into a series of layered protocols. Here, the example of communication is a simple conversation in English between two people. The conceptual level comprises the actual ideas to be communicated. The logical level comprises the language in which the ideas are to be expressed. The physical level comprises the physical phenomena that are used to convey the English words. In the case of speech, this involves movements of the mouth, air, and the listener's eardrums.*

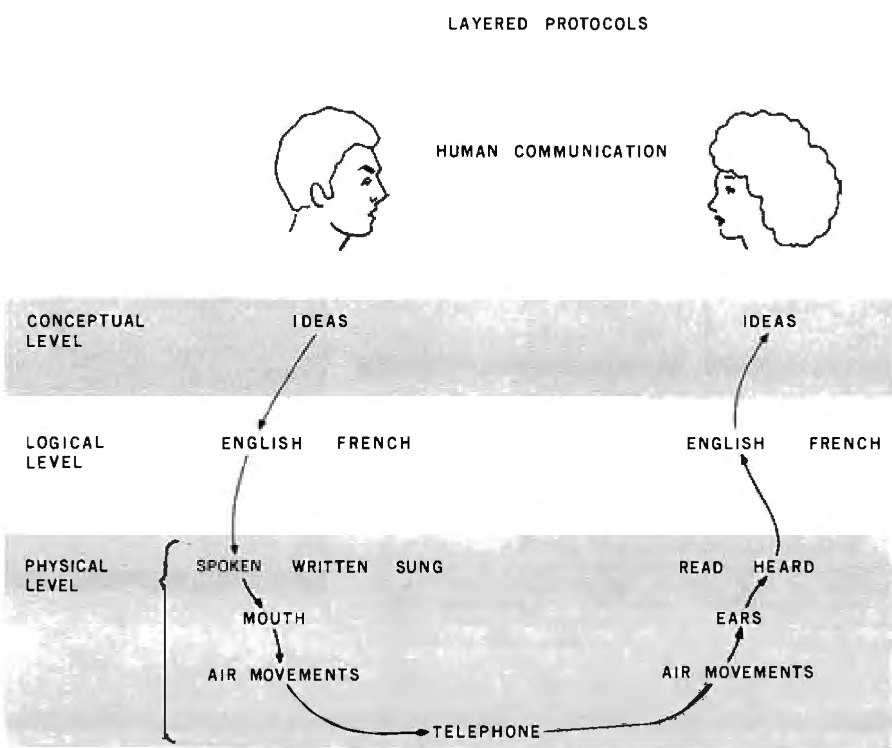

Figure 4: *If the conversation in figure 3 were conducted over a telephone, we could interpret this as a change of the physical layer. The advantage of layered protocols is that one layer can be changed without affecting the other layers. Although the physical level here has been changed, the logical level—English—is unaffected.*

Once English is chosen, a mechanism is needed to physically transfer the logical representations of the conceptual ideas from one person to another. This will be done on the *physical* level. In human communication, several choices exist. The most obvious is speech. When we speak, a set of physical tools is used. The English constructs from the logical level are converted to movements of the diaphragm, tongue, and mouth, which result in the movement of air. The vibrating air is detected by the other person's ears (if she is listening) and is transferred into bone and muscle movements. The second person must decode these movements, recreate the English, and conceptualize the idea.

This example can also be used to illustrate why layering is useful in preventing complete system redesign when changes are made. It can even be used to show how standard layers can be mixed and matched as the needs of a system change.

Suppose that the two people are separated by a large distance and that a telephone must be used so that they can talk to one another. The lowest level (the physical level) is the only area affected. As shown in figure 4, the telephone and the telephone network are used to transport the sounds from one location to another. The logical English constructs can remain the same and the ideas can be communicated.

If French or German is substituted at the logic level, no changes need to be made to the physical level. The conceptual level may or may not be affected, depending on how adept the languages are in representing certain ideas. For example, when learning a second language, one usually runs into the case where an instructor says, "That idea really can't be translated into this language."

As mentioned before, layering is done to prevent expensive system redesign when parts of a complex communication system are changed. Imagine how inconvenient it would have been if everyone had had to learn a new language when the telephone was invented. Or imagine how expensive it would be if a dif-

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ferent telephone system were needed to speak different foreign languages.

Data-communication systems have likewise been divided into various layers. A seven-level model promoted by the International Organization for Standardization (ISO) is typically used. A complete description of the model is beyond the scope of this article. In general terms, however, this seven-layer model, like our simple example, runs from the more abstract layers at the top (level 7) to the physical layers at the bottom (level 1). Most of the work in standardizing data-communication protocols has heretofore been done at the lower, physical levels.

NAPLPS is a standard for the sixth level, commonly called the *presentation level,* of the seven-level model. In our example of human communication, NAPLPS is similar to the logical (English, French, and German) level. NAPLPS has been designed to allow a large variety of information to be encoded in a manner that preserves the conceptual content of the information. NAPLPS codes can be physically transported between computer systems via modems and data links, floppy disks, magnetic tapes, and other common mechanisms.

Code-Extension Techniques

The coding of NAPLPS begins with bits and bytes. The 8-bit byte can be used to represent 256 unique patterns or code points. At first glance, the 256 codes might seem to be a large enough set, especially if only letters, digits, and control information must be encoded. But in order to encode graphics coordinates, colors, graphics drawing commands, and advanced control information, more than 256 codes are needed. The obvious solution is to group bytes together sequentially to form an extremely large set of commands. This is similar to what occurs in English where the 26 letters of the alphabet are grouped to form words.

In NAPLPS, 96-code sets can be swapped in and out of a large 256-code table.

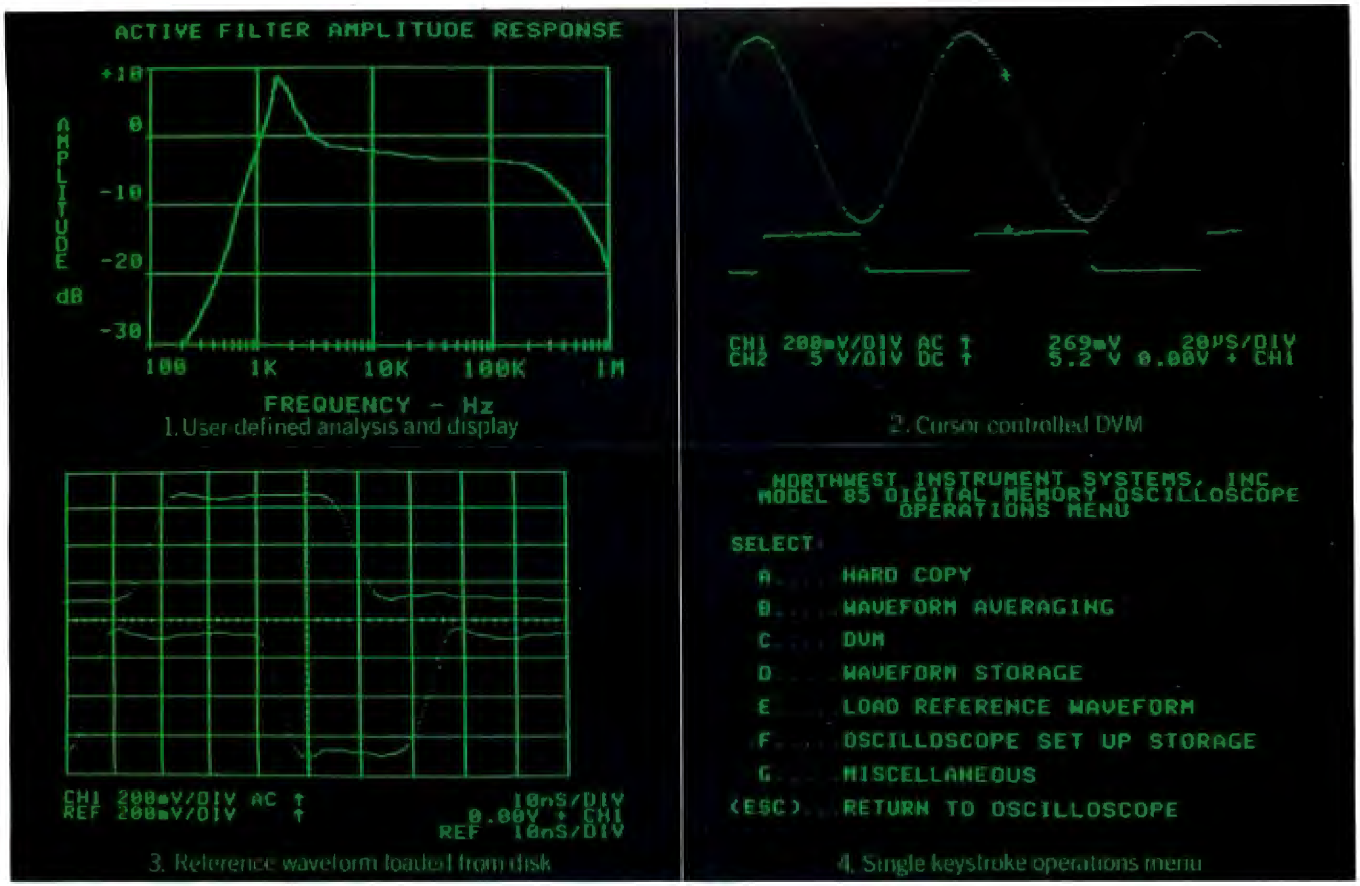
Grouping of bytes is commonly called *code extension.* Many code-extension techniques use the ASCII Escape character (ESC, hexadecimal 1B, decimal 27) as an indicator that the next character has a special meaning. Many times, the next character indicates that more characters follow. (An example of this type of code extension is the typical multicharacter Escape sequence for the cursor-positioning sequence supported by many terminals.)

This approach to code extension is fine for a small number of extensions, but tends to become a hodgepodge of inconsistent code sequences when a large number of extensions are defined.

NAPLPS has been designed with an extremely general code-extension structure that is independent of the specific "meanings" of the codes, and is based on an ISO recommendation (ISO 2022.2).

Keep in mind that up to this point we have been talking about codes as 8-bit binary numbers in the decimal range 0 to 255. No meaning has been placed on the codes. Because of the widespread use of ASCII, many people assume that a capital "C" must *always* be coded as a decimal 67, as it is in ASCII. The assumption is also made that the value 67 cannot be used to code anything but capital Cs. In order to fully understand NAPLPS, you must first realize that the relationship that exists between the capital C and 67 is by *convention* and not due to some physical limitation of computers or an act of God. Furthermore, you must realize that the decimal value 67 (or any code) can be given other meanings in other contexts as long as an indication is given as to which context is currently in effect.

The basic strategy underlying code extension in NAPLPS is to take a large table of codes (128 or 256) and divide it into smaller sets of codes that can be "swapped" in and out of the large table. The small code sets



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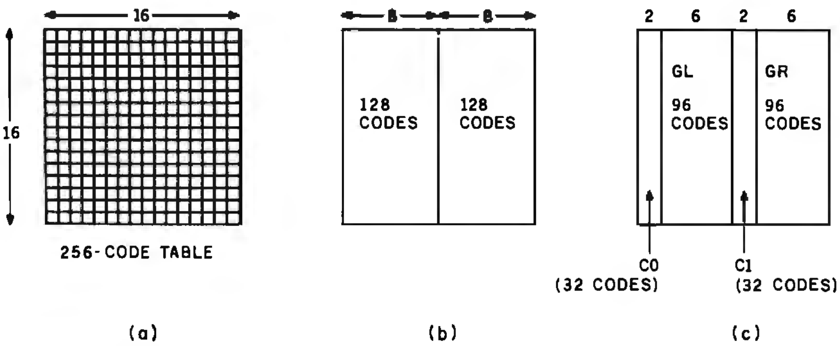

Figure 5: *With an 8-bit code, 256 combinations are possible. These can be represented on a 16 by 16 table (a). For convenience, this large table can be divided into two 128-code tables (b). Each of these 128-code tables can then be further subdivided into a 32-code table and a 96-code table (c).*

can include codes with similar characteristics. The sets can have standard names, and a standard mechanism can be established to control the swapping. New sets can be added as long as a unique name is chosen. Because a standard mechanism would already be in place to handle the swapping, the new code set could be added without affecting other sets.

Up to now, we have been talking mainly about an 8-bit code. Actually, two code-extension techniques are supported in NAPLPS: 7-bit and 8-bit. The 7-bit extension technique is used in systems where only 7 data bits can be passed through the lower, physical levels of communication (levels 1 through 5). The eighth bit is often reserved for parity so that errors can be detected. In a seven-level system, error control is usually performed at level 2. Because NAPLPS is a level-6 protocol, the error-control bits have already been handled prior to the data's reaching level 6.

The 8-bit code-extension technique is used when all 8 data bits are available for NAPLPS information. This is the method that is used in systems where the low-level protocols can support 8 bits. It will also be used when files containing NAPLPS are exchanged between users via disks and tapes. Because of the eventual widespread use of the 8-bit code-extension technique, it is the one that will be described in this article.

With 8 data bits, the 256 codes or patterns can be grouped in the form of a table with 16 rows and 16 columns (16 × 16 = 256), as shown in figure 5a.

The 16 by 16 table can be divided into two sets of 128 codes, as shown in figure 5b. These two sets can each be partitioned into sets of 32 and 96 codes (32 + 96 = 128), as shown in figure 5c. The 32 codes will occupy two columns of the original 16 by 16

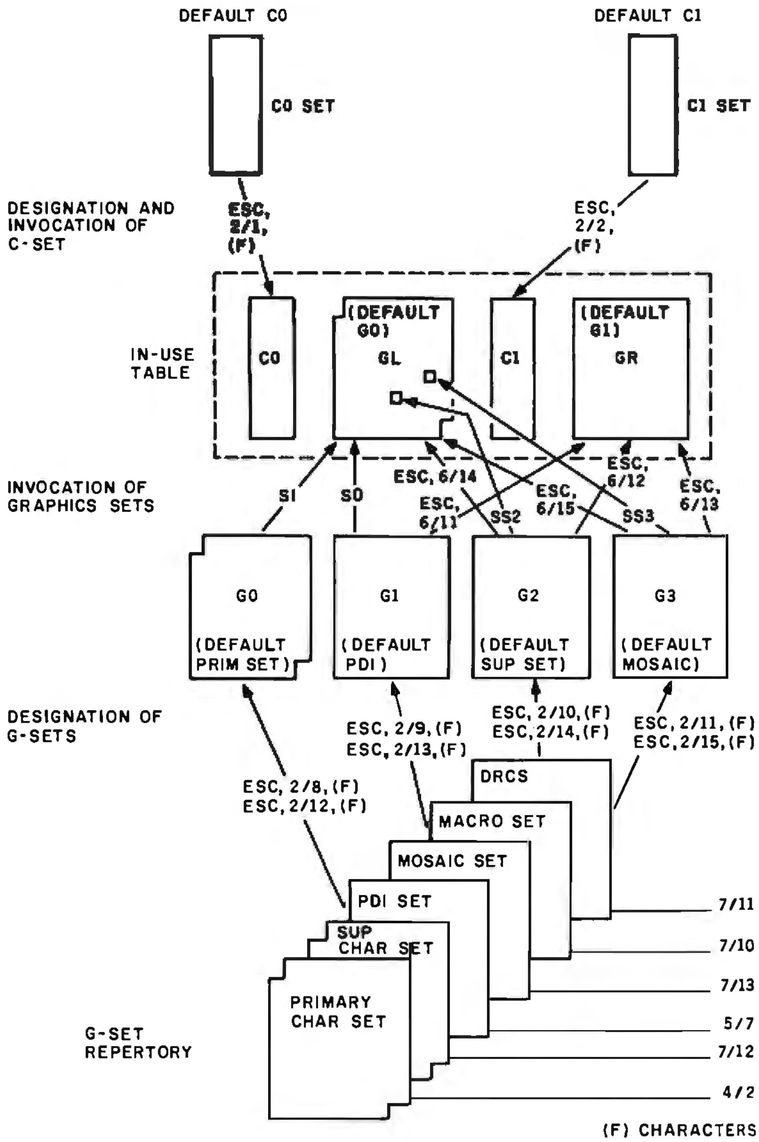

Figure 6: *A diagram showing the NAPLPS code-extension technique in an 8-bit environment. By swapping various 96-character graphics sets into and out of the graphics areas of the "in use" table, we can access a large number of characters or commands. Four graphics sets (or G-sets) are selected from the G-set repertory and placed in designated sets (G0 through G3). Then, two of these designated sets are placed in the graphics areas (GR and GL) of the 256-code "in use" table. Various code sequences (e.g., ESC 6/14) or control codes (e.g., SI) are used to swap the G-sets. The notation "6/14" represents the number 6E in hexadecimal. "(F)" refers to a single-code name of a particular G-set.*

table; the 96-code set will require six columns.

As you can see, the large 256-character table has now been divided into four smaller regions. These regions (or sets) allow us to group codes of similar use into tables of manageable size. The two small tables are called *control sets* or C-sets; the two large tables, *graphics sets* or G-sets.

As we mentioned before, a mechanism has been designed to allow a variety of code sets to be swapped into and out of these four areas of the large table. Currently, however, code-set swapping is done only with the large 96-character G-sets. Although a mechanism exists for swapping the small areas (C-sets), it is not being used at this time.

Before a G-set is swapped into one of the large areas, it must be selected from a repertory and placed into one of four designated sets. Two of these designated sets are then placed into GL and GR, the two large areas in figure 5c. Codes are then interpreted based on the current G-sets that are in use in the large table.

Figure 6 illustrates this mechanism for the 8-bit code-extension technique. The arrows and labels indicate special code sequences that are used to cause the swapping. Most of these code sequences begin with the Escape character. The notation "6/14" used in figure 6 is an alternate way of specifying a code with a specific bit pattern. On a 16 by 16 table, 6/14 represents the bit pattern that refers to column 6 and row 14 of the table. In hexadecimal, 6/14 would be 6E; in decimal, $(6 \times 16) + 14 = 110$.

To move a G-set from the repertory to one of the designated sets, a three-character sequence is used. The third character in the sequence (represented by "(F)" in figure 6) is the "name" of the G-set. Each G-set has a unique name that is specified in the NAPLPS standard. For example, the name of the ASCII G-set is 4/2 (42 in hexadecimal). To move the ASCII G-set from the repertory to the G0 designated set, you would use the following sequence: ESC, 2/8, 4/2. New G-sets can be added at a later date by specifying a new name that has not been used.

If figure 6 looks confusing, the following analogy may help. Imagine that figure 6 illustrates a complex jukebox that has a number of albums

The Primary Character Set contains 96 "oldies but goodies"...

(G-sets) stored in a rack (repertory) and four turntables (designated sets G0, G1, G2, and G3). Buttons are available (e.g., the sequence ESC, 2/8, (F)) that allow you to specify which album should be placed on which turntable. Furthermore, this jukebox has two sound systems (GL and GR). And more buttons (SO—Shift Out, SI—Shift In, ESC 6/14, etc.) are provided that allow turntables to be connected to one (or both) of the sound systems.

As we continue our analogy, imagine that each album has exactly 96 songs, and that the turntable can very quickly locate and play any of these songs. Furthermore, both sound systems have 96 buttons that can be used to select and play any of the songs instantly.

It should be noted that in order to lessen the amount of record changing involved, four turntables are provided. With two sound systems, we can have two albums or 192 (96×2) songs available instantly. Also, we can have another 192 songs available simply by switching the correct turntable to a sound system. We can play an almost unlimited number of songs if we are willing to go to the trouble of selecting an album, placing it on one of the turntables, switching the turntable to one of the sound systems, and finally selecting a song.

At this point, you are probably wondering what this has to do with text, graphics, NAPLPS, and the price of tea in China. You are also probably wondering what albums are available in the repertory.

NAPLPS currently has six selections available in the repertory (this record industry is still in its infancy). The *Primary Character Set*, also known as ASCII, is full of 96 oldies but goodies like 0, 1, 2, . . . A, B, C, and x, y, z, etc. The *Supplementary Character Set* is full of 96 new and old international favorites, most of which are rarely played in the U.S. These include α and β. The *Picture-Description Instructions* album (PDIs) contains selections like "Line," "Arc," and "Draw Me a Polygon." Some of the hottest hits going are on this album. The *Mosaics* album is full of some very old songs that all sound the same. It is seldom played except by people over 40. The *Macro* album contains songs that cause other songs to be played. (You get a lot for your quarter here.) The *Dynamically Redefinable Character Set* album (DRCS) is initially blank. It can be used to mix existing songs together to form new songs. (Yes, on this juke-

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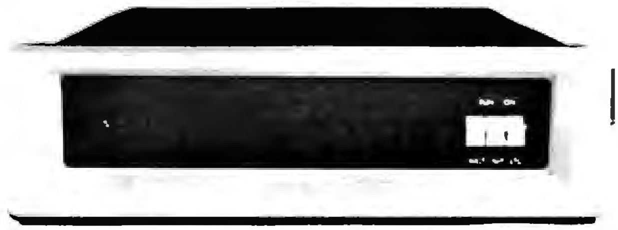

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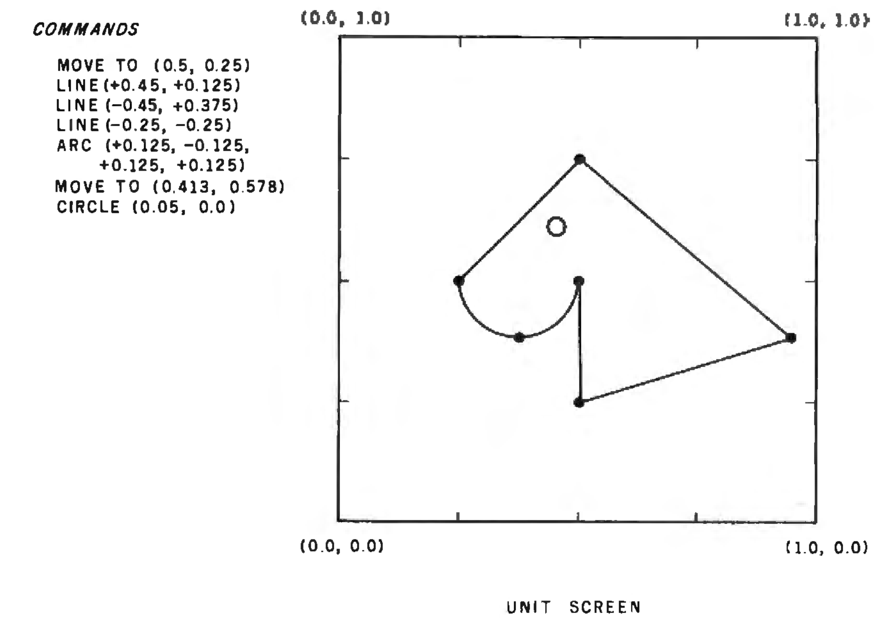

Figure 7: *The unit screen of NAPLPS. All coordinates are represented as fractions between 0.0 and 1.0. The figure on the screen was drawn with the commands listed on the left. The advantage of this coordinate scheme is that it can be easily implemented on display screens of various resolutions and sizes.*

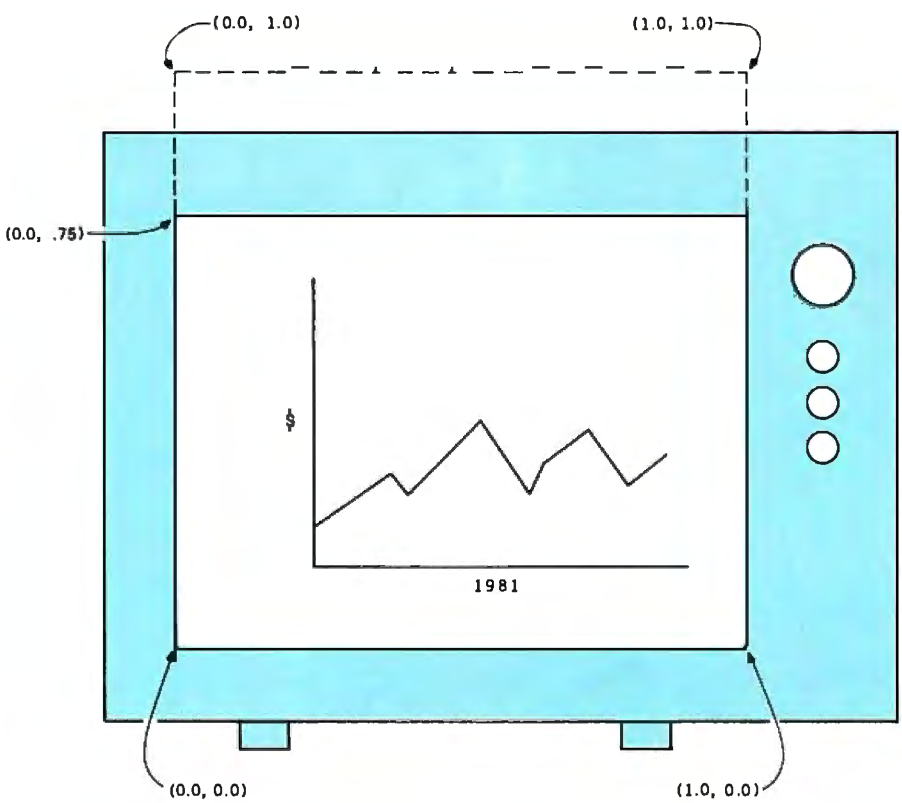

Figure 8: *The unit screen is square, but most display screens are rectangular. The convention that has been adopted is to represent on the display screen only the lower 75 percent of the unit screen. That is, any point with a y coordinate greater than 0.75 will not be seen.*

box you can record as well as play.)

As mentioned before, default selections have been set up so that no swapping commands are needed in many applications. As shown in figure 6, the ASCII character set is the default for the G0 designated set, and whatever is in G0 is the default for GL. Therefore, the codes in GL (decimal 32 to 127) will be mapped to the ASCII character set as the default condition. (Isn't it amazing how the simplicity of the present can be represented as a subset of the complexity of the future?)

The default for the G1 designated set is the PDI set, and G1 in turn is the default for GR. This arrangement allows text and graphics to be used without any swapping.

The default for G2 is the Supplementary Graphics Set, and the default for G3 is the Mosaic Set. We believe that the Macros and DRCS should have been the defaults. When you devise a standard, however, sometimes a little "default diplomacy" is necessary.

The entire NAPLPS code-extension structure is designed to support future growth in an organized manner. As can be seen, it provides a means of increasing the number of codes far beyond the 256 codes we would have had if there were no code-extension techniques. The overhead has been kept to a minimum while maintaining compatibility with existing ASCII systems.

The Unit Screen and Coordinate System

Now that we have plenty of room for character sets and commands, we can get down to the real purpose of NAPLPS—creating pictures.

In NAPLPS, pictures are drawn on a *unit screen*. As shown in figure 7, the unit screen is a square area of unknown resolution and size. The lower left corner of the screen has *x-y* coordinates equal to (0.0, 0.0); the upper right-hand corner of the screen has *x-y* coordinates of (1.0, 1.0).

The name "unit screen" is derived from the fact that all coordinates in the unit screen have an *x* and *y* component between 0.0 and 1.0. In NAPLPS, all coordinates and dis-

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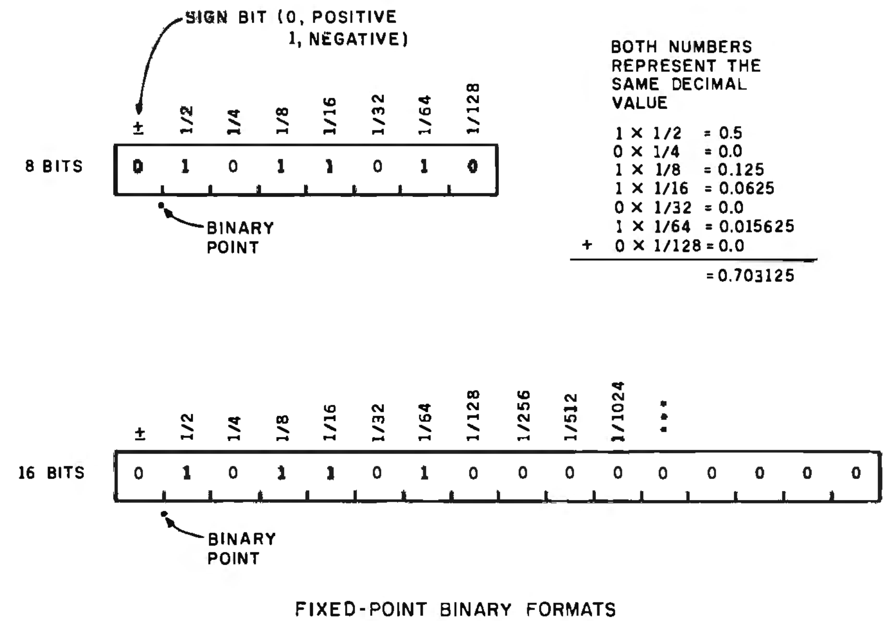

Figure 9: *NAPLPS coordinates are formatted as "fixed-point binary numbers." The 8- and 16-bit numbers given here represent the same decimal number, 0.703125.*

tances are specified thus in subunits relative to the unit screen. The advantage of specifying the coordinates in this manner is that the pictures will be independent of any particular hardware configuration. Another advantage is that objects in pictures will remain in the same relative position with respect to each other even though the resolution of the physical display may be increased.

In order that pictures may be seen, the unit coordinates must be *mapped* to a physical display. The only requirement imposed (under normal conditions) when making this mapping is that the *squareness* (commonly called *aspect ratio*) of the unit screen should be preserved. Unfortunately, when the unit screen is mapped to the rectangular screen of a television set, some of the unit screen cannot be seen. This is shown in figure 8. The convention that has been adopted is that only the lower 75 percent of the unit screen will be visible on the physical screen. Thus, any point with a y coordinate greater than 0.75 (it is usually closer to 0.78) will not be displayed on a television screen.

This technique of mapping points on the unit screen to the physical screen is called one-to-one mapping. In the future, additional mapping techniques may be added to NAPLPS that will allow the unit screen to be scaled, rotated, and mapped to the physical screen in a variety of ways. These capabilities will be added at the same time that three-dimensional features are defined.

Now that we know that all coordinates must be between 0.0 and 1.0, a problem arises: How do we represent these coordinates? Floating-point representations could be used. But this would make it difficult for integer-oriented microprocessors to handle the coordinates. Instead of a floating-point format, a *fixed-point binary* (not binary-coded decimal or BCD) format was chosen. This format is the same as a typical integer format, except the *binary point* is assumed to be on the left between the sign bit and the data bits. Figure 9 illustrates the formats for 8- and 16-bit systems.

The important thing to note about this format is that, unlike integers, as more bits of precision are added, they are added on the *right* instead of the left. Also, the values of the binary places work from the left to the right. The value of the bit position immediately to the right of the binary point is 1/2. The next bit position to the right is worth 1/4. The next ones are worth 1/8, 1/16, 1/32, etc.

The decimal value of a number is determined in a manner similar to integers. A number such as 0.1011010000000 represents a positive number (the sign bit of 0) equal to 1/2 + 1/8 + 1/16 + 1/64 or 0.703125, which of course is less than 1.0. An infinite number of zeros is assumed on the right of the number, just as with decimal numbers that are less than 1. Of course, the number will never equal 1.0 no matter how many 1s are placed on the right. (If you do not believe it, try figuring out what the fixed-point binary number 0.111111111111111 is in decimal.)

When coordinates are encoded in NAPLPS, each byte can contain 6 bits of data. (The other 2 bits will be accounted for later.) The standard two-dimensional format is shown on the left of figure 10 (page 227). On the right side of figure 10 is a three-dimensional format. Some three-dimensional capability is supported by NAPLPS today, but many more three-dimensional options will be available in the future. In that case, coordinates are specified in a unit cube rather than a unit screen.

In the two-dimensional format, the 6 data bits are used for 3 bits of x and 3 bits of y. Obviously, multiple bytes are needed if high-precision coordinates are used. As shown in figure 11, as each new byte is added to a coordinate specification, the x and y components each obtain 3 more bits of precision. The least significant bits are obtained after the most significant bits. A terminal may choose to throw away some of the least significant bits if more bits are sent than are needed for the resolution of that particular terminal.

When most people are first exposed to this method of coordinate encoding, their first reaction is that it will be too complex for a simple microprocessor to handle. On the contrary, there is a very easy way to handle this encoding technique: just ignore the binary point and the fractional concepts and treat the bits as integers.

To do this, you must first choose an adequate integer size for internal representations. On 16-bit microprocessors, 16 bits are commonly used. If signed 16-bit numbers are used, a grid can be set up that ranges from −32,768 to 32,767 in both the x and y directions (see figure 12). The display screen or unit screen would occupy the first quadrant. The unit screen would then be 32,768 by 32,768, which is far more resolution than almost all graphics devices have today.

In this 16-bit internal form, an integer such as 0100000000000000 would have a decimal value of 16,384. This is equal to ½ of 32,768, which should not be surprising because we originally said that the binary number 0.100000000000000 was equal to ½ (it's all done with mirrors!). The integer 0101101000000000 that we used before would of course be equal to 23,040 (16,384 + 4096 + 2048 + 512). A quick check with a calculator shows that 23,040/32,768 is exactly 0.703125. (Does this number look familiar?)

It should be clear that treating the fixed-point binary numbers as normal integers is the same as moving the binary point 15 places to the right (for a 16-bit system), which is the same as multiplying the binary fractions by 32,768. We can recover the fractional form by dividing by 32,768, which was demonstrated above.

In order to map the unit screen to a physical display screen, more simple shifting can be used. The sign bits of the x and y components must be positive for the coordinate to be in the unit screen. If the rightmost 7 bits of the 16 bits above are dropped by shifting the integer right seven places, the numbers that result are in the range 0 to 255.

This operation maps the 32K- by 32K-bit grid to a 256 by 256 grid. Each point on the 256 by 256 grid then represents a 128 by 128 area on the original grid. This indicates that when 16-bit integers are used, 128 would have to be added to a coordinate component to move to a different point on the physical display.

If a 512- by 512-bit-resolution display screen is available, another bit on the right of the coordinate integer would be saved. (The 16-bit integer would be shifted right six places instead of seven.) In this case, each point on the 512 by 512 grid

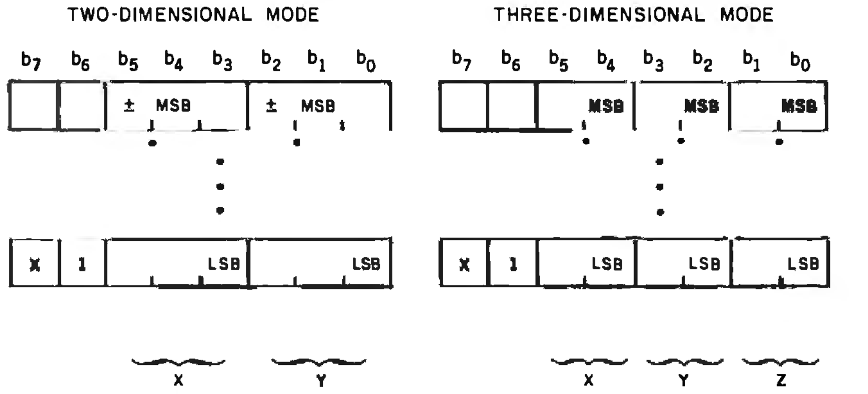

Figure 10: *In NAPLPS, coordinates are specified with a varying number of bytes. In the two-dimensional mode, each byte contains 3 bits of the x coordinate and 3 of the y. In the three-dimensional mode, each byte contains 2 bits each for the x, y, and z coordinates. MSB indicates the most significant bit; LSB, the least significant bit.*

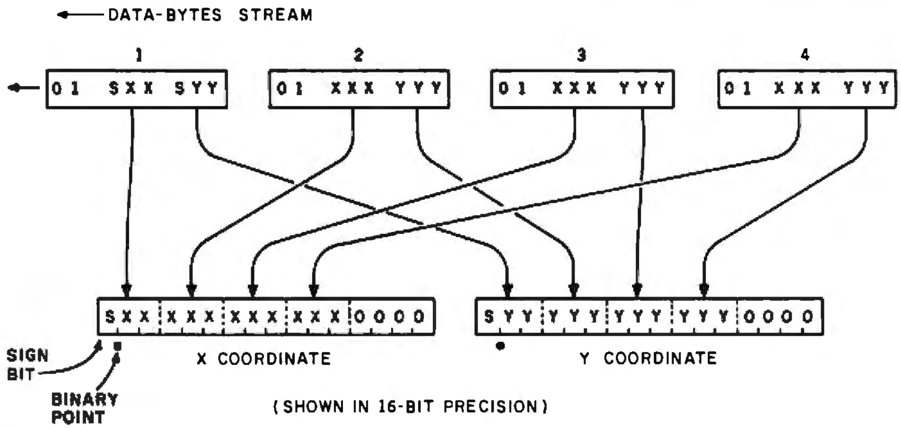

Figure 11: *The data bytes shown in figure 10 can be combined to specify coordinates of almost unlimited resolution. Here, 4 data bytes in the two-dimensional mode are combined to form a pair of 12-bit coordinates. This would support a resolution of 2048 by 2048.*

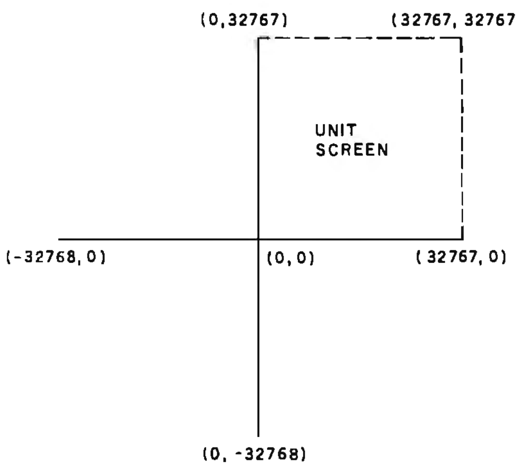

Figure 12: *The maximum resolution of a 16-bit coordinate system. The unit screen occupies only the first quadrant of the grid.*

represents a 64 by 64 area on the original grid. Adding 128 to an integer in this case would move the coordinates by *two* display points, not one. If this did not occur, pictures developed for a 256 by 256 grid would end up in the lower corner of a 512 by 512 display. That lack of portability would discourage increasing the resolution of the terminal. Fortunately, with NAPLPS we can increase the resolution of a display and still be able to receive pictures developed for older displays. They will look as good or better on the new display.

So far, we have discussed only positive coordinates and integers. Negative values can occur in the normal two's complement form used by most microprocessors. Negative values can be used to code relative coordinates (*dx* and *dy* values) when relative movements are needed, rather than absolute coordinates. The values *dx* and *dy* can also be used to indicate sizes of areas on the screen.

Part 2 of this series will describe how the *dx* and *dy* values are used to specify character sizes. We will also see that many of the graphics commands have an absolute form and a relative form. The absolute forms are used when the drawing must appear at a particular spot on the unit screen. Relative forms are useful when one wants to draw relative to the current drawing point, which may be in different places depending on the previous figure.

Color Control

NAPLPS supports a wide range of color control. Three color modes (0, 1, and 2) are available to satisfy many different applications. The first of these (color mode 0) is fairly simple and is designed to be compatible with almost all color display screens. The other two (color modes 1 and 2) use what is known as *color mapping*. This allows you to create some fantastic visual effects, but this technique requires special hardware not found in most color displays.

Color mode 0 is the most primitive mode in NAPLPS. It can best be described by the following analogy using the robot mentioned at the

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beginning of the article. Imagine that the robot has one pen and three inkwells filled with the primary colors red, blue, and green. By mixing various amounts of each of these colors in the pen, the robot can draw in almost any color. For example, we could instruct the robot to mix three drops of red, one drop of blue, and seven drops of green, and then tell the robot to draw various shapes or text characters. When we tell the robot to mix a new color, the robot would automatically clean out the pen and mix the next color.

In NAPLPS, color is similarly specified in terms of its red, green, and blue intensities. Each byte of color data contains 6 bits of color information, 2 each for red, green, and blue. Several bytes, however, can be grouped together so that colors can be specified with as much precision as desired. In figure 13, 2 bytes have been used to yield a total of 12 bits of color information (i.e., 4096 possible colors). As with coordinate encoding,

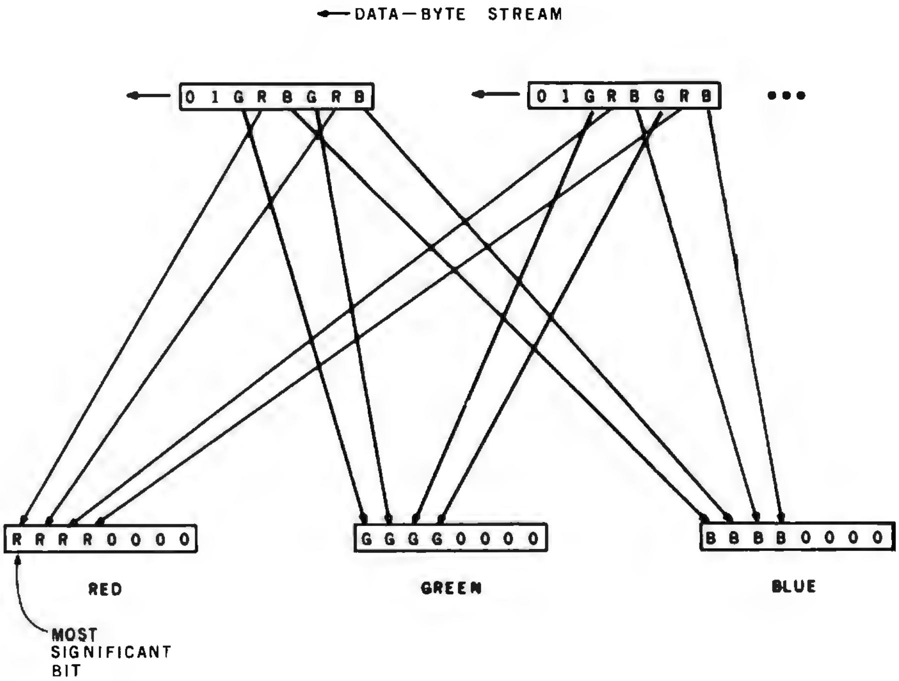

Figure 13: *Color information is encoded in a manner similar to that used for coordinates. Each data byte contains 2 bits of information for each of the primary color components: red, green, and blue. A varying number of bytes can be combined to specify colors with almost unlimited precision. Here, 2 data bytes have been combined to yield 4 bits of information on each red, green, and blue component of a color.*

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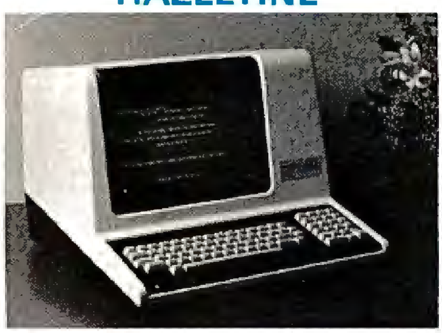

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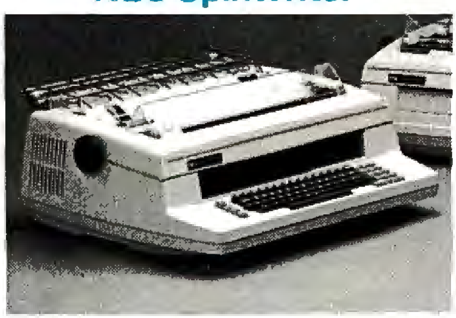

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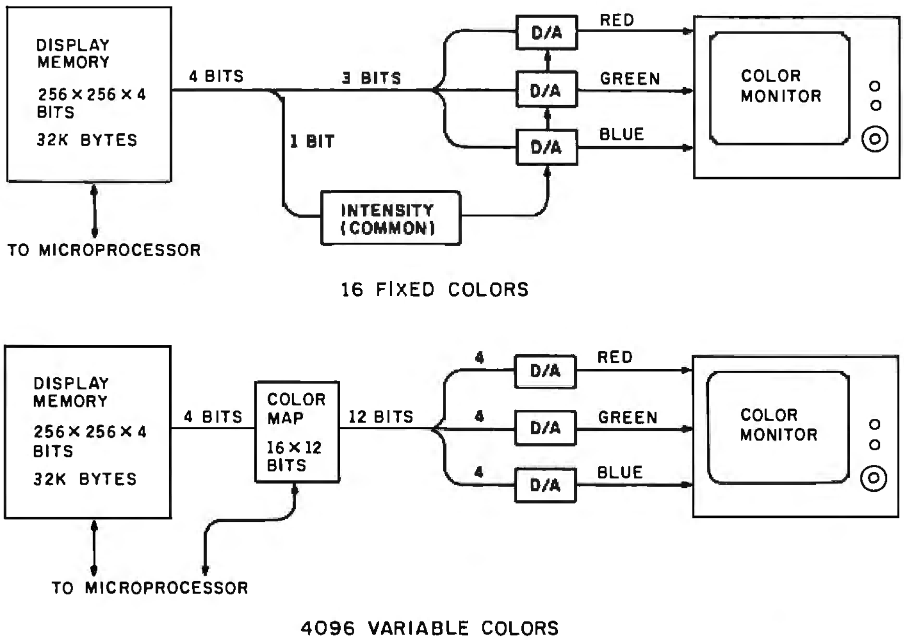

Figure 14: *Two popular schemes for storing color information. Both use the same amount of display memory. In the top scheme, the 4 bits for each pixel specify 16 fixed colors. In the lower scheme, the 4 bits specify 16 color registers in the color map. Each color register in turn specifies one of 4096 colors. D/A designates a digital-to-analog converter.*

the most significant bits are sent first, and a terminal is free to ignore the least significant bits.

With this kind of system, a tremendous spectrum of colors may be displayed, depending on the amount of memory available.

Most personal computers have only a small number of colors available. In the above analogy, the robot might have 8 or 16 pens with premixed colors. When we gave the robot instructions to mix a certain color, it would merely pick the pen with the color closest to the specified color.

The advantage of color mode 0 is that it can be received on almost all terminals. An inexpensive color terminal can display the same picture—although much less vividly—as an expensive, dedicated graphics terminal.

Color mapping, which is used in color modes 1 and 2, allows a terminal to display a wide spectrum of colors without requiring a large amount of memory. The Atari 400 and 800 are two of the few home computers that make use of this technology (see "Computer Animation with Color Registers" by David Fox and Mitchell Waite, BYTE, November 1982, page 194).

In color mapping, if we return to the above analogy, the robot has the three primary-color inkwells again and a set of, say, 16 pens numbered 0 through 15. Using NAPLPS, we can instruct the robot to mix various colors in each of the pens. We can then instruct the robot to draw with a given pen, referring to it by its number rather than by its color. In a computer, we would store the color information not in a pen, but in a color register as part of a color map or color table.

With NAPLPS, an inexpensive color terminal can display the same picture—although much less vividly—as an expensive, dedicated graphics terminal.

In figure 14, we compare a system using fixed colors with one using color mapping. Both have the same amount of display memory (32K bytes). In the fixed-color system, the 4 bits in memory for each pixel specify one of 16 combinations of red, green, blue, and intensity. In the color-mapped system, the 4 bits refer to one of 16 color registers, each of which in turn refers to one of 4096 combinations of red, green, and blue.

Another important advantage of color mapping is that if we instruct the robot to change the color in a given pen, everything previously drawn with that pen will also change color. This amazing capability can be used to create some dramatic animation effects. These effects are typically referred to as color-table animation.

Color-table animation is a very complex area of NAPLPS. A mechanism has been provided that allows you to specify color interchanges in the color map based on timed relationships. (This command has been given the innocuous name BLINK.) Time intervals can be set in units of $\frac{1}{10}$ of a second, which allows compatibility with 60-Hz (U.S.) and 50-Hz (Europe) systems. Color-table animation will be discussed in greater detail in the third part of this series.

As we mentioned before, the major drawback of color modes 1 and 2 is the dependence on special hardware to achieve the full capabilities of the modes. This drawback was known at the time NAPLPS was designed, but it was determined that because of the incredible special effects that can be achieved using these modes they would be included. Anyone who does not have a need for these special effects should concentrate on using color mode 0 to insure portability of information.

Text Features

Text is handled as a subset of graphics. Text is a special form of graphics that involves predefined "templates" that are rectangular in shape. The rectangular templates can be scaled to any size and positioned *anywhere* on the unit screen. The

				b6	0	0	1	1	1	1
				b5	1	1	0	0	1	1
				b4	0	1	0	1	0	1
b3	b2	b1	b0		2	3	4	5	6	7
0	0	0	0	0		0	@	P	`	p
0	0	0	1	1	!	1	A	Q	a	q
0	0	1	0	2	"	2	B	R	b	r
0	0	1	1	3	#	3	C	S	c	s
0	1	0	0	4	$	4	D	T	d	t
0	1	0	1	5	%	5	E	U	e	u
0	1	1	0	6	&	6	F	V	f	v
0	1	1	1	7	/	7	G	W	g	w
1	0	0	0	8	(	8	H	X	h	x
1	0	0	1	9	)	9	I	Y	i	y
1	0	1	0	10	*	:	J	Z	j	z
1	0	1	1	11	+	;	K	[	k	{
1	1	0	0	12	,	<	L	\	l	|
1	1	0	1	13	−	=	M	]	m	}
1	1	1	0	14	.	>	N	^	n	~
1	1	1	1	15	/	?	O	_	o	

Figure 15: *The Primary Character Set, which is very similar to ASCII. Note that bit 7 is not shown. The value of bit 7 would depend on which graphics area (GL or GR) this G-set was placed in.*

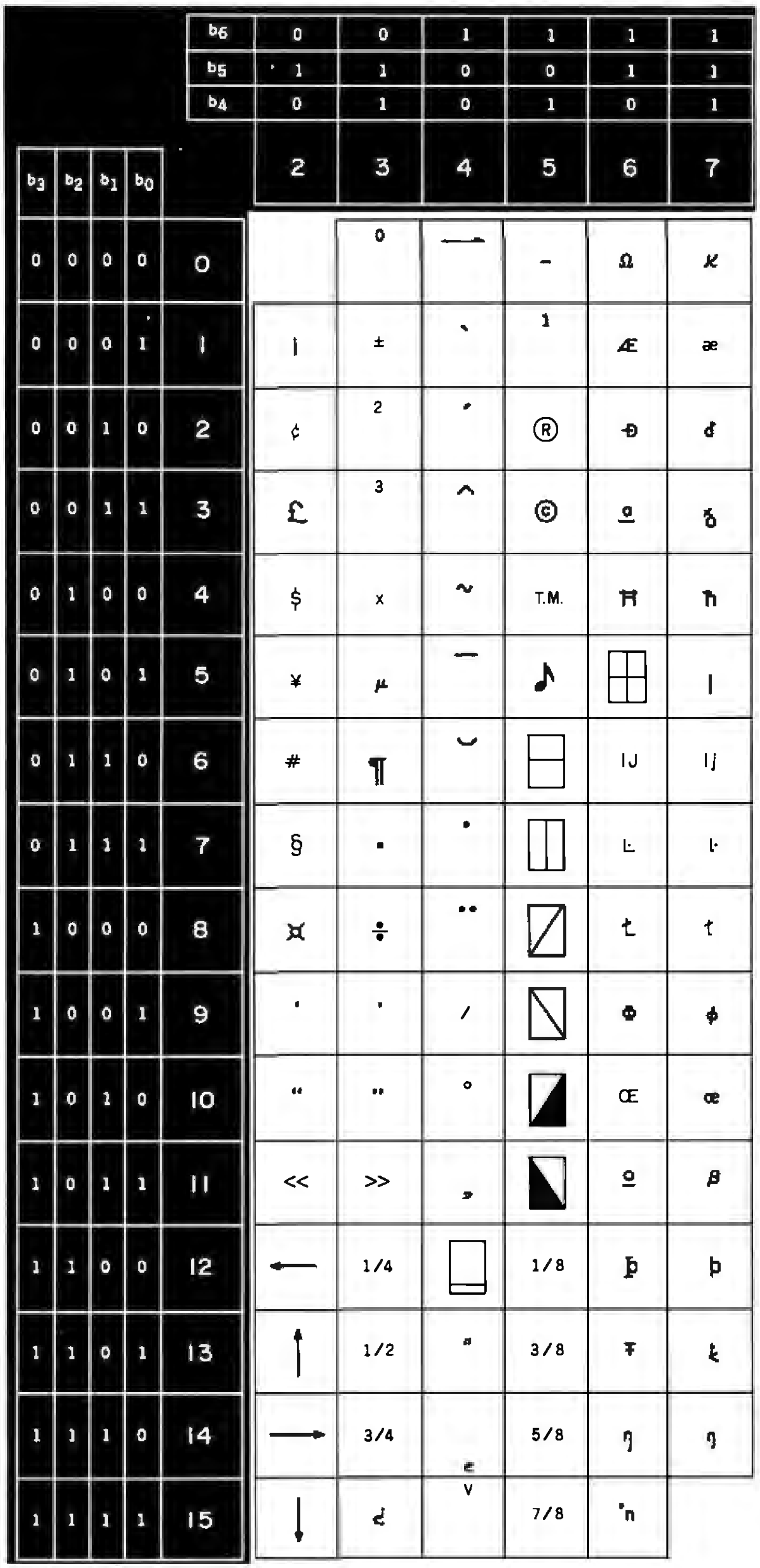

Figure 16: *The Supplementary Character Set of NAPLPS.*

"pattern" on the template is transferred to the screen, overwriting only those areas drawn with the template.

As mentioned earlier, NAPLPS currently specifies three fixed character sets and one redefinable character set. The Primary Character Set (ASCII) is shown in figure 15 on page 236. Most text is taken from this set. The ASCII character set is the default for the G0 and GL sets in figure 6. Therefore, it is accessed via the usual codes, 32 through 127 decimal.

A Supplementary Character Set has also been specified in NAPLPS (see figure 16). This character set contains a smorgasbord of symbols and international characters. Most applications will require only a few of these symbols. This character set is the default for the G2 designated set, and must be moved to GL or GR before these characters can be accessed.

The Mosaic Character Set is the third of the fixed sets (see figure 17 on page 242). Although the Mosaic characters do not look like text characters, they are treated exactly like text because of their rectangular shape. The Mosaics have very little use because of the extensive graphics capabilities contained in NAPLPS. The Mosaics are the default for the G3 designated set. Thus, they cannot be directly accessed without a G-set change. (We should have made it harder than that to use.)

The fourth text set in NAPLPS is the Dynamically Redefinable Character Set (DRCS). The templates in this character set are initially blank rectangles. We can define each template, however, by using NAPLPS to draw a pattern on the unit screen and mapping that pattern to the template. The pattern can be drawn with either graphics or text commands. Once the template is defined, it can be used just like any other character. (Yes, existing DRCS characters can even be used to define a new DRCS character.) Thus, the 96 characters in the DRCS set can be used to create custom fonts and special symbols.

NAPLPS provides a variety of text-oriented features, which can be applied to any of the four text sets. Figure 18 on page 244 illustrates many of the available capabilities. In parts 2 and 3 of this series, we will describe how these features are selected and applied.

Graphics Features

The graphics instructions (or primitives) are specified using codes from the Picture-Description Instruction (PDI) G-set. As shown in figure 19 on page 246, the PDI G-set is a 96-character set that is divided into

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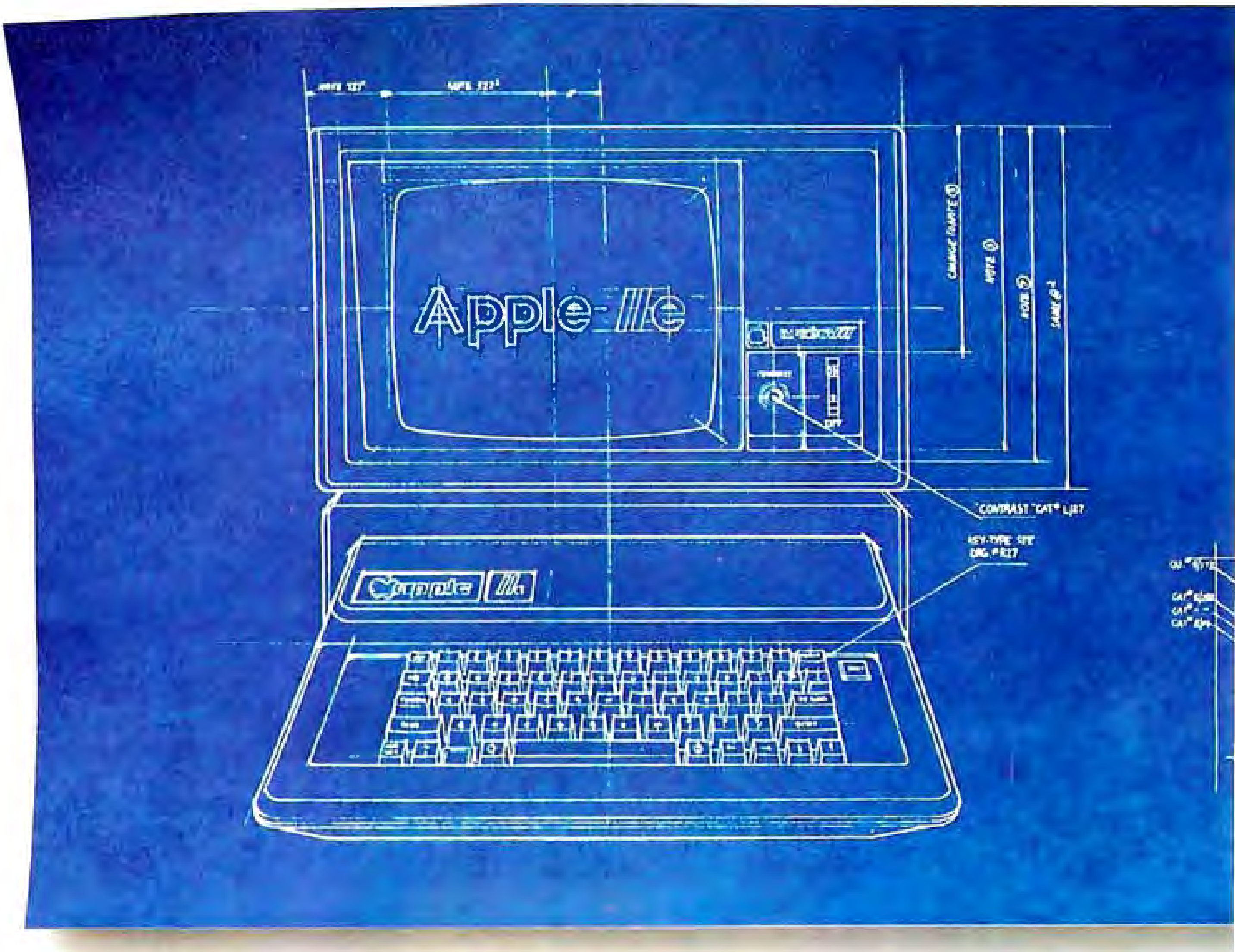

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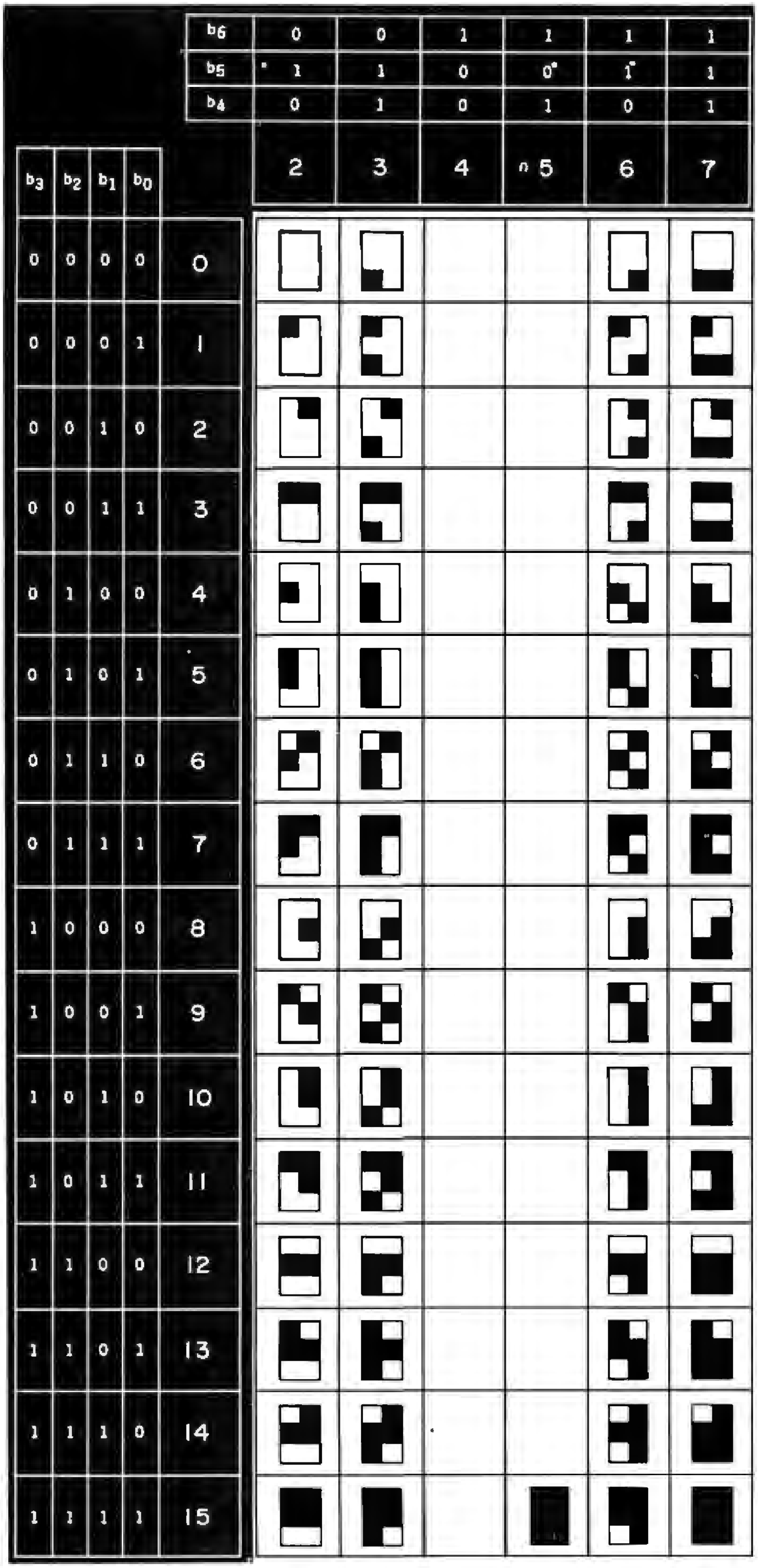

Figure 17: *The Mosaic Set.*

two smaller sets. The first 32 characters are graphics operation codes. These op codes are used to specify text control, drawing primitives, and color control.

The 64 codes in the right four columns of the PDI G-set are used to encode data for these op codes. These data bytes are encoded and interpreted according to the preceding op code. Six bits are available for information in each byte. Many of the op codes require multiple data bytes to encode one data item. Coordinates, for example, are typically encoded in 3 consecutive data bytes.

As shown in figure 20 on page 250, this distinction of op codes and data within the PDI G-set leads to a convenient decoding structure. Once it has been determined that a code falls in the PDI set, bit 6 (the seventh from the right) can be used to determine if an op code is specified or data. If bit 6 is 0, the byte is interpreted as an op code; if it is 1, it is a data byte.

Such a distinction is necessary because the picture-description instructions have been set up so that a *variable* amount of data can follow an op code. The bytes following the op code are assumed to be data as long as bit 6 is a 1.

Figure 21 on page 250 illustrates how text, graphics, and color can be integrated to draw a simple picture. Approximately 180 bytes of NAPLPS were needed to specify this picture. In parts 2 and 3, we will describe in detail how graphics commands for such pictures are encoded.

Control

Up to this point, the emphasis has been on the 96-character G-sets. Two C-sets (control sets), C0 and C1, are also specified in NAPLPS. These control sets contain the codes needed to accomplish the G- and C-set swapping. They also contain codes for moving the cursor, controlling the DRCS, clearing the screen, and so on.

Figure 22 on page 252 illustrates the C0 and C1 control sets. The C0 set should be familiar to those of you who have worked with ASCII. The C1 set contains a variety of codes associated with the new features of NAPLPS.

A mechanism has been provided, but not used, that allows C-sets to be changed like G-sets. The C-sets were originally going to be used whenever a small (fewer than 32) number of similar codes were added to NAPLPS. As it turns out, the 96-character G-sets have proven to be more useful. The C-sets have ended up becoming a catchall for codes that do not seem to "fit" (either physically or logically) anywhere else. This

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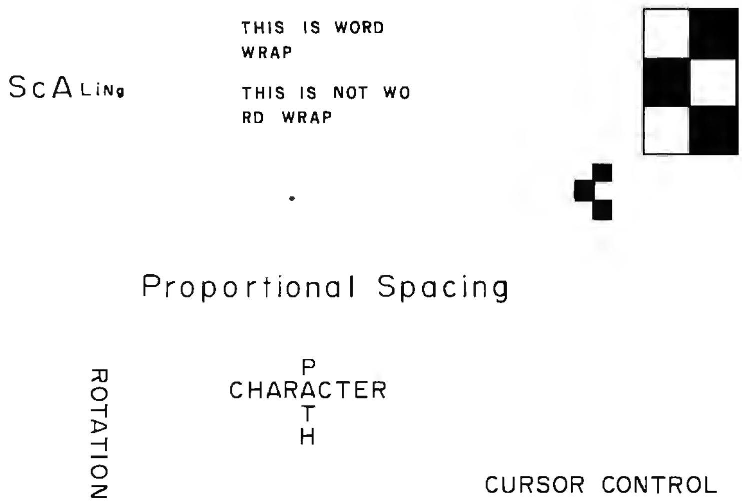

Figure 18: *Some examples of the text and Mosaic features of NAPLPS.*

compromise was not desired, but compromises such as this occur frequently when standards are being developed.

User Input

Because of the heavy emphasis on text and graphics in NAPLPS, the *user-input* features are often overlooked. User input is needed to allow a terminal user to enter information that will eventually be sent to the central host computer. This input could be used to request information from a database, order products, schedule an airline reservation, or send electronic mail.

User input has been integrated with the rest of NAPLPS in an elegant manner. Certain areas or fields of the unit screen can be designated as user-input areas. These areas are called *unprotected fields*.

The user can enter information into the unprotected fields using a variety of input devices such as keyboards, light pens, joysticks, graphics tablets, and even a "mouse." Information entered in the fields is stored as NAPLPS data. The user must eventually indicate (usually via a Send key) that all the information has been entered and should be sent to the host.

When the host computer receives the block of information, it may or may not decode it, depending on the application. For example, a graphics electronic-mail message would merely be sent to the appropriate addressee and would not have to be decoded.

The text of a message does not have to be entered on rigid lines as in most terminal systems. In applications such as electronic mail, a user who

				b6	0	0	1	1	1	1
				b5	1	1	0	0	1	1
				b4	0	1	0	1	0	1
b3	b2	b1	b0		2	3	4	5	6	7
0	0	0	0	0	RESET	RECT (OUT-LINED)	NUMERIC DATA			
0	0	0	1	1	DOMAIN	RECT (FILLED)				
0	0	1	0	2	TEXT	SET & RECT (OUT-LINED)				
0	0	1	1	3	TEXTURE	SET & RECT (FILLED)				
0	1	0	0	4	POINT SET (ABS)	POLY (OUT-LINED)				
0	1	0	1	5	POINT SET (REL)	POLY (FILLED)				
0	1	1	0	6	POINT (ABS)	SET POLY (OUT-LINED)				
0	1	1	1	7	POINT (REL)	SET & POLY (FILLED)				
1	0	0	0	8	LINE (ABS)	FIELD				
1	0	0	1	9	LINE (REL)	INCR POINT				
1	0	1	0	10	SET & LINE (ABS)	INCR LINE				
1	0	1	1	11	SET & LINE (REL)	INCR POLY (FILLED)				
1	1	0	0	12	ARC (OUT-LINED)	SET COLOR				
1	1	0	1	13	ARC (FILLED)	WAIT				
1	1	1	0	14	SET & ARC (OUT-LINED)	SELECT COLOR				
1	1	1	1	15	SET & ARC (FILLED)	BLINK				

Figure 19: *The operation codes (or op codes) of the Picture-Description Instruction (PDI) G-set. The four columns on the right (that is, bits 0 through 5) are used as data for various op codes.*

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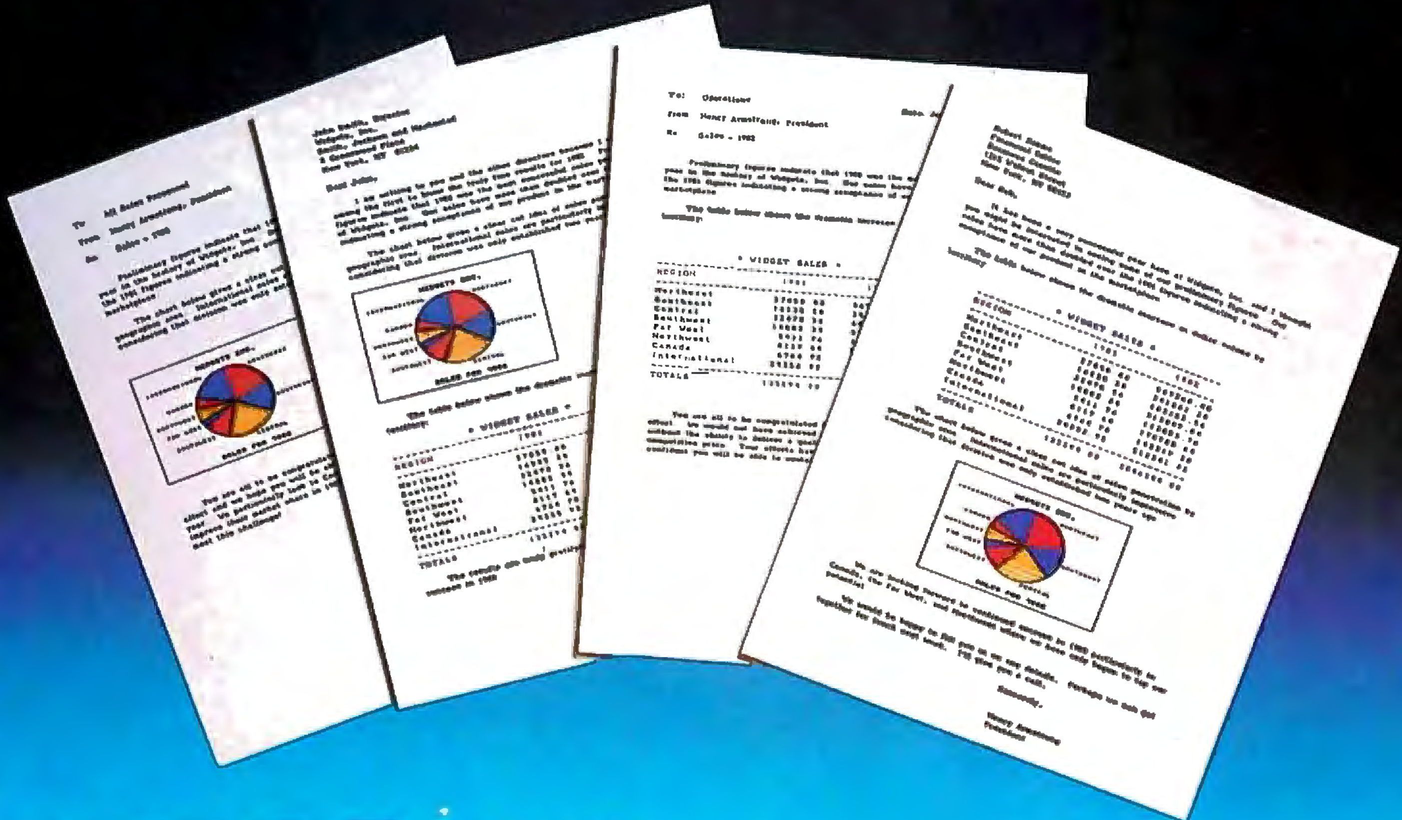

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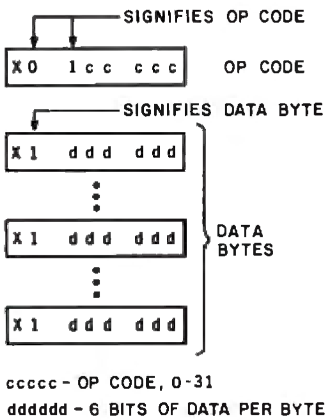

Figure 20: *In the PDI G-set of NAPLPS, op codes are distinguished from data bytes by bit 6. If bit 6 is 0, the byte is an op code; otherwise, it is a data byte.*

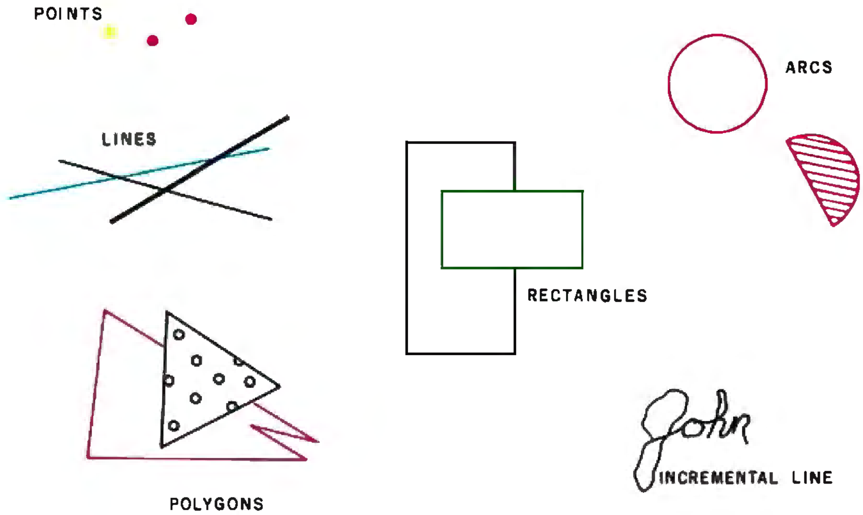

Figure 21: *Some examples of pictures that can be created with NAPLPS instructions. Approximately 180 bytes would be used to encode the entire figure. The signature alone requires 51 bytes.*

has the appropriate input device can even send *handwritten* messages using NAPLPS as the encoding mechanism.

The best analogy to describe user input in NAPLPS is to imagine that the user is handed one or more blank sheets of paper. (When the three-dimensional mode is supported, the user will be given an empty box.) The user is able to type on the paper, draw a sketch on the paper, or do anything that his or her terminal allows.

The "paper" is eventually passed to a host computer, where it can be forwarded to another user (electronic mail), stored for later recall, or analyzed by the host. The analysis by the host can be minimal or extensive, again depending on the application.

At this point, remember that NAPLPS is only a sixth-level specification in a seven-level model.

Circle 82 on inquiry card.

b3	b2	b1	b0	b7 b6 b5 b4 →	0 0 0 0	0 0 0 1
					0	**1**
0	0	0	0	0	NUL	DLE
0	0	0	1	1	SOH	DC_1
0	0	1	0	2	STX	DC_2
0	0	1	1	3	ETX	DC_3
0	1	0	0	4	EOT	DC_4
0	1	0	1	5	ENQ	NAK
0	1	1	0	6	ACK	SYN
0	1	1	1	7	BEL	ETB
1	0	0	0	8	APB (BS)	CAN
1	0	0	1	9	APF (HT)	SS2
1	0	1	0	10	APD (LF)	SUB
1	0	1	1	11	APU (VT)	ESC
1	1	0	0	12	CS (FF)	APS
1	1	0	1	13	APR (CR)	SS3
1	1	1	0	14	SO	APH
1	1	1	1	15	SI	NSR

b3	b2	b1	b0	b7 b6 b5 b4 →	1 0 0 0	1 0 0 1
					8	**9**
0	0	0	0	0	DEF MACRO	PROTECT
0	0	0	1	1	DEFP MACRO	EDC_1
0	0	1	0	2	DEFT MACRO	EDC_2
0	0	1	1	3	DEF DRCS	EDC_3
0	1	0	0	4	DEF TEXTURE	EDC_4
0	1	0	1	5	END	WORD WRAP ON
0	1	1	0	6	REPEAT	WORD WRAP OFF
0	1	1	1	7	REPEAT TO EOL	SCROLL ON
1	0	0	0	8	REVERSE VIDEO	SCROLL OFF
1	0	0	1	9	NORMAL VIDEO	UNDER LINE START
1	0	1	0	10	SMALL TEXT	UNDER LINE STOP
1	0	1	1	11	MED TEXT	FLASH CURSOR
1	1	0	0	12	NORMAL TEXT	STEADY CURSOR
1	1	0	1	13	DOUBLE HEIGHT	CURSOR OFF
1	1	1	0	14	BLINK START	BLINK STOP
1	1	1	1	15	DOUBLE SIZE	UNPROTECT

Figure 22: *The two control sets used in NAPLPS.*

NAPLPS merely provides a vehicle for the seventh level (commonly called the application level) that comprises the application programs and software (e.g., a banking program) that will run on NAPLPS. Many special applications can be developed and standardized at level 7 using NAPLPS as a foundation. These applications may be very specialized and might use only a subset of NAPLPS.

When we discuss user input, it should be noted that NAPLPS was *not* developed as a standard to be used for massive amounts of data entry in large data-processing centers. NAPLPS was developed to be used by people at home, at work, and at play. It was designed to be elegant and free-form.

NAPLPS was designed in this manner based on the assumption that most people do not want to interact with computers in robot-like ways. People will enter data by looking at menus and pointing to selections, rather than learning some complex command syntax. As we mentioned earlier, with a graphics tablet or other digitizer, people will even be able to input handwritten messages. Studies have shown that people want as much of their personality as possible to be reflected in their communication. And they expect that if they enter something reasonable, that it should be accepted and handled in a reasonable manner.

Macros

Macros (or macroinstructions) are specified in NAPLPS to reduce the amount of data that must be transmitted from the host to the terminal. Macros provide a mechanism whereby a frequently used multibyte string of text and/or graphics can be represented by a single-character macro. If the name of that macro appears later in the incoming data stream, the terminal retrieves the multibyte string and inserts it into the incoming stream in place of the macro name.

Once the string has been inserted into the incoming stream, the terminal processes it as if it had come from the host. Also, nesting of macros is allowed so that one macro can be used to retrieve several other macros. Of course, you must be careful to avoid looping and recursive macros that will endlessly refer to each other.

Ninety-six macro names are available. NAPLPS allows a unique, variable-length string to be stored for each name. Also, macros can be used in two directions: from the host to the

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Circle 307 on inquiry card.

```
NAPLPS CODE

DEFINE MACRO 26
   SELECT BLUE
   CLEAR SCREEN
   SELECT WHITE
   POSITION (.05, .25)
   TEXT "READY:"
END
•
•
•
MACRO 26
```

RESULT

Figure 23: *An example of the use of macros in NAPLPS. Each time the code for Macro 26 occurs in the data stream, the word "READY:" will appear on a blank screen.*

terminal and vice versa. The direction can be specified when the macro is defined. The typical direction is to expand the macro *into* the terminal as described above. In the so-called transmit macros, the expansion of the macro occurs toward the host.

Transmit macros are usually associated with programmable function keys on the terminal. When a key is pressed, the string associated with the macro and the key is sent to the host.

Figure 23 illustrates a typical application of macros. Here, a macro has been defined. In this case, it was given the number 26. Later in the stream of NAPLPS instructions, the macro name 26 appears and the macro is expanded and processed by the terminal. The screen will be cleared to blue, the color white will be selected, and the word "READY:" will appear one-fourth of the way up the screen and a little in from the left edge. (Note that on the display screen the word "READY:" may appear to be *one-third* of the way up from the bottom; this results from the fact that the top quarter of the unit screen is not displayed.) Only 1 byte was sent to invoke this multibyte sequence. With this type of compression, a system can be made to appear very fast, even over 300-bit-per-second data links.

The Future of NAPLPS

NAPLPS has finally started to emerge as the most extensive text and graphics standard in existence. Many companies have hundreds of people working on NAPLPS-related projects. A survey in *Data Communications* magazine predicted that NAPLPS will be one of the most significant achievements in information exchange in the latter half of this century.

Part of the reason for this popularity is the fact that NAPLPS is not only a video-graphics protocol but an information-exchange language. NAPLPS has been used to encode pictures for plotters, printers, laser printers, and phototypesetters. NAPLPS can be used to encode precise descriptions of logos, trademarks, and physical objects, things which heretofore have been very difficult to describe precisely.

NAPLPS comes at a time when the information industry is bursting with new technology that exceeds existing standards for information interchange. NAPLPS is a standard that pushes this new technology to its limits and still provides the capability to accommodate unknown expansions.

NAPLPS is only the tip of the iceberg. In subsequent parts of this series, we will describe how NAPLPS fits into the larger scheme of local and regional area networks and distributed intelligent-terminal systems. Topics such as down-loading, file transfer, and operating-system evolution and compatibility will be covered.

Next month, we will begin to describe in detail how to write and decode NAPLPS information. In the meantime, anyone interested in obtaining more information about NAPLPS should obtain a copy of the ANSI standard specification. ■

Circle 10 on inquiry card. ⟶

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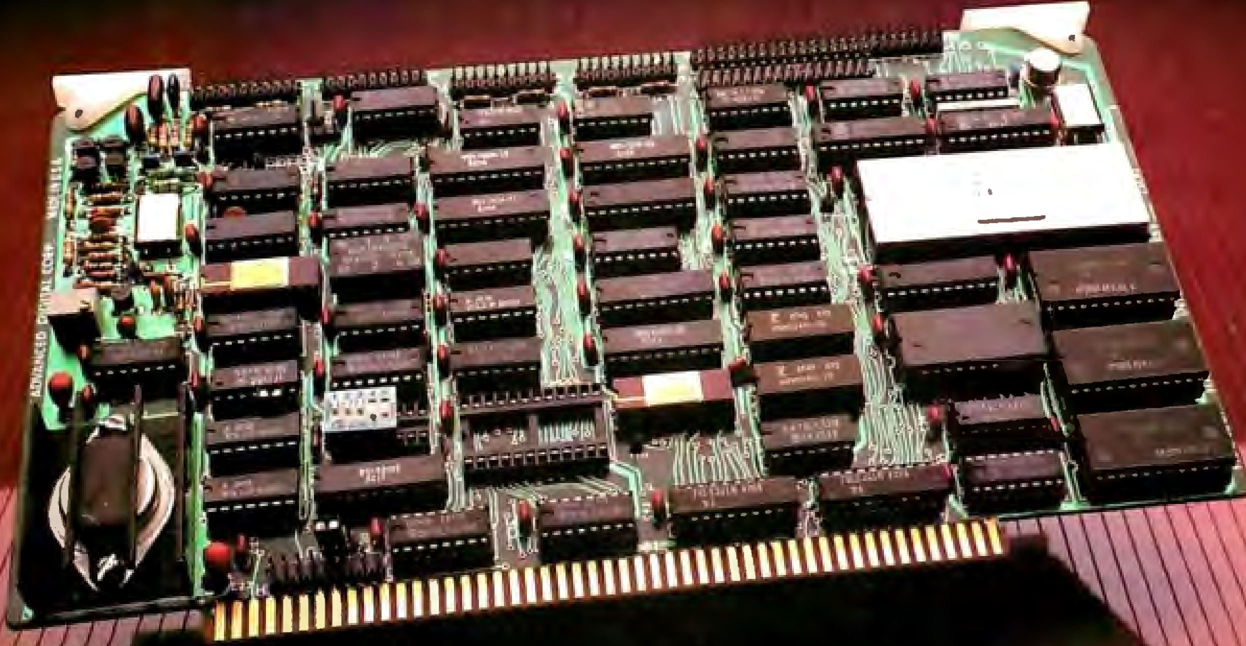

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Realizing Graphics Standards for Microcomputers

Use of the Virtual Device Interface graphics system will make portable graphics application software possible.

Fred E. Langhorst
Digital Research Inc.
POB 579
Pacific Grove, CA 93950

Thomas B. Clarkson III
Graphic Software Systems Inc.
POB 673
Wilsonville, OR 97070

Emerging standards for interactive computer graphics herald an era in which serious graphics applications will be as ubiquitous as spreadsheet and word-processing programs. By promoting program portability, making it possible to run the same programs on different computer systems, standards will create large markets for both software and hardware graphics products. As a result, the development of sophisticated graphics applications for microcomputers will be economically feasible. The benefit for the end user will be more software offerings of higher quality at reduced cost.

A History of Graphics Standards

The earliest graphics standards were de facto standards created by a small number of manufacturers who established dominance in the field by producing various successful graphics output devices, such as Calcomp plotters and Tektronix graphics terminals. When these companies added software support (for example, Tektronix's Plot-10 package), their implementation of graphics-device-control routines became the common graphics language for applications. This situation lasted until the early 1970s, when the need for broader and more flexible standards was recognized.

In 1974, the Special Interest Group on Computer Graphics (SIGGRAPH) of the Association for Computing Machinery (ACM) held the Workshop on Machine Independent Graphics at the National Bureau of Standards near Washington. This conference marked the beginning of formal efforts in the United States to standardize graphics. The goal: to define a generic method for describing pictures that could be output to a variety of graphics devices such as hard-copy plotters and vector or raster video displays.

The International Workshop on Graphics Standards Methodology held in 1976 in Seillac, France, accelerated the work begun by SIGGRAPH. A significant development was the decision to break the standardization task into two components: first, to develop methods for making applications programs portable, and second, to develop a functional description of a "core" or basic graphics system.

In 1977, the Graphic Standards Planning Committee released its first draft of a graphics standard, the SIGGRAPH Core Standard. This draft incorporated input and output capabilities for a range of graphics devices but did not address the emerging field of raster graphics. Then, after two more years of work, the committee released a major publication, the *Status Report of the Graphic Standards Planning Committee*, at the annual SIGGRAPH conference in 1979. Included was a methodology and specification for the Core Graphics System, raster-graphics extensions to the Core System, a description of Metafile (a device-independent picture file) and a model for distributed graphics systems. This document also provided the impetus for the formation of the ANSI (American National Standards Institute) Technical Committee X3H3 for Computer Graphics Programming Languages. Formed in 1979, this ANSI group is now the major graphics-standardization body in the United States. Meanwhile in Europe, the Deutsches Institut fur Normung (DIN), the German standardization institute, was working on a parallel effort to produce its Graphical Kernel System (GKS).

Current Standards Efforts

Present efforts in standardization focus on two main interface levels: the programmer interface and the

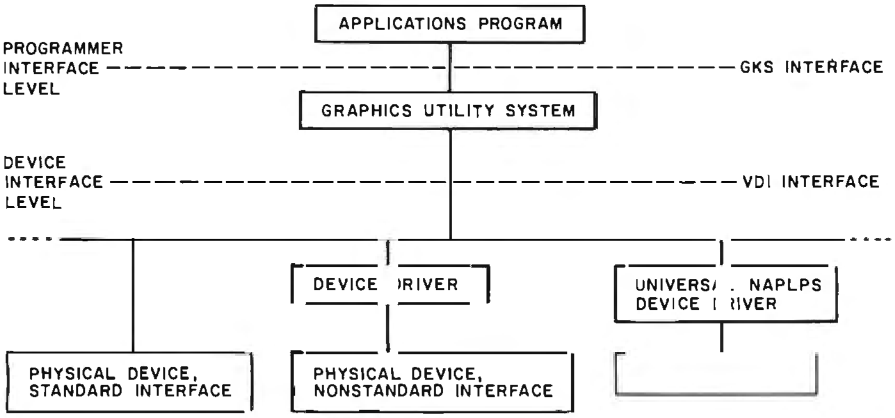

Figure 1: *The two main levels of graphics standardization are the programmer and device-interface levels. The Graphical Kernel System (GKS) provides a standard interface between the application program and graphics utility programs. The Virtual Device Interface (VDI) standardizes the interface between graphics utilities and device drivers.*

device interface. The *programmer interface* refers to the conceptual model as well as the syntax the programmer uses when incorporating graphics functions into an application program. The *device interface* refers to the protocol used for communication between the device-independent and the device-dependent functions (sometimes called the DI/DD interface). The programmer interface standardizes the calling sequence and functions of a graphics-procedure library, while the device interface defines a device-driver protocol that is consistent for all graphics devices (see figure 1).

The Graphical Kernel System

The Graphical Kernel System (GKS) is the principal emerging standard at the programmer level. GKS has felt the influence of many national organizations, including ANSI in the United States, and is justifiably described as an international standard. Now a Draft International Standard, the GKS specification is frozen awaiting final adoption as an ISO (International Organization for Standardization) standard.

GKS allows portability of graphics application programs between different computer installations by providing a consistent interface in high-level languages such as FORTRAN and Pascal. It also improves a programmer's ability to work on different systems by providing a graphics model and syntax that are common to several systems. This is accomplished by standardizing the way in which graphics functions are accessed and by providing graphics output on a virtual device surface defined in normalized device coordinates. The application program may then control the way individual workstations interpret the normalized coordinates, which are translated to real-device coordinates for display, although the other layers of the system are fooled into thinking they are communicating with the idealized virtual device.

Reflecting the rigors of its origin in the flexibility it provides, GKS supports a full set of drawing primitive commands (with variable attributes) for data input and drawing, support for multiple workstations, and device-independent picture segments. It also supports raster graphics through a comprehensive set of area-fill and pixel-array primitives. While GKS provides device independence for standard functions, nonstandard operations are also made available through the Generalized Drawing Primitive, a well-defined mechanism to escape from GKS that allows a programmer to access the unique capabilities of a particular device.

Let's take a look at some parts of the GKS specification.

GKS Workstations: A GKS workstation is a single display surface and one or more input devices. The display surface is usually a cathode-ray-tube screen, although it could be a plotter bed or some other device. Multiple workstations that may operate in a single, interactive graphics session might include, for example, a raster display, a plotter, and a storage display tube. GKS provides the logical interface through which the application program controls physical devices, allowing the application to redirect the flow of graphics data to another I/O device at any time.

GKS Graphics Primitives: The basic drawing primitives in GKS are the polyline, polymarker, and text primitives. The *polyline* primitive draws a sequence of vectors (straight lines) between pairs of points that form a sequence specified as an array (sort of a "connect the dots" command). A single line is merely a special case of the polyline, defined by specifying both endpoints (rather than relying on a sometimes ambiguous and confusing current-position model). The *polymarker* primitive, chiefly used to identify points on plotted curves, is similar to the polyline except that a marker symbol, rather than a vector, is drawn at each specified point. The *text* primitive allows text strings to be displayed at any position with any orientation.

GKS also supports raster devices with fill and pixel-array primitives. The *fill* operation paints the interior of a closed polyline (polygon) with a specified color or pattern (such as a crosshatch). The *pixel-array* primitive allows a two-dimensional array of pixels of different colors, called a *cell*, to be defined. The cell may then be replicated over an arbitrary area simply by giving the desired boundaries. This operation finds many uses in imaging applications such as video-frame displays, cartography, and other scientific areas.

Some graphics-output devices have incorporated unusually powerful capabilities into their repertoire, such as the ability to draw arcs, circles, and bars. GKS allows an application program to access these capabilities through a special escape mechanism

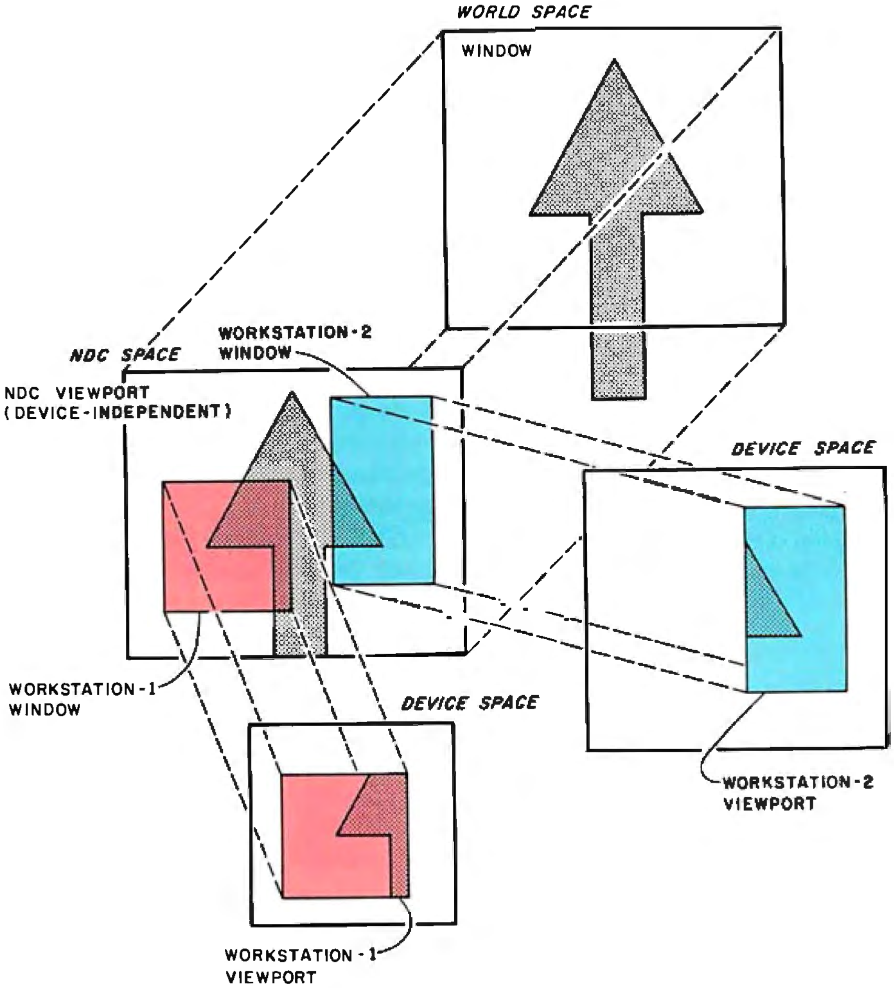

Figure 2: *GKS provides a versatile set of viewing transformations. A window may be defined in the application's conceptual "world space," which selects a portion of that space to be viewed. The window is mapped to an area or* viewport *in an intermediate virtual space called the normalized-device-coordinate (NDC) space. This space appears identical to all devices in the system. Each workstation can then define its own window into the NDC space; each workstation window is mapped to its own viewport on the device display surface. This transformation allows each workstation to have a separate view of the NDC space.*

called the Generalized Drawing Primitive. By passing an identification number and the required parameters to the driver, any unique feature of the device may be invoked. In effect, the Generalized Drawing Primitive is a standard way to be nonstandard.

Attributes: Associated with each output primitive are attributes that alter the object's appearance. For example, the polyline primitive has linetype (solid, dashed, etc.), width, and color attributes. Polymarkers have attributes of style, size, and color; the styles comprise a choice of common ASCII (American Standard Code for Information Interchange) characters. Text primitives have attributes of size, color and orientation; and multiple character fonts can be accessed if they are available in the graphics device. Color indexes may be defined by associating a desired color specified in RGB (red-green-blue) intensities with a color-index number; the color values of primitives are then given as the appropriate index.

Viewing and Transformations: GKS allows the user or programmer to define a coordinate space, called the *world coordinate space*, that is appropriate for each application. This world coordinate space is mapped into device coordinates in a controlled manner through two distinct operations: normalization transformations and workstation transformations. GKS first transforms world coordinates into a normalized-device-coordinate (NDC) space by defining a working region, or *window*, in world-coordinate space. NDC space acts as an abstract viewing surface or an intermediary space between applications and devices. The NDC space is then transformed into the device coordinates (DC) of the workstation. When multiple workstations are used, each may have a distinct view of the application by setting its own workstation window. The last transformation allows the workstation to set a viewport, the active region of the device's potential workspace, which can be used for scaling and translating the original picture (see figure 2).

Graphics Input: A full set of input operations allows an application program to receive input from a broad range of interactive input devices. The input operations are grouped into five classes: choice, locator, pick, string, and valuator. This vital flexibility allows GKS to support the optimum input device for a particular working environment. The result is improved interactivity through which the full potential of the graphics man/machine interface can be realized. The *request-locator* function returns the position of an image entity in world coordinates, while the *request-valuator* function returns an indication of the current value of a continuous valuator device such as a potentiometer. The *request-choice* function returns an integer that represents one of a set of choices. The *pick* function returns the graphics segment number that corresponds to the objects being selected with graphics input. Finally, the *request-string* function reads character input from a keyboard device. The way in which these logical functions are implemented (through a joystick, a mouse—like the one used with the Apple Lisa, function keys, etc.) is workstation dependent.

Inquiries: To aid the programmer, GKS provides an *inquire* capability that allows the application program to find out information about its system environment: the current operat-

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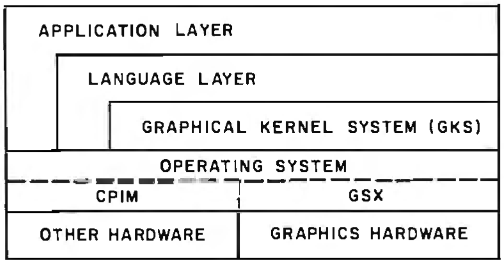

Figure 3: *This layer model shows the relationship of GKS and VDI to other components in a graphics system. Each module may call the functions of the adjoining layer below. An example of this is the Graphics System Extension (GSX) to the popular CP/M family of operating systems.*

ing state, primitive attributes, viewing operations and transformations, and device capabilities.

Device-Level Interfaces

Two emerging standards are addressing the hardware-driver interface level. One of these, the North American Presentation-Level-Protocol Syntax (NAPLPS), was developed by a team at Bell Laboratories as an extension of graphics developments in the Canadian Telidon videotex system. (See the article "NAPLPS, A New Standard for Text and Graphics: Part 1" by Jim Fleming and Bill Frezza on page 203.) NAPLPS (pronounced "nap-lips") has been adopted by AT&T as a standard for transmitting text and graphics over telecommunication lines. In some computer-graphics applications, NAPLPS probably will "sit below" another, more general, device interface called the Virtual Device Interface (VDI). This relationship is illustrated in figure 1, where the NAPLPS block is placed under the dashed line of the Virtual Device Interface.

The VDI standard is being developed by the ANSI X3H33 Technical Committee as a standard interface between device-independent software and graphics devices. VDI makes all devices appear as identical virtual graphics devices by defining a standard input/output protocol. The unique characteristics of the physical graphics device are isolated in the device-driver software module. This technique has been employed by individual vendors to make their own products compatible with a wide range of devices, similar to the way operating systems such as Unix or CP/M are interfaced to a multitude of hardware configurations. VDI takes the concept a step further by providing potential industry-wide compatibility.

The VDI specification is expected to be frozen during the summer of 1983. For the graphics-equipment manufacturer, the adoption of this standard means that a VDI driver for a particular graphics device need be written only once. All graphics applications that conform to VDI would then be able to communicate with the device through the standard device driver. Long-range benefits will be more evident as equipment and semiconductor manufacturers begin implementing more of the software-driver functionality in hardware—in effect moving the VDI interface down into the graphics device itself. This development in graphics is a direct parallel to other standardization efforts, such as the Shugart Associates Standard Interface (SASI) for disk-drive subsystems. The SASI hardware and protocol specification allows OEMs (so-called original equipment manufacturers) to freely mix disk subsystems and host computers made by different firms. The popularity of this approach stems from the many benefits it offers to the industry: less design effort expended reinventing the wheel, numerous second sources of parts, higher reliability with a proven design, reduced costs, and larger markets. Similar benefits will accrue to computer graphics as a result of the standardization efforts that are at last bearing fruit.

Graphics Standards as Products

Although the cost of hardware, especially semiconductor memory, is usually cited as the major inhibitor to truly widespread use of interactive graphics, this is becoming less and less accurate. The lack of universal standards has dulled the impact of the dramatic reduction in component costs in the past decade. The impending advent of these important standards paves the way for implementations of computer graphics that will enjoy widespread availability and economies of scale. The success of this approach has been demonstrated in the microcomputer world by such de facto standards as the 8080-compatible microprocessors and the CP/M operating system.

Digital Research in collaboration with Graphics Software Systems Inc. (GSS) has recently responded to the potential offered by the new standards by expanding the capability of the CP/M family of operating systems with an upgrade called the *Graphics System Extension,* or GSX. This upgrade provides full graphics capabilities to the user through the normal CP/M function-call access mechanism. The architecture of GSX has been carefully designed to allow the extended CP/M to maintain compatibility with nongraphics applications and to use system resources in a way that is consistent with a small-system environment, according to the structure shown in figure 3.

Digital Research has also provided a package called GSS-Kernel that presents a GKS interface to the graphics-application programmer using the graphics functions provided by GSX. GSS-Kernel, a linkable run-time library, will increase programmer productivity while providing program portability through the standard GKS interface. In addition, applications using GSS-Kernel will be source-code compatible with large computer systems running GKS procedures libraries.

GSX Architecture

GSX is composed of three major components: the graphics-device operating system, the graphics input/output system, and the Gengraf

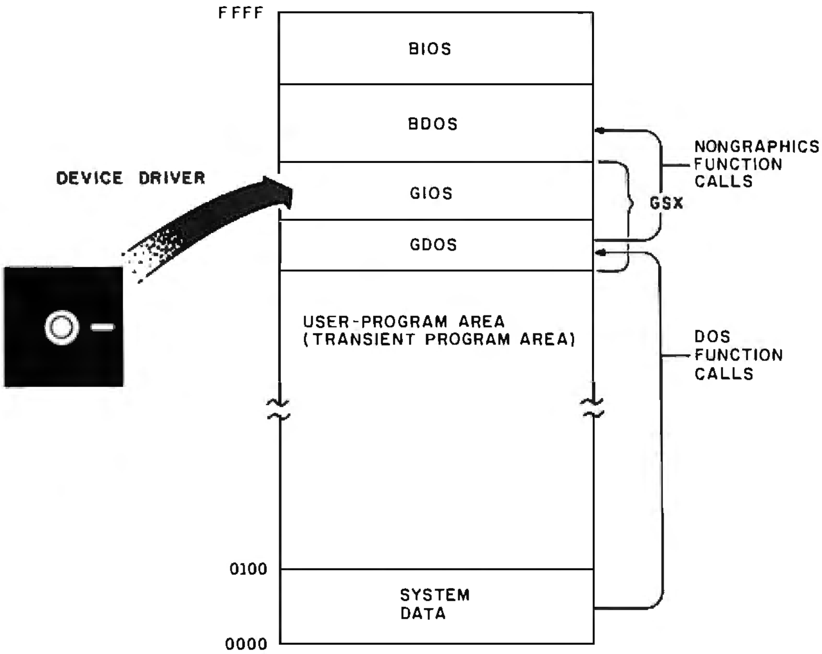

Figure 4: *GSX consists of the device-independent (GDOS) and device-dependent (GIOS) components. These are loaded at run time below the BDOS (basic disk operating system) module in high memory. Initial loading of GIOS and GDOS from the system disk is performed by a loader routine attached to the application program by the GSX Gengraf utility when the program is created. During operation, graphics workstations may be changed by making a request to GDOS that causes a new device driver to be loaded from the disk.*

utility routine. The *graphics-device operating system*, or GDOS, is analogous to the BDOS (basic disk operating system) module in the standard CP/M system and contains the device-independent portion of GSX. The *graphics input/output system*, or GIOS, contains the device-dependent drivers which, like the basic input/output system (BIOS) in standard CP/M, provide the necessary "glue" to connect GDOS with the particular characteristics and command sequences of a specific graphics device. Finally, the *Gengraf* utility configures a graphics-application program to run in the GSX environment.

Figure 4 shows the relationship of software components of a GSX-extended CP/M-80 system. GDOS and GIOS form a path to graphics devices that is essentially parallel to the BDOS and the BIOS. Normal operating-system calls, such as reading from or writing to the console or a disk drive, are initiated by the BDOS, and the BIOS provides the device-dependent interface. Graphics calls are intercepted and serviced by GDOS and passed to the appropriate device-dependent driver within GIOS. In reality, only one device-driver routine is resident in memory at any time; the other device drivers are stored on disk. The application program may request use of a new workstation at any time, and GSX will insure that the proper device driver is loaded as needed. This choice of implementation maximizes the memory available for the application program.

Graphics-Device Operating System: Access to all graphics operations is through function calls to GDOS, made in the same manner as BDOS calls except that an additional parameter list is specified to transfer graphics information. This information includes a graphics operation code, a control array, a parameter array, and a point array. Point locations are passed to GSX in a normalized-device-coordinate space. Here all point locations are specified with x,y coordinates between 0,0 and 32767,32767. GDOS then transforms the NDC coordinates into the device coordinate system through a scaling operation using device-specific information that was passed when the current workstation was opened for use. This scheme not only provides a VDI-compatible method of passing coordinate values, but also allows points to be specified as integer arrays, thus saving memory space and processing time.

GDOS is also responsible for dynamic workstation assignment. Each device on a system is associated with a workstation-identification (ID) number. When GDOS receives a request to assign a workstation (change the currently active graphics device), it determines which driver corresponds to the indicated workstation ID and loads that driver into memory. The new driver is loaded into memory in the same locations formerly occupied by the previous driver so that memory requirements are minimized. The logical association of workstation ID number to a particular device is made through an assignment table, a text file stored on the system disk. You can alter the correspondence of workstation ID to specific device drivers simply by editing the assignment-table file with any text editor.

Graphics Input/Output System: The GIOS component of GSX contains the device-dependent code that translates between the Virtual Device Interface and the unique characteristics of a real graphics device, making all graphics devices appear to the application program as identical virtual devices. The VDI specifies the pseudo-operation code for a graphics operation as well as a set of input and output arguments. The input arguments include an array of control parameters, an array of input parameters, and an array of input point coordinates. The output arguments include control parameters, output parameters, and output point coordinates. The control, input, and output parameters are unique to the particular operation being performed (see table 1).

Often, the capabilities specified by

Op Code	Description
1	Open Workstation: initialize a graphics device (load driver routine if necessary)
2	Close Workstation: stop graphics output to this workstation
3	Clear Workstation: clear display device
4	Update Workstation: display all pending graphics on workstation
5	Escape: enable special device-dependent operation
6	Polyline: output a polyline
7	Polymarker: output markers
8	Text: output text starting at a specified position
9	Filled Area: display and fill a polygon
10	Cell Array: display a cell array
11	Generalized Drawing Primitive: display a generalized drawing primitive function
12	Set Character Height: set text size
13	Set Character-Up Vector: set text direction
14	Set Color Representation: define the color associated with a color index
15	Set Polyline Line Type: set line style for polylines
16	Set Polyline-Line Width: set width of lines
17	Set Polyline-Color Index: set color for polylines
18	Set Polymarker Type: set marker type for polymarkers
19	Set Polymarker Scale: set size for polymarkers
20	Set Polymarker-Color Index: set color for polymarkers
21	Set Text Font: set device-dependent text style
22	Set Text-Color Index: set color of text
23	Set Fill-Interior Style: set interior style for polygon fill
24	Set Fill-Style Index: set fill style for polygons
25	Set Fill-Color Index: set color for polygon fill
26	Inquire Color Representation: return color representation values of index
27	Inquire Cell Array: return definition of cell array
28	Input Locator: return value of locator
29	Input Valuator: return value of valuator
30	Input Choice: return value of choice device
31	Input String: return character string
32	Set Writing Mode: set current writing mode (replace, overstrike, complement, erase)
33	Set Input Mode: set input mode (request or sample)

Table 1: *Operation codes available under the Graphics System Extension (GSX).*

the VDI standard are not provided by a particular graphics device. In some cases, the device-driver software emulates the required function. For example, four line styles are specified by VDI: solid, dashed, dotted, and dashed-dotted. If a graphics device does not have the ability to produce these directly, their automatic generation is emulated in software. For example, if a dotted line cannot be produced by a device, the required line style is produced by generating a series of short solid lines with intervening spaces.

Gengraf: The final component of GSX is the Gengraf program. Gengraf is a utility program used by the application programmer to configure a graphics program for use with GSX. Gengraf appends a special loader routine onto the graphics program. This loader brings GDOS into memory and loads the default graphics-device driver before execution of the graphics program begins; therefore, GSX (GDOS and GIOS) is brought into memory only when a graphics-application program is executed. Otherwise, the programmer has use of the full user-program space available under CP/M.

The loading and linking of GSX is completely transparent to the user at run time. In CP/M-80, the linkage to GDOS is established by the Gengraf loader at run time by a substitution of the GDOS entry point in place of the

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normal BDOS vector at memory location 5. GDOS intercepts all operating-system function calls. If the call is a standard CP/M request, it passes control to BDOS; if the function call is for a graphics operation, GDOS services the request. Because GDOS is loaded below GIOS, memory is automatically allocated for GIOS and GDOS; the size of the transient program area (TPA), determined by the GDOS entry point, is automatically adjusted. The memory map in figure 4 shows how GDOS and GIOS are loaded into memory at run time below the standard CP/M-80 components, BDOS and BIOS. The GSX extension to CP/M-86 works slightly differently by reserving a special interrupt vector for GSX communications. Also, the memory-management facilities of CP/M-86 take care of loading the GSX modules into the free memory available.

Conclusion

The adoption of the GKS and VDI standards at the programmer and device-interface levels offers potential object-code portability for microcomputer graphics-application programs. Not only will programmers see a consistent interface to graphics functions in their high-level languages, but compilers and graphics run-time libraries can be generic, with device dependencies residing in the operating system. Because of this, each hardware OEM will install the graphics portion of an operating system only once. Compilers and other utilities that conform to the VDI standard will then be able to access the virtual devices of a system without special adaptation. In time, the hardware manufacturer, confident of a stable device interface, will begin to place higher-level functions into the device hardware (or firmware). Eventually, graphics devices may incorporate a full VDI interface, eliminating the need for device drivers entirely.

New products, such as GSX and GSS-Kernel, that are based on the emerging standards, will contribute to the realization of widespread, low-cost computer graphics. In the past, the adoption of formal standards or the emergence of de facto standards has proved to be a powerful market stimulant. Because of its unique emphases on low cost and a competitive software environment, the microcomputer industry is especially sensitive to the benefits of graphics standardization. Graphics users owe a debt of gratitude to the many researchers who distilled an inherently complex technology into a consistent and flexible set of useful constructs. In the end we shall all benefit from the power of computer graphics. ■

Reference

"Graphical Kernel System (GKS)—Functional Description," *Draft International Standard ISO/DIS7942*, version 7.02, August 9, 1982. Copies of this approximately 200-page document can be obtained for $28 from American National Standards Institute Inc., 1430 Broadway, New York, NY 10018, (212) 354-3300.

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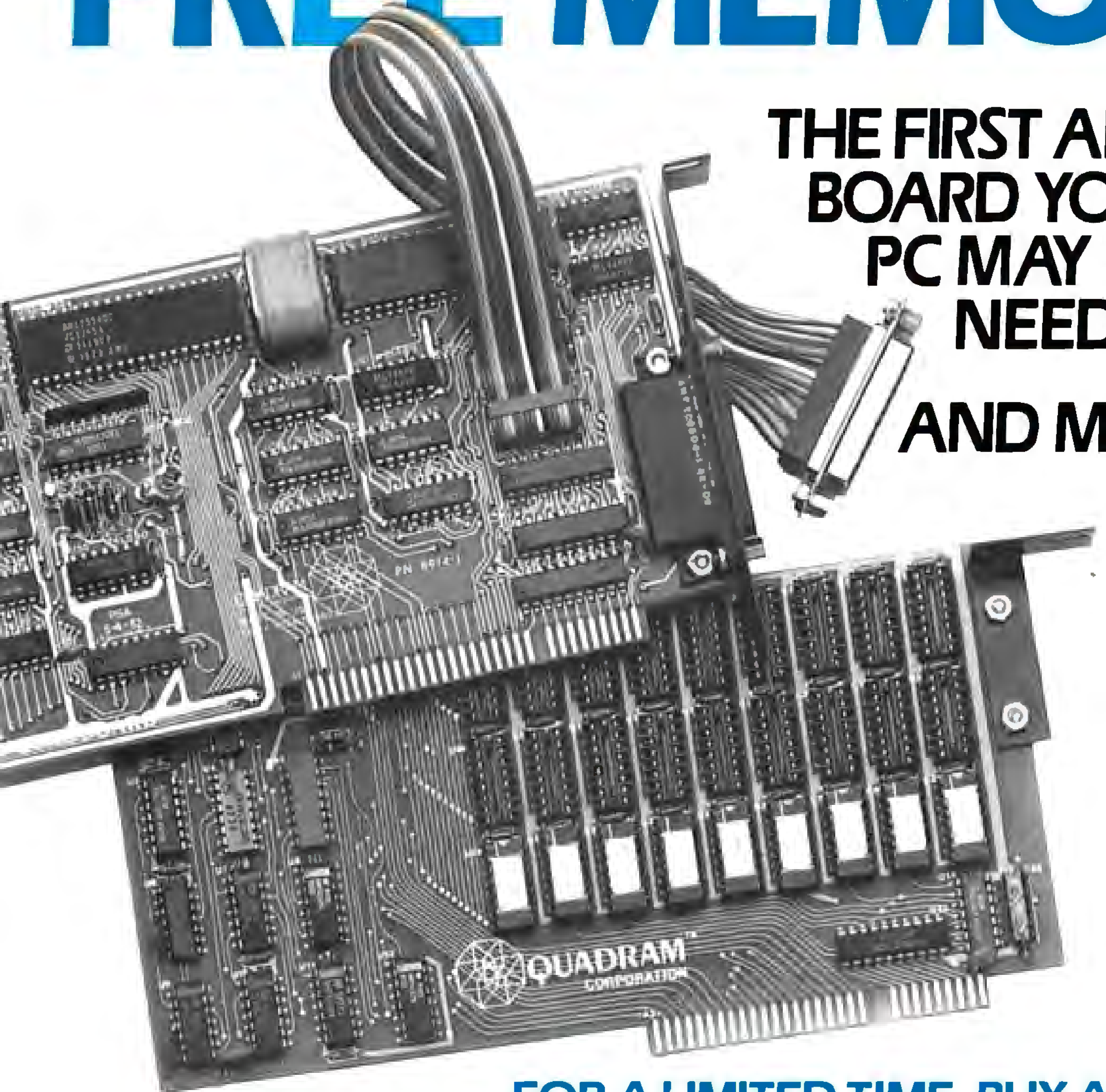

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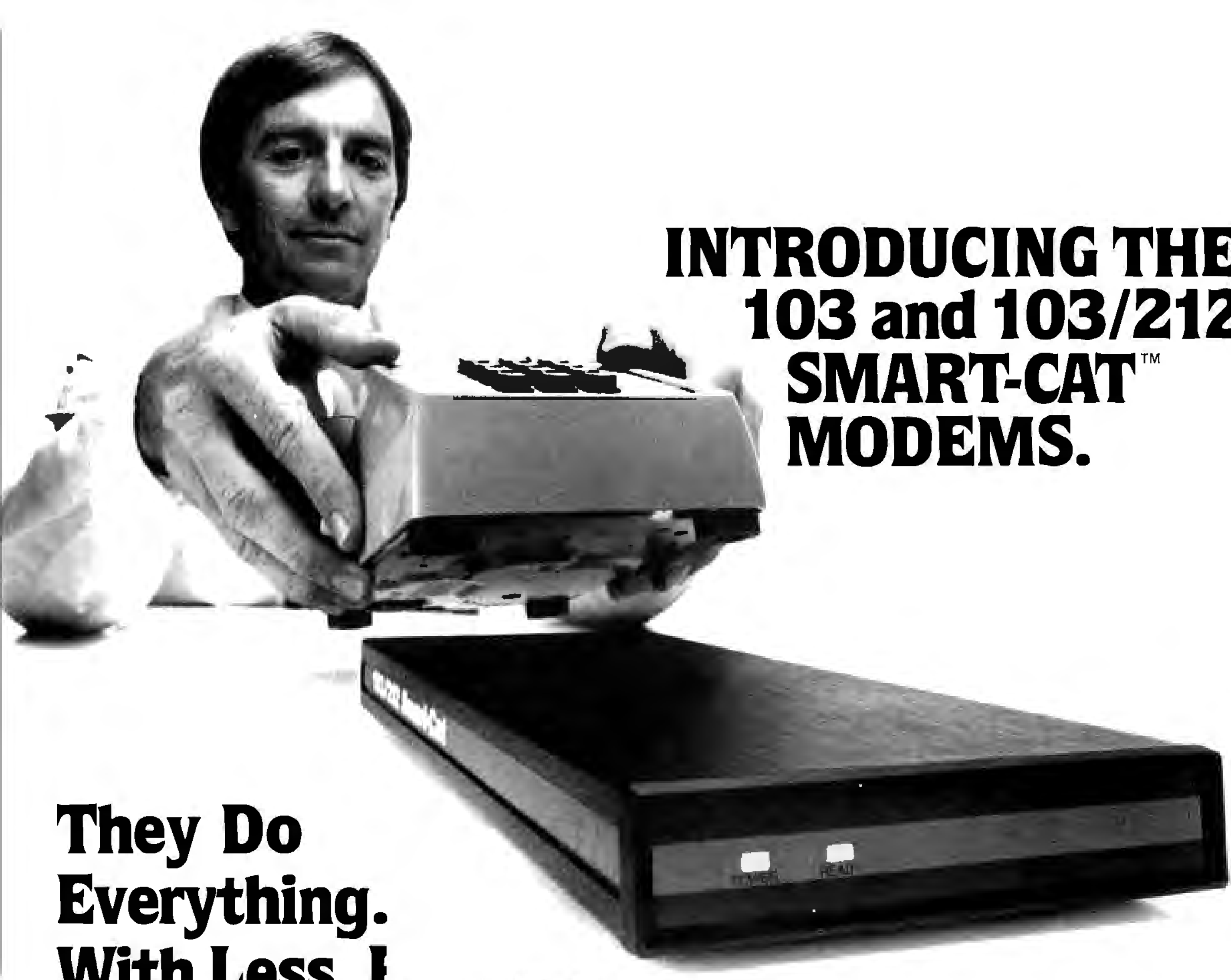

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The microcomputer industry got started in late 1974 when a series of articles appeared in *Radio Electronics* magazine describing construction plans for a computer called the Mark 8. It was based on the first commercially available microprocessor, Intel's 8008. Today, the 8008 is obsolete. Nevertheless, the Mark 8 was the first microcomputer to be put within the reach of anyone but employees of a very large company, and response to the magazine articles was tremendous.

Just before the Mark 8 articles appeared, Intel had announced a greatly enhanced microprocessor, the 8080. Les Solomon, who was an editor at competing *Popular Electronics*, decided that his magazine should also publish a computer-construction article, but that it should use the newer 8080. He suggested to Ed Roberts, then the president of a small company called MITS, that Ed's company come up with a microcomputer kit. (MITS, or Micro Instrumentation and Telemetry Systems, usually specialized in electronics for model rocketry but had just published a successful scientific-calculator construction article.) Ed agreed and the Altair 8800 computer was born. The first Altair article appeared in the January 1975 issue of *Popular Electronics* and was an instant success. MITS figured that it might sell a grand total of 200 units. It received more than 200 orders the first day the article appeared!

Pioneer microcomputer builders MITS and IMSAI both chose to use a 100-pin bus to connect motherboard and daughter boards.

The Altair was a modular computer system, meaning that each of the computer's functional blocks was contained on one circuit board, or module. The circuit boards plugged into slots on a motherboard, which connected the various modules (daughter boards) together, with electrical connections made over a group of common lines called the bus. This type of system is described as *bus-oriented*. MITS called its bus the Altair Bus. The designers chose a connector for the motherboard that had 100 pins—not because of any design considerations but rather because they got a good buy on a surplus quantity of them. The layout of the signals on the bus seems as if it were chosen by the printed-circuit-board layout artist rather than a design engineer. The signals themselves are little more than the buffered control, address, and data lines from the 8080 microprocessor. (We are all lucky that Intel did its homework when designing the 8080's architecture.)

Being one of the first commercially available microcomputers, the Altair had many shortcomings. After all, the electronics community was low on the design curve of microprocessor systems. Learning from MITS's mistakes, designers in a company called IMSAI (IMS Associates Inc.) decided they could build a better version of the Altair and proceeded to do so. Luckily the IMSAI designers decided to "second source" the Altair and used the same bus in their computer, which was called the IMSAI 8080.

Meanwhile, many other small companies appeared, advertising add-on boards designed to work in both Altairs and IMSAIs. The bus was soon being called the Altair/IMSAI

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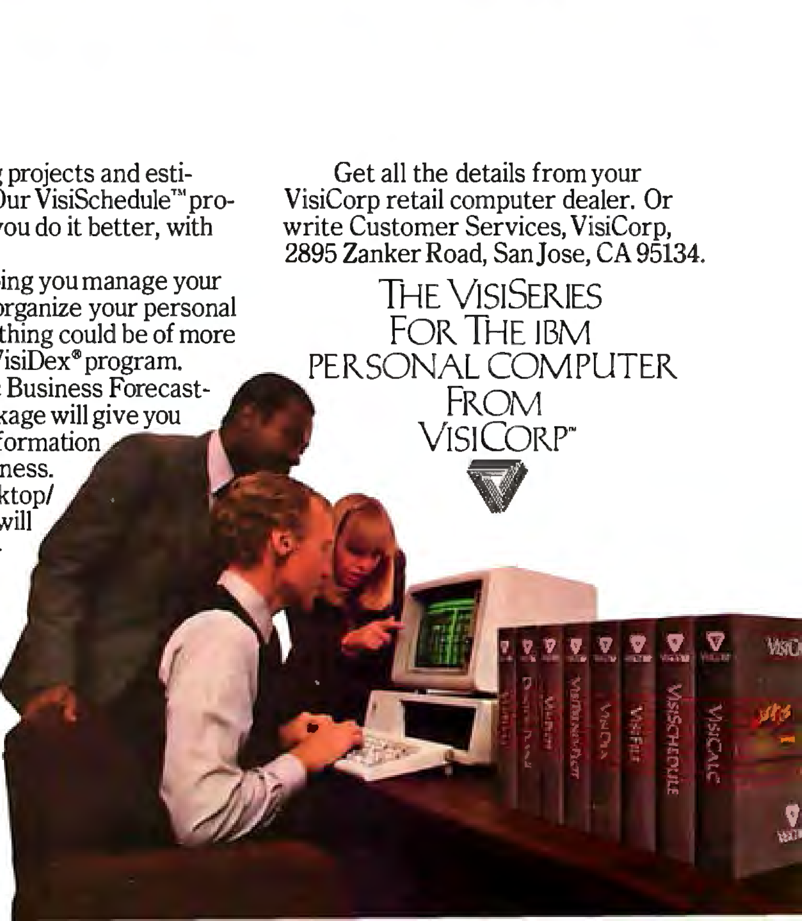

bus. Many other companies also produced bus-compatible computers and products, and each wanted to tack its name on as well. Names such as the Altair/IMSAI/Cromemco/Polymorphic/Processor Technology bus were not uncommon. The situation was clearly getting out of hand.

Roger Mellen, one of the principals of Cromemco, decided that a generic name was needed for the bus. His idea was to call it the Standard 100 bus, or *S-100* for short (100 because it had 100 pins). The name caught on.

All the various manufacturers of S-100-compatible products had adhered to the bus pin arrangement fairly well. Only a few minor variations existed, and most of these were compatible additions using previously unused lines. However, although the various manufacturers used the same names for the signals, the timing of the signals could vary widely from manufacturer to manufacturer. This created many problems for people trying to get Board X to work with Board Y, etc. Something had to be done.

Bob Stewart, then chairman of the IEEE (Institute of Electrical and Electronics Engineers) Computer Standards Committee, suggested to George Morrow and Howard Fullmer (two noted S-100 designers) that they attempt to quantify the bus-timing relationships and other aspects of the bus and submit the bus for approval as an IEEE standard. The IEEE thought it was a good idea, and so did George and Howard, so a task number was assigned to the effort and a working group was formed to draft the standard. The task number was 696, and the standard will be known as IEEE 696.

The working group prepared a preliminary draft and passed it around for comments to everyone working with the S-100 bus. John Walker of Marinchip Systems proposed a method for allowing 16-bit processors and memory to use the bus as well as 8-bit processors. David Gustavson proposed a scheme that would allow up to 16 DMA (direct memory access) devices to exist on the bus at any one time. A few new signals were proposed by Kels Elmquist of Ithaca In-

A Quick Reference to the IEEE-696 Bus Layout

Here is a guide to the IEEE-696 bus layout for easy reference. The letters RFU stand for "reserved for future use"; the IEEE committee may assign signals to these pins at some future date. The letters NDEF mean "not defined"; these pins are available to be assigned signals by manufacturers, a procedure that requires notifying the committee and providing full documentation for the users. The asterisk (*) indicates a negative-true signal; note that some signals are not necessarily true or false, although the lack of an asterisk in their name might imply positive-true sense.

Pin	Signal Name	Origin: master	Origin: slave	Origin: master or slave	Origin: anywhere
1	+ 8 V				X
2	+ 16 V				X
3	XRDY		X		
4	VI0*		X		
5	VI1*		X		
6	VI2*		X		
7	VI3*		X		
8	VI4*		X		
9	VI5*		X		
10	VI6*		X		
11	VI7*		X		
12	NMI*		X		
13	PWRFAIL*				X
14	TMA3*	X			
15	A18	X			
16	A16	X			
17	A17	X			
18	SDSB*	X			
19	CDSB*	X			
20	0 V				X
21	NDEF				
22	ADSB*	X			
23	DODSB*	X			
24	ϕ	X			
25	pSTVAL*	X			
26	pHLDA	X			
27	RFU				
28	RFU				
29	A5	X			
30	A4	X			
31	A3	X			
32	A15	X			
33	A12	X			
34	A9	X			
35	DO1 (or ED1)	X		(X)	
36	DO0 (or ED0)	X		(X)	
37	A10	X			
38	DO4 (or ED4)	X		(X)	
39	DO5 (or ED5)	X		(X)	
40	DO6 (or ED6)	X		(X)	
41	DI2 (or OD2)		X	(X)	
42	DI3 (or OD3)		X	(X)	
43	DI7 (or OD7)		X	(X)	
44	sM1	X			
45	sOUT	X			
46	sINP	X			
47	sMEMR	X			
48	sHLTA	X			
49	CLOCK				X
50	0 V				X

Pin	Signal Name	Origin: master	Origin: slave	Origin: master or slave	Origin: anywhere
51	+ 8 V				X
52	− 16 V				X
53	0 V				X
54	SLAVE CLR*				X
55	TMA0*	X			
56	TMA1*	X			
57	TMA2*	X			
58	sXTRQ*	X			
59	A19	X			
60	SIXTN*		X		
61	A20	X			
62	A21	X			
63	A22	X			
64	A23	X			
65	NDEF				
66	NDEF				
67	PHANTOM*			X	
68	MWRT				X
69	RFU				
70	0 V				
71	RFU				
72	RDY		X		
73	INT*		X		
74	HOLD*	X			
75	RESET*				X
76	pSYNC	X			
77	pWR*	X			
78	pDBIN*	X			
79	A0	X			
80	A1	X			
81	A2	X			
82	A6	X			
83	A7	X			
84	A8	X			
85	A13	X			
86	A14	X			
87	A11	X			
88	DO2 (or ED2)	X		(X)	
89	DO3 (or ED3)	X		(X)	
90	DO7 (or ED7)	X		(X)	
91	DI4 (or OD4)		X	(X)	
92	DI5 (or OD5)		X	(X)	
93	DI6 (or OD6)		X	(X)	
94	DI1 (or OD1)		X	(X)	
95	DI0 (or OD0)		X	(X)	
96	sINTA	X			
97	sWO*	X			
98	ERROR*		X		
99	POC*			X	
100	0 V			X	

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tersystems (then known as Ithaca Audio). The second draft of the document that came out of the working group contained important additions and enhancements to the original Altair bus but still retained a significant level of compatibility with older designs. (The original Altair processor board still conforms to today's standard.)

This second draft was published in the July 1979 issue of the IEEE's *Computer* magazine for public comment. There were lots of comments, mostly favorable. The 1979 draft needed lots of work. Definitions were unclear in places, and many additional parameters needed to be specified. The committee grew; George resigned as chairman, and Howard took over. Meetings were sporadic, but heated debates occurred on some issues, preventing other work from being accomplished. Howard called for a final meeting to occur on June 30, 1981, at 10:30 a.m. All final comments on the draft were to be submitted in writing prior to that date.

More than 20 people were present at that meeting from all parts of the country. The meeting began at 10:30 a.m. and ended around 11:30 that evening. All the issues had been resolved to everyone's satisfaction. I volunteered the services of CompuPro (the company I work for, in Oakland, California) to produce a third draft of the standard, incorporating all the changes approved at the meeting.

Now the activities of the committee entered a period of dormancy. Howard took a long time in organizing his notes of the various changes; he was losing interest in chairing the committee (having moved out of the S-100 business some time before) and so turned the chairmanship over to me. With the help of Bob Davis, I prepared the third draft of the standard and sent it out to the members of the working group for comment. Changes were still necessary. After spending many hours on the phone to various committee members, draft 5 was completed and sent out for a vote for final approval by the working group. It passed with only one dissenting vote.

The next step was to submit it to the Microprocessor Standards Committee of the IEEE for approval. It passed unanimously. Next the draft was submitted to the Computer Standards Committee and was accepted. The last hurdle was the IEEE Standards Board, which passed the draft on December 9, 1982. With that vote, IEEE 696 became a bona fide IEEE standard.

Technical Features of the Bus

The IEEE-696/S-100 bus is one of the highest-performance buses in existence today. It supports both 8- and 16-bit processors, up to 16 megabytes of memory, and 64K I/O (input/output) ports. Almost every type of processor imaginable, from the 8080 to the latest Intel iAPX 286, is available for the bus. There are more than 100 active manufacturers of products for the bus and many more than 500 different circuit cards available.

IEEE-696/S-100 systems consist of anywhere from 4 to 22 slots. Each system must contain a *permanent bus master*, which is usually the processor board. The system will have some memory and I/O boards called *slaves*. In addition to the permanent master, the system may contain up to 16 *temporary masters*, DMA-like devices, such as disk controllers or secondary processors. As many as 16 temporary masters may exist because each is assigned a priority number. If more than one temporary master requests the bus at the same time, the one with the highest priority number will take precedence, and the lower priority master will have to wait its turn. (This process is called *arbitration*.)

Because a temporary master can perform any type of cycle when it gets control of the bus (not just a memory cycle), the committee deemed the term DMA inappropriate and substituted the term TMA (for temporary master access). Four new lines were added to the bus to implement this arbitration scheme, TMA0* through TMA3* (the style of the standard defines any signal with an asterisk suffix as negative-true, a style I will use in this article). Each temporary master asserts its priority on

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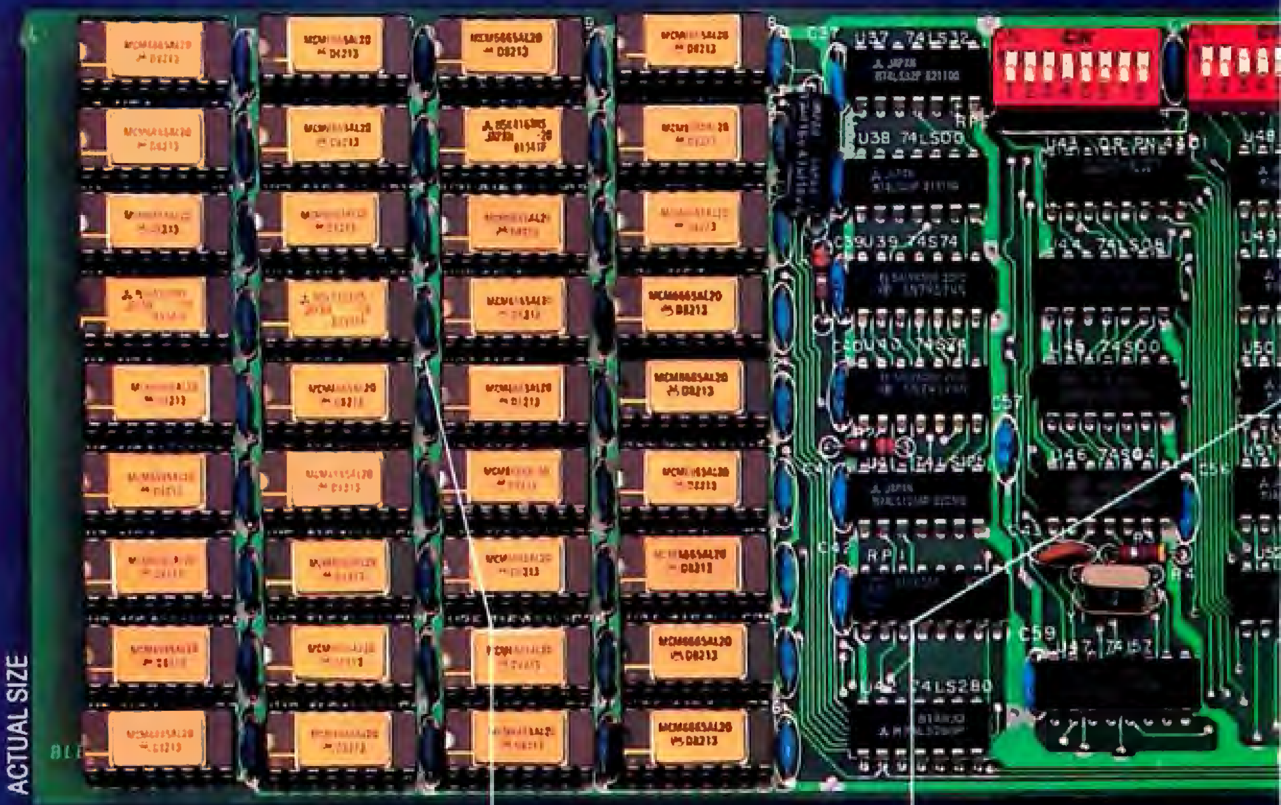

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these lines, while simultaneously evaluating whether another master asserting a higher priority is on the line. If a temporary master sees that its priority is not the highest, it defers to the higher priority.

Formerly, memory slaves responded to only 16 address bits (giving the system a total memory capacity of 64K bytes). The new standard defines an additional 8 address lines, called the *extended address bus*. Now the memory capacity of the system is 16 megabytes.

In the past, I/O slaves responded to only 8 address bits, giving a total of 256 I/O port locations. Now 16 address lines may be used, upping the number to 64K I/O ports.

8- and 16-Bit Operation

One of the more significant changes to the original bus was the addition of a mechanism for performing 16-bit data transfers between masters and slaves. To explain this, first we need to explore how the bus does 8-bit transfers.

The IEEE 696 has two 8-bit data buses. For 8-bit transfers, the DO (data-out) bus carries data from the master to a slave, and the DI (data-in) bus carries data from a slave to a master. Because data always flows in one direction, these buses are called *unidirectional*. For 16-bit transfers, these two buses become *bidirectional*, meaning that data can flow in or out, depending on the type of cycle in progress, and are combined so that two 8-bit buses are now capable of transmitting or receiving 16 bits of data.

To accomplish this bidirectional flow, two new lines were added to the bus. They are sXTRQ* (sixteen request) and SIXTN* (sixteen acknowledge). Here's how the mechanism works: If a master is capable of conducting a 16-bit transfer and desires to do so (16-bit processors don't always want to transfer 16 bits at a time), it will send the signal sXTRQ*, telling the addressed slave that a 16-bit transfer is requested. If the slave is capable of 16-bit operation, it will respond by asserting the SIXTN* line. The master will look at the SIXTN* signal and, if the signal is true, will conduct a 16-bit-wide transfer. If the master sends the signal sXTRQ* and the slave is not capable of 16-bit transfers, SIXTN* will not be asserted. The master can then do one of two things. The desired response would be to perform the 16-bit transfer as two sequential 8-bit transfers, called *byte-serial* transfers. The other option is to assert the ERROR* line and transfer control to some error-recovery routine.

This protocol is completely compatible with older 8-bit slaves. Eight-bit slaves will not have any circuitry for driving the SIXTN* line, and because SIXTN* is active low, a 16-bit master will properly assume that 16-bit transfers are not possible. This also allows for both 8- and 16-bit slaves to be mixed in a system, assuming the master has "byte-serializer" circuitry.

This basic 16-bit transfer protocol was agreed to by everyone in the working group very early on, but

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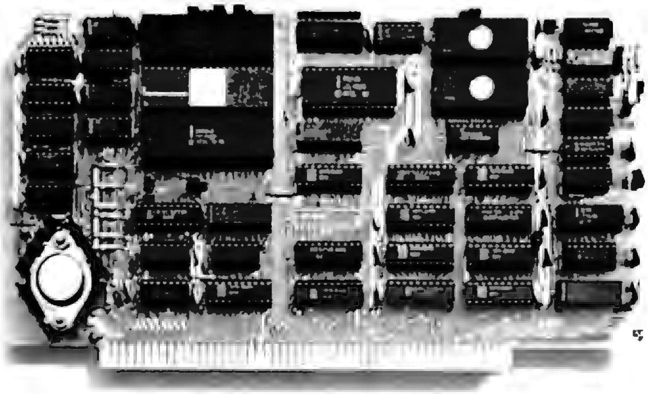

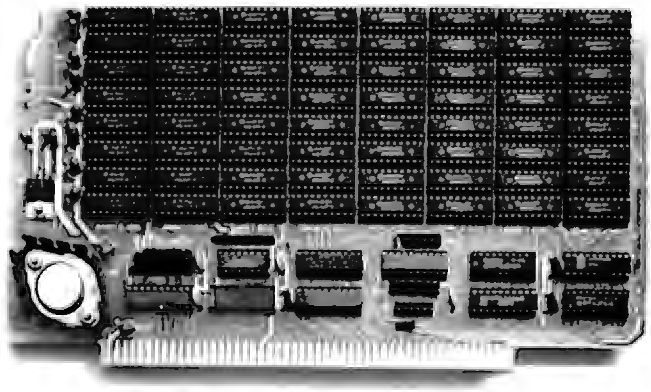

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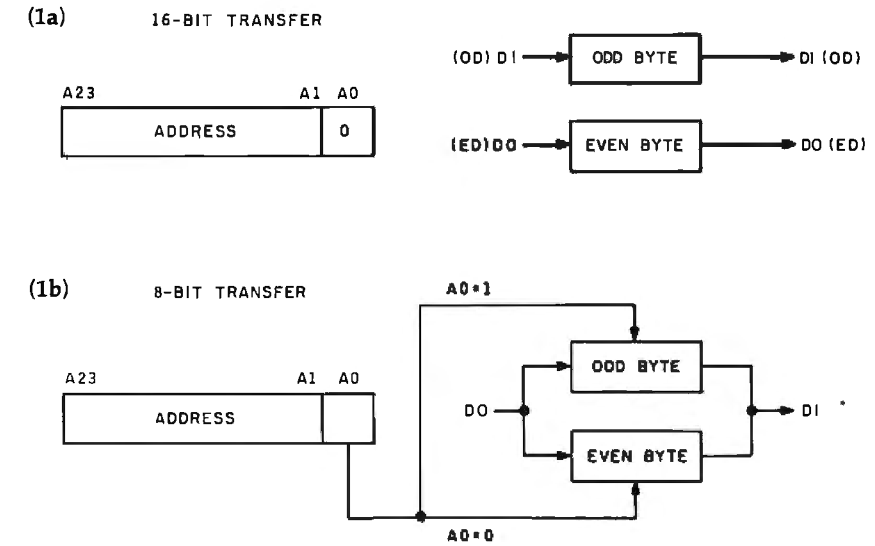

Figure 1: *Data transfers as performed according to the IEEE-696 standard. In figure 1a, a 16-bit transfer is shown using all of the available data lines. Data whose least-significant address bit is 0 is considered even, while data whose least-significant address bit is 1 is considered odd. Figure 1b shows how the odd and even bytes are employed during an 8-bit-wide transfer of 16-bit data (called a byte-serial transfer).*

heated debate took place about what byte should be where (i.e., should the low-order byte be transferred on the DI or the DO bus?).

The problem arises because different microprocessors do things completely differently. For example, the 8080-type 8-bit processors always store 16-bit values with the low-order byte first. So does Intel's 8086/88 family of processors. But along came Motorola's 68000, which stores the high-order byte first. The working group was faced with the problem of deciding which to favor. Naturally, there were proponents of both in the working group.

The group's final solution was both clever and unique in that it made everybody happy. The first published draft had renamed the lines of the DI and DO buses DATA0 through DATA15 during 16-bit transfers. DATA0 through DATA7 were called the low byte (and were transferred on the DO bus), and DATA8 through DATA15 were called the high byte (and were transferred on the DI bus). These signal names and byte designations carried an implied significance: DATA0 through DATA7 were lower than DATA8 through DATA15, and "low" is clearly lower than "high." The committee decided to rename the signals to be free of this implication and be concerned only with making sure that bytes and words always got read or written in a consistent manner.

The low byte became the *even byte*, and the high byte became the *odd byte*. The even-byte lines are now called ED7 through ED0 (ED for even data), and the odd-byte lines are now called OD7 through OD0 (OD for odd data). Even data is transferred on the DO bus, and odd data is transferred on the DI bus.

Where did even and odd come from? Well, it has to do with how the bytes would be read or written *as a byte* (i.e., in 8-bit mode). During 16-bit transfers, address line A0 is always low. During 8-bit transfers, if A0 is low, that byte is an even byte (because any address where A0 is low would be even). Conversely, if A0 is high, that byte is an odd byte. It is up to the processor-card designer to ensure that data read or written 16 bits at a time has the "even" data on the ED lines (DO bus) and "odd" data on the OD lines (DI bus).

Figure 1 is a block diagram of where the bytes go for 8- and 16-bit cycles. Figure 2 shows a block diagram of how a typical slave would be set up to handle 8- and 16-bit transfers. In figure 2, the signal SEL selects either the A input (for 16-bit transfers) or the B input (for 8-bit transfers). The control signals employed must obey the following logic equations:

$$A = 16_{RD} + (8_{RD} \cdot A0)$$
$$B = 8_{RD} \cdot \overline{A0}$$
$$C = 16_{RD}$$
$$E_{WR} = 16_{WR} + (8_{WR} \cdot \overline{A0})$$
$$O_{WR} = 16_{WR} + (8_{WR} \cdot A0)$$

where:

$$16_{RD} = \text{device select} \cdot \text{sXTRQ*} \cdot \text{pDBIN}$$
$$8_{RD} = \text{device select} \cdot \overline{\text{sXTRQ*}} \cdot \text{pDBIN}$$
$$16_{WR} = \text{device select} \cdot \text{sXTRQ*} \cdot \text{pWR*}$$
$$8_{WR} = \text{device select} \cdot \overline{\text{sXTRQ*}} \cdot \text{pWR*}$$

Designers should take note that the state of A0 as shown in these new diagrams is the opposite of what is shown in the 1979 draft. It has been changed since the 1979 draft and is correctly shown in figures 1 and 2.

It is important to realize that this new terminology does not change how 16-bit transfers occur on the bus but just changes the way we think about them.

Other Technical Changes

The committee debated whether or not the PHANTOM* line (pin 67, see table 1, pages 288 and 292) should disable memory slaves for both read and write operations, or just read operations. We decided to require memory slaves to be disabled for both read and write cycles during PHANTOM*. The timing of PHANTOM* was also specified as not occurring later than 30 ns (nanoseconds) before a read or write strobe and not going away until at least 30 ns after the read or write strobe goes away. The committee specified this timing to ensure that false reads or writes do not occur on memory slaves. In addition, the committee required that all normal memory slaves (as opposed to PHANTOM* slaves) have the capa-

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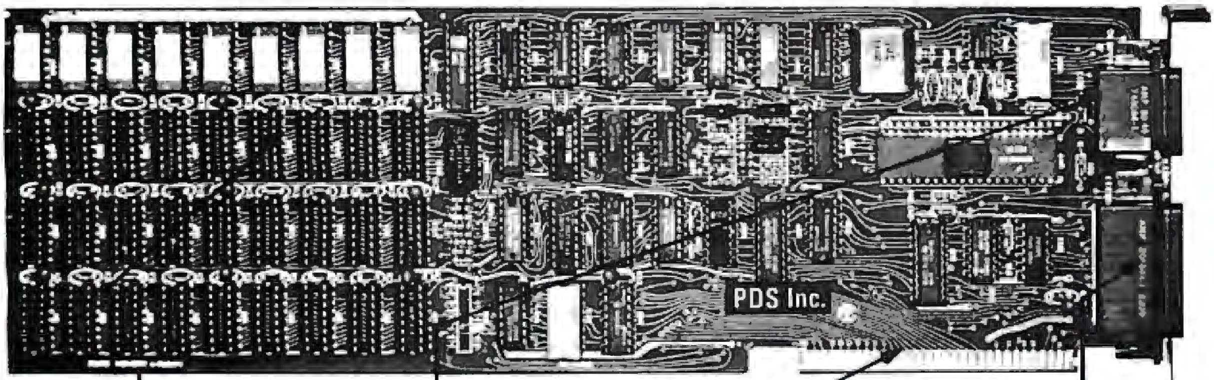

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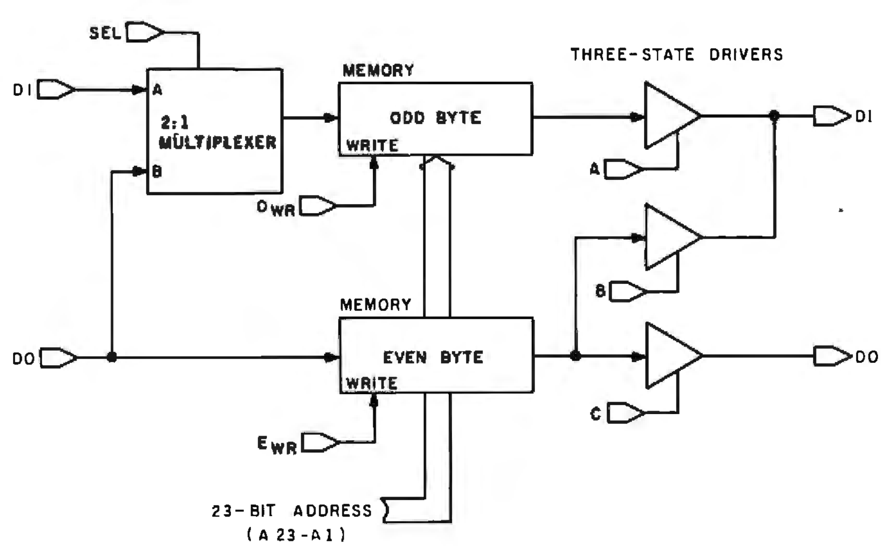


Figure 2: *Block diagram of the circuitry needed by S-100 bus slaves for byte and word transfers under the IEEE-696 standard.*

bility of being disabled in response to a PHANTOM* signal.

A new signal was defined in the 1979 draft called PWRFAIL*, which should go low 16 ms (milliseconds) before the power goes away. (Note that this time is shorter than the time originally published.) A problem was discovered in actual implementations of this signal: when power momentarily dips just low enough to cause the PWRFAIL* signal to be activated but doesn't actually go away, PWRFAIL* returns high again. But the system is now waiting for a POC* (power-on-clear) signal that won't ever happen because power never went low enough.

The solution to this was to specify that the rising edge of PWRFAIL* (which will occur at the end of the power dip) shall cause POC* to be asserted. We chose the rising edge rather than just the low level of PWRFAIL* because otherwise no time would be available to execute a power-fail routine.

The TMA cycles now have more specific timing associated with them. In general, the tHDHA terms were added to ensure adequate time for TMA arbitration to take place and to ensure that the transfer occurs in a "glitch-free" manner. Figure 3 and table 2 show the new timing relationships. Figure 4 and table 3 show basic bus timing as it appears in the new standard.

We made one major mechanical change to the standard in order to make room for an optional 10-inch-high board. This "double-height" board allows much more circuitry per board, which will reduce costs and increase system performance. Of course, these boards will not fit into most existing system cabinets, but it is just a matter of time before double-height boxes appear. In the meantime, all manufacturers of double-height boards must clearly state that a board is double-height in all product literature and advertisements.

That's about it for technical changes to the standard draft. The other minor changes are not really significant. As was mentioned earlier in this article, they are mostly to clear up ambiguities for the sake of designers.

Why Use the IEEE-696/S-100 Bus?

The IEEE-696/S-100 bus offers many advantages over single-board computers, the biggest of which is that the IEEE-696/S-100 systems are

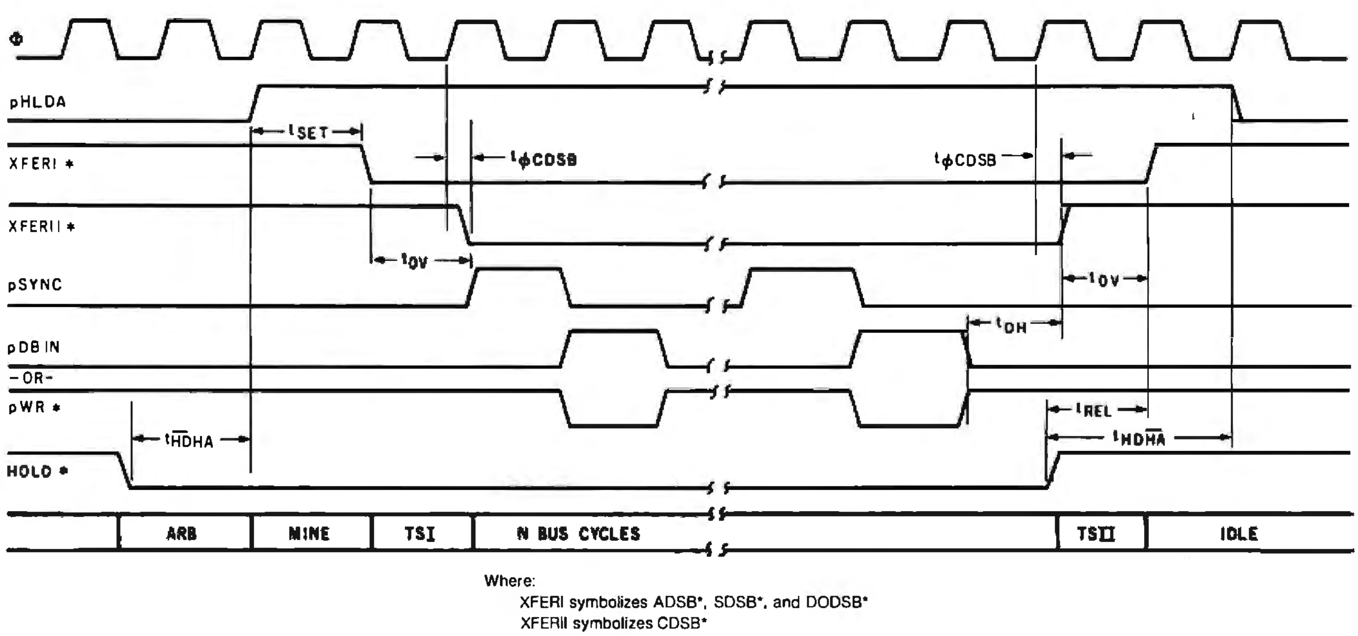
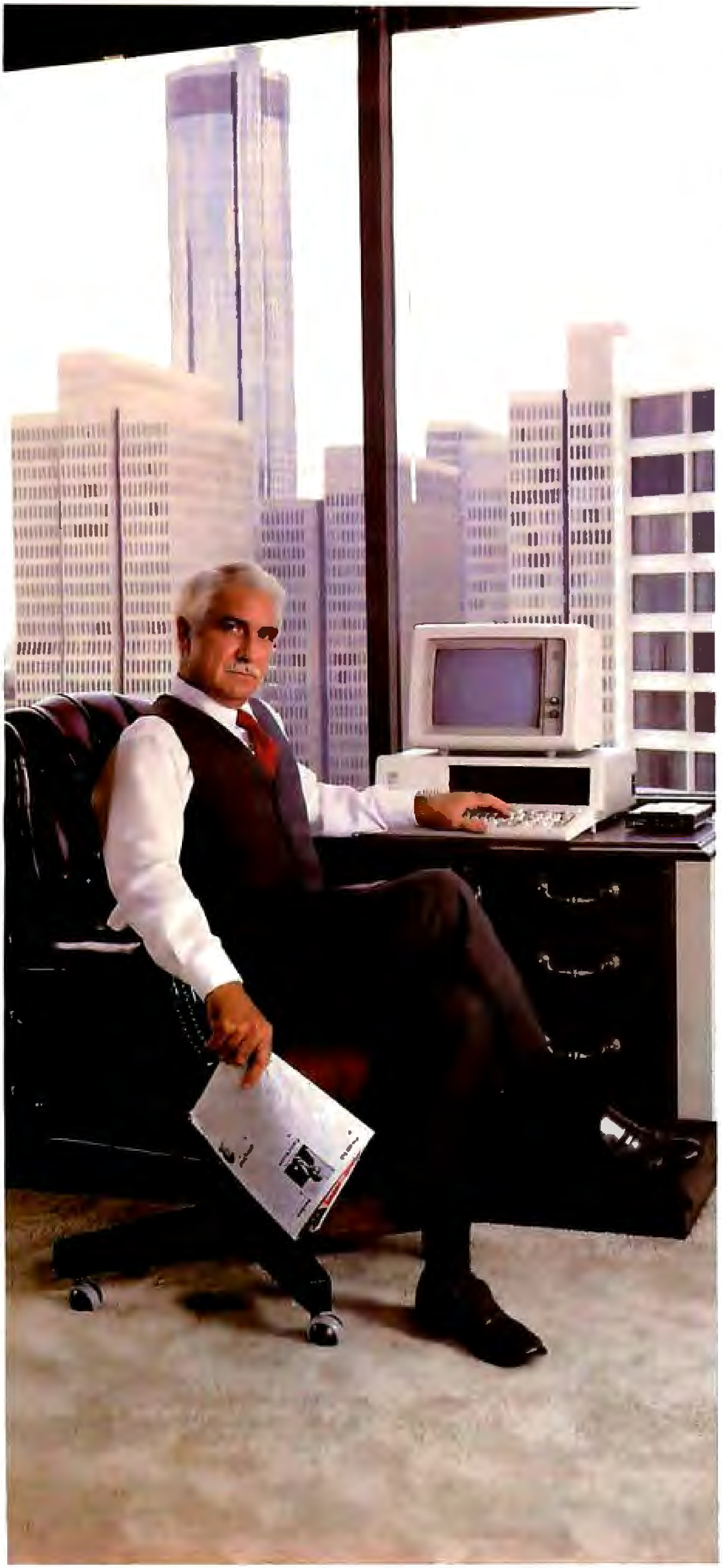


Figure 3: *Diagram of the timing relationships for temporary-master access to the bus.*



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Circle 276 on Inquiry card.

Pin Number	Signal (and Origin)	Active Level	Description
1	+8 V (B)		Instantaneous minimum greater than 7 V, instantaneous maximum less than 25 V, average maximum less than 11 V.
2	+16 V (B)		Instantaneous minimum greater than 14.5 V, instantaneous maximum less than 35 V, average maximum less than 21.5 V.
3	XRDY (S)	H	One of two ready inputs to the current bus master. The bus is ready when both these ready inputs are true. See pin 72.
4	VI0*(S)	L OC	Vectored-interrupt line 0.
5	VI1*(S)	L OC	Vectored-interrupt line 1.
6	VI2*(S)	L OC	Vectored-interrupt line 2.
7	VI3*(S)	L OC	Vectored-interrupt line 3.
8	VI4*(S)	L OC	Vectored-interrupt line 4.
9	VI5*(S)	L OC	Vectored-interrupt line 5.
10	VI6*(S)	L OC	Vectored-interrupt line 6.
11	VI7*(S)	L OC	Vectored-interrupt line 7.
12	NMI*(S)	L OC	Nonmaskable interrupt.
13	PWRFAIL*(B)	L	Power-fail bus signal.
14	TMA3* (M)	L OC	Temporary-master priority bit 3.
15	A18 (M)	H	Extended-address bit 18.
16	A16 (M)	H	Extended-address bit 16.
17	A17 (M)	H	Extended-address bit 17.
18	SDSB* (M)	L OC	The signal to disable the 8 status signals.
19	CDSB* (M)	L OC	The signal to disable the 5 control output signals.
20	0 V (B)		Common with pin 100.
21	NDEF		Not to be defined. Manufacturer must specify any use in detail.
22	ADSB* (M)	L OC	The signal to disable the address signals.
23	DODSB* (M)	L OC	The control signal to disable the data-output signals. (DO7–0 for 8-bit transfers, ED7–0 and OD7–0 for 16-bit transfers).
24	ϕ (B)	A	The master timing signal for the bus.
25	pSTVAL*(M)	L	Status-valid strobe.
26	pHLDA (M)	H	A control signal used in conjunction with HOLD* to coordinate bus-master transfers.
27	RFU		Reserved for future use.
28	RFU		Reserved for future use.
29	A5 (M)	H	Address bit 5.
30	A4 (M)	H	Address bit 4.
31	A3 (M)	H	Address bit 3.
32	A15 (M)	H	Address bit 15 (most significant for nonextended addressing).
33	A12 (M)	H	Address bit 12.
34	A9 (M)	H	Address bit 9.
35	DO1 (M)/ED1 (M/S)	H	Data-out bit 1, bidirectional even-data bit 1.
36	DO0 (M)/ED0 (M/S)	H	Data-out bit 0, bidirectional even-data bit 0.
37	A10 (M)	H	Address bit 10.
38	DO4 (M)/ED4 (M/S)	H	Data-out bit 4, bidirectional even-data bit 4.
39	DO5 (M)/ED5 (M/S)	H	Data-out bit 5, bidirectional even-data bit 5.
40	DO6 (M)/ED6 (M/S)	H	Data-out bit 6, bidirectional even-data bit 6.
41	DI2 (S)/OD2 (M/S)	H	Data-in bit 2, bidirectional odd-data bit 2.
42	DI3 (S)/OD3 (M/S)	H	Data-in bit 3, bidirectional odd-data bit 3.
43	DI7 (S)/OD7 (M/S)	H	Data-in bit 7, bidirectional odd-data bit 7.
44	sM1 (M)	H	The status signal that indicates that the current cycle is an op-code fetch.
45	sOUT (M)	H	The status signal identifying the data-transfer bus cycle to an output device.
46	sINP (M)	H	The status signal identifying the data-transfer bus cycle from an input device.
47	sMEMR (M)	H	The status signal identifying bus cycles that transfer data from memory to a bus master and that are not interrupt-acknowledge/instruction-fetch cycle(s).
48	sHLTA (M)	H	The status signal that acknowledges that an HLT instruction has been executed.
49	CLOCK (B)	A	2-MHz ($\pm$0.5%) 40–60% duty cycle. Not required to be synchronous with any other bus signal.
50	0 V (B)		Common with pin 100.

Table 1: *Signals and their definitions according to the IEEE-696 standard. The letter in parentheses tells the signal's origin: master, slave, or bus. OC specifies open-collector drivers and A means alternating.* *(Table 1 continues on page 292.)*

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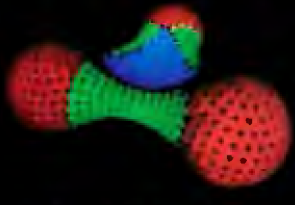

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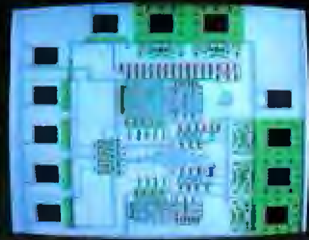

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Table 1 continued:

Pin Number	Signal (and Origin)	Active Level		Description
51	+8 V (B)			Common with pin 1.
52	−16 V (B)			Instantaneous maximum less than −14.5 V, instantaneous minimum greater than −35 V, average minimum greater than −21.5 V.
53	0 V (B)			Common with pin 100.
54	SLAVE CLR* (B)	L	OC	A reset signal to reset bus slaves. Must be active with POC* and may also be generated by external means.
55	TMA0* (M)	L	OC	Temporary-master priority bit 0.
56	TMA1* (M)	L	OC	Temporary-master priority bit 1.
57	TMA2* (M)	L	OC	Temporary-master priority bit 2.
58	sXTRQ* (M)	L		The status signal that requests 16-bit slaves to assert SIXTN*.
59	A19 (M)	H		Extended-address bit 19.
60	SIXTN* (S)	L	OC	The signal generated by 16-bit slaves in response to the 16-bit request signal sXTRQ*
61	A20 (M)	H		Extended-address bit 20.
62	A21 (M)	H		Extended-address bit 21.
63	A22 (M)	H		Extended-address bit 22.
64	A23 (M)	H		Extended-address bit 23.
65	NDEF			Signal not to be defined.
66	NDEF			Signal not to be defined.
67	PHANTOM*(M/S)	L	OC	A bus signal that disables normal slave devices and enables phantom slaves—primarily used for bootstrapping systems without hardware front panels.
68	MWRT (B)	H		pWR • −sOUT (logic equation). This signal must follow pWR* by not more than 30 ns.
69	RFU			Reserved for future use.
70	0 V (B)			Common with pin 100.
71	RFU			Reserved for future use.
72	RDY (S)	H	OC	See comments for pin 3.
73	INT* (S)	L	OC	The primary interrupt-request bus signal.
74	HOLD* (M)	L	OC	The control signal used in conjunction with pHLDA to coordinate bus-master transfers.
75	RESET* (B)	L	OC	The reset signal to reset bus-master devices. This signal must be active with POC* and may also be generated by external means.
76	pSYNC (M)	H		The control signal identifying BS_1.
77	pWR* (M)	L		The control signal signifying the presence of valid data on DO bus or data bus.
78	pDBIN (M)	H		The control signal that requests data on the DI bus or data bus from the currently addressed slave.
79	A0 (M)	H		Address bit 0 (least significant).
80	A1 (M)	H		Address bit 1.
81	A2 (M)	H		Address bit 2.
82	A6 (M)	H		Address bit 6.
83	A7 (M)	H		Address bit 7.
84	A8 (M)	H		Address bit 8.
85	A13 (M)	H		Address bit 13.
86	A14 (M)	H		Address bit 14.
87	A11 (M)	H		Address bit 11.
88	DO2 (M)/ED2 (M/S)	H		Data-out bit 2, bidirectional even-data bit 2.
89	DO3 (M)/ED3 (M/S)	H		Data-out bit 3, bidirectional even-data bit 3.
90	DO7 (M)/ED7 (M/S)	H		Data-out bit 7, bidirectional even-data bit 7.
91	DI4 (S)/OD4 (M/S)	H		Data-in bit 4, bidirectional odd-data bit 4.
92	DI5 (S)/OD5 (M/S)	H		Data-in bit 5, bidirectional odd-data bit 5.
93	DI6 (S)/OD6 (M/S)	H		Data-in bit 6, bidirectional odd-data bit 6.
94	DI1 (S)/OD1 (M/S)	H		Data-in bit 1, bidirectional odd-data bit 1.
95	DI0 (S)/OD0 (M/S)	H		Data-in bit 0 (least significant for 8-bit data), bidirectional odd-data bit 0.
96	sINTA (M)	H		The status signal identifying the bus input cycle(s) that may follow an accepted interrupt request presented on INT*.
97	sWO* (M)	L		The status signal identifying a bus cycle that transfers data from bus master to slave.
98	ERROR* (S)	L	OC	The bus status signal signifying an error condition during present bus cycle.
99	POC* (B)	L		The power-on clear signal for all bus devices; when this signal goes low, it must stay low for at least 10 ms.
100	0 V (B)			System ground.

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Parameter	Description	Minimum	Maximum
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t_{OV}	Time for both temporary and permanent master to drive the control output lines	$0.4t_{CY}$	
t_{DH}	Hold time for address, status, and data out from end of strobe to CDSB* rising	$0.2t_{CY}$	
t_{REL}	Delay from HOLD* rising to ADSB*, SDSB* and DODSB* high		$1.0t_{CY}$
$t_{HD\overline{HA}}$	Delay from HOLD* false to pHLDA false	$1.0t_{CY}$	
$t_{\phi CDSB}$	Delay from ϕ rising to CDSB* low Delay from ϕ rising to CDSB* high	0	$0.3t_{CY}$
$t_{\overline{HD}HA}$	Delay from HOLD* falling to pHLDA rising	$1.0t_{CY}$	

Table 2: *Bus-transfer timing parameters (see also figure 3).*

completely modular in nature. Users can purchase just the system they need because any system can be tailored to individual requirements. You are not stuck buying what a manufacturer feels is the optimum computing system.

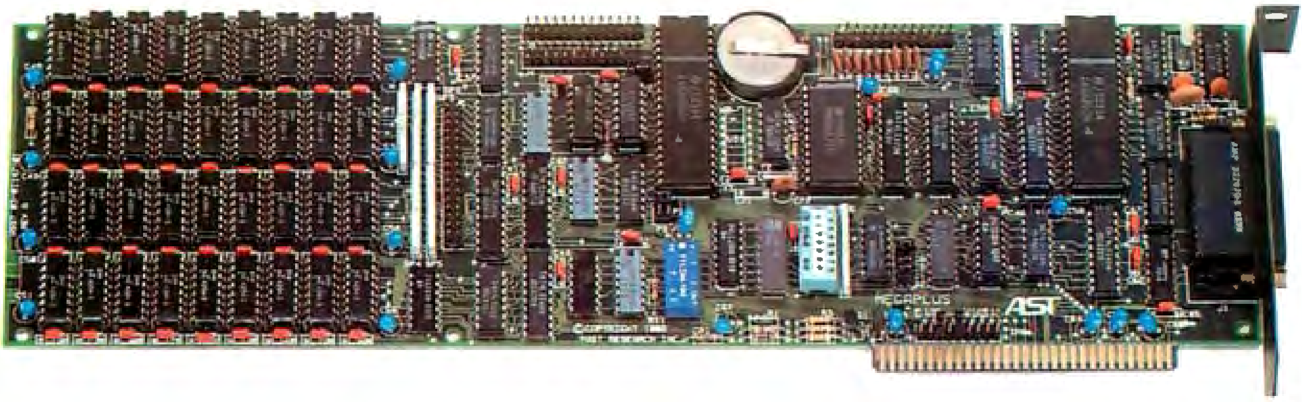
By the same token, a modular system can be upgraded at any time to take advantage of newer technology, expand the system's capabilities as your computing needs grow, or even turn a single-user computer into one capable of handling multiple users. You have a choice of a wide variety of processor types, including many 16-bit offerings. Some systems even allow a mixture of processor types, including both 8- and 16-bit processors.

Another big advantage of IEEE-696/S-100 systems is the large number of manufacturers with products for that bus. A wide range of products exists for almost any application.

Hardware and software developers prefer the IEEE-696/S-100 bus because the latest technology seems to appear on that bus first. Every major new processor has been available on an S-100 board long before it has been ready for other systems. Computer systems based on the S-100 bus tend to run a lot faster than other systems. Although the standard specifies that the maximum clock rate is 6 MHz, the S-100 bus is capable of running much faster, with some manufacturers routinely shipping 10-MHz products.

Some people perceive cost as a disadvantage to IEEE-696/S-100 systems. It is true that an S-100-based system may cost more to start with than a single-board-type system, but S-100 systems quickly become much more cost-effective when it comes time to upgrade the system. A single-board system may have to be discarded altogether; but, change a card or two in an S-100 system, and you

Circle 387 on inquiry card.



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THE BASICS

The main board has three functions standard: Parity checked and fully socketed memory up to 256k in 64k increments, clock/calendar with battery back-up, asynchronous communication port (RS232C serial) which can be used as COM1 or COM2, (DCE for a printer, or DTE for a modem). Optional is a 100% IBM compatible parallel printer port, and a second async port for another $50 each. Also included are: SuperDriveTM disk emulation and SuperSpoolerTM printer buffer software.

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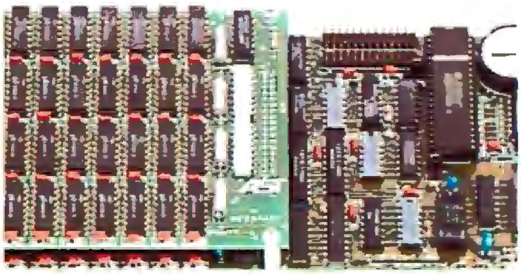
MEGAPAK OF MEMORY

The picture in the inset shows the optional 256k MegaPakTM board mounted "piggy-back" on the main board. This expandability feature gives those who need it 512k of add-on memory in a single slot. Now you can create disk drives in memory up to 320k, set aside plenty of space for print spooling, and still have plenty of memory for your biggest programs. An exclusive design allows the memory to be split at two memory addresses to take full advantage of the memory disk feature of concurrent CP/M.



FREE SOFTWARE

The disk emulation software creates "disk drives" in memory which access your programs at the speed of RAM memory. The print spooler allows the memory to accept data as fast as the computer can send it and frees your computer for more productive work. Some manufacturers sell hardware printer buffers that do only this for hundreds of dollars. SuperSpoolerTM eliminates the need for these slot robbing products.

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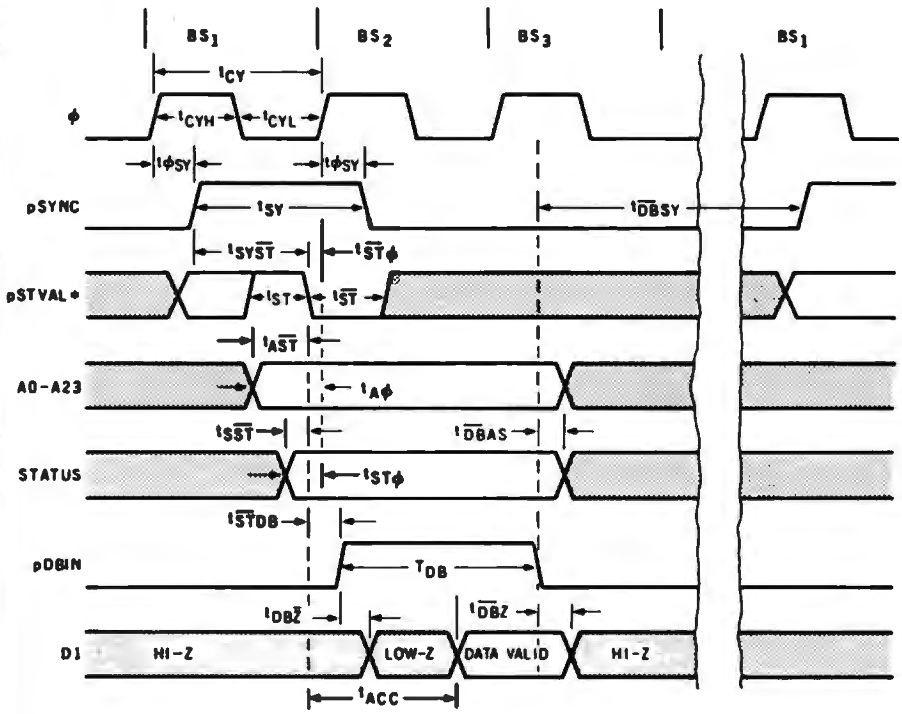

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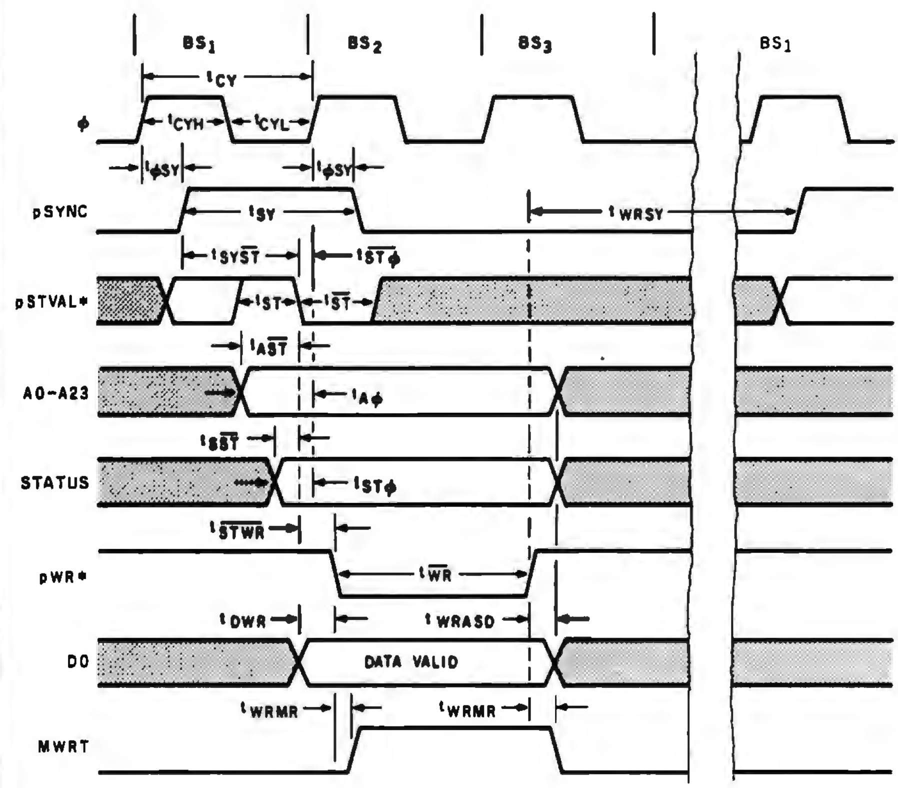

Figure 4: *Timing diagrams for basic bus cycles. Figure 4a shows a read cycle; figure 4b shows a write cycle; and figure 4c shows the timing required for the RDY, XRDY, and SIXTN* signals (when pSYNC is false, RDY and XRDY are tested only when the master is in a wait state).*

Parameter	Description	Minimum (ns)	Maximum (ns)
t_{CY}	ϕ Period	166	2000
t_{CYH}	ϕ Pulse width high	$0.4t_{CY}$	
t_{CYL}	ϕ Pulse width low	$0.4t_{CY}$	
$t_{\phi SY}$	Delay ϕ high to pSYNC high; Delay ϕ high to pSYNC low	10	$0.4t_{CY}$
t_{SY}	pSYNC pulse width high	$0.7t_{CY}$	
$t_{\overline{ST}\phi}$	pSTVAL* low prior to ϕ high during pSYNC	0	
t_{ST}	PSTVAL* pulse width high	50	
$t_{\overline{ST}}$	pSTVAL* pulse width low	50	
$t_{A\overline{ST}}$	Addresses stable prior to pSTVAL* low during pSYNC high	70	
$t_{S\overline{ST}}$	Status stable prior to pSTVAL* low during pSYNC high	40	
t_{DB}	pDBIN pulse width high	$0.9t_{CY}$	
$t_{\overline{ST}DB}$	Delay pSTVAL* low to pDBIN high	20	
$t_{\overline{DB}SY}$	Delay pDBIN low to pSYNC high	0	
$t_{\overline{DB}AS}$	Hold time for addresses and status after pDBIN low'	50	
$t_{\overline{DB}Z}$	Delay pDBIN low to slave DI drivers high impedance		70
t_{DBZ}	Delay pDBIN high to slave DI drivers active	10	70
t_{ACC}	Delay pSTVAL* low to data valid	Specified by manufacturer worst-case maximum for all slaves and worst-case minimum for all masters.	
$t_{\overline{WR}}$	pWR* Pulse width low	$0.9t_{CY}$	
$t_{\overline{STWR}}$	Delay pSTVAL* low to pWR* low	30	
t_{WRSY}	Delay pWR* high to pSYNC high	0	
$t_{D\overline{WR}}$	Setup time DO valid to pWR* low	$0.1t_{CY}$	
t_{WRASD}	Hold time addresses, status, and DO from pWR* high	$0.2t_{CY}$	
$t_{\overline{WR}MR}$	Delay pWR* low to MWRT high; delay pWR* high to MWRT low		30
$t_{RDY\phi}$	Setup time RDY, XRDY, SIXTN* to ϕ rising	70	
$t_{\phi RDY}$	Hold time RDY, XRDY, SIXTN* after ϕ rising	20	
t_{POV}	Overlap of PHANTOM* and pDBIN or pWR*	30	
$t_{SY\overline{ST}}$	Delay from pSYNC high to pSTVAL* low	30	
$t_{A\phi}$	Addresses stable prior to ϕ high during pSYNC high	80	
$t_{\overline{ST}\phi}$	Status stable prior to ϕ high during pSYNC high	50	

Table 3: *Memory-access cycle timing parameters.*

may have what appears to be a whole new machine.

Of course, no discussion of IEEE-696/S-100 bus advantages would be complete without mentioning that the existence of a standard helps everybody. It makes the modular concept truly workable.

The Future of IEEE 696

Those of us in the industry perceive the IEEE-696/S-100 bus to be long-lived. The most powerful systems in the industry are currently available on the bus, and the trend seems to be continuing. With the new standard's provision for 16-bit capability, 16 megabytes of memory, and expanded TMA capabilities, it will be a long time before computing needs outgrow it.

One point I can't stress enough is that, when buying S-100 systems and products, insist upon products that meet or exceed the IEEE-696 specifications. Be wary of the phrase "compatible with IEEE 696." If you are in doubt about a product, ask for verification, or at least get a guarantee.

Where to Get More Information

If you would like a copy of the standard, send me a legal-size, self-addressed, stamped envelope along with a note indicating your request. By the time this article is published, I should know how the standard is to be distributed. I will return your envelope with a note describing how to get your copy.

Send your self-addressed, stamped envelope to:

Mark Garetz
Chairman, IEEE-696 Committee
c/o Compupro
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If you want to read a text that describes the IEEE-696/S-100 bus in clear, precise terms, plus gives a wealth of useful circuits and information, pick up a copy of *Interfacing to S-100/IEEE 696 Microcomputers* at a computer bookstore. It is written by Sol Libes and me and is published by Osborne/McGraw-Hill (1981). ■

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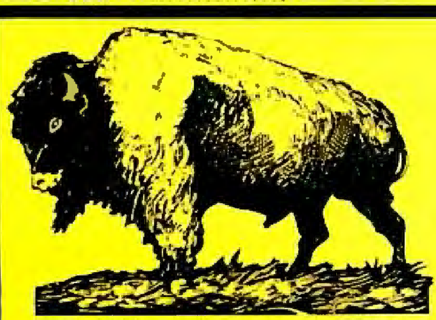

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Scribble, by contrast, might be described as a high-level language for text. A single formatting instruction in a Scribble document could correspond to several of the more primitive instructions that are available in other text-processing programs. Scribble isn't perfect, and as with any other high-level language, whether or not you are comfortable with it will be to some extent a matter of taste. But there is no question that Scribble can greatly simplify the production of complex documents. It represents a real step forward in the evolution of text-processing tools for small computers.

Scribble might be described as a high-level language for text.

This ability to perform complex operations in response to a single formatting instruction changes the way users think about the documents they are creating. With the average text-processing program, the sequence of commands to display a long quotation within a text would be "skip a couple of extra lines, enlarge the left margin slightly, enlarge the right margin slightly, and single space." The analogous Scribble command would be "format the next piece of text as a quotation." Scribble encourages users to ignore the final appearance of the document—the program will take care of that for them—and to concentrate instead on the logical relationships among the various sections of their texts. Scribble instructions tend to be functional rather than typographical.

Scribble Environments

For example, business letters are commonly formatted with the sender's address, date, and closing signature on the right side of the page. With one popular type of text processor, the sequence of commands would be something like those shown in figure 1a.

This sequence tells the text-processing program to indent the address 40 characters from the current left margin (.in +40) and to stop filling each line with as many words as possible (.nf). After the address is typed, the text processor is told to restore the previous left margin and to resume filling text. The same sequence of commands must be repeated for the

About the Author
Chris Kern is a Washington, DC, journalist and a frequent contributor to BYTE.

At a Glance

Name
Scribble, version 1.3

Type
Text-processing software

Author
Mark of the Unicorn
POB 423
Arlington, MA 02174
(617) 489-1387

Distributors
Westico, Lifeboat Associates, Cornerstore or direct from manufacturer

Price
$175

Format
Various CP/M disk formats

Computer
CP/M 8-bit machines; CP/M-86 version to be introduced

Documentation
100-page user manual; 99-page program logic manual

Audience
Anyone needing a sophisticated text-processing program

(1a)

```
.in +40
.nf
1600 Pennsylvania Ave.
Washington, D.C.
Jan. 20, 1985
.in -40
.fi
```

(1b)

```
@address<1600 Pennsylvania Ave.
Washington, D.C.
Jan. 20, 1985>
```

Figures 1a and 1b: *Comparison of Scribble formatting commands with those of another word processor. Figure 1a shows how the address portion of a letter might be done using a popular word-processing program; figure 1b shows the same address with analogous Scribble commands.*

closing of the letter. To do the same thing with Scribble, the source text would look like figure 1b.

The command @address and its synonym, @closing, are examples of what Scribble's authors call *environments.* (The @ character is reserved to signal commands to the Scribble text processor.) An environment is a section of text that is to be formatted in some particular way. For example, in the @address environment:

—Each line is kept the same length as it appears in the input file (i.e., short lines are not filled and long lines are not wrapped).
—The lines of the address are left-justified.
—The left edge of the address is placed at the center of the page.

Scribble provides 23 predefined environments. One is the @itemize environment, which arranges a list of items in the format shown in the preceding paragraph. Another environment prints long quotations as single-spaced, indented paragraphs so that they will stand out from the surrounding text. Several other Scribble environments perform operations that are available in all sophisticated text-processing programs. Text can be centered or printed flush left or flush right. You can also create paragraphs with hanging indentations, in which the first line of the paragraph is

(2a)

```
@description<FORTRAN @\ The great progenitor.  A real step
forward in its day, but it has had a tendency to hold back
progress ever since.

COBOL @\ Is prolix.  Reminds me of what Abraham Lincoln once
said about a fellow lawyer: "He can compress the most words into
the smallest ideas of any man I ever met."

BASIC @\ You can love it or you can hate it, but you can't
ignore it.  BASIC is characterized by the best acronym of the
lot: "Beginner's All-purpose Symbolic Instruction Code."

PL/I @\ Is to computer languages what Texas is to states:
smaller than Alaska but bigger than everything else.

LISP @\ Can be most clearly described in LISP.
((Parenthetically, LISP is considerably easier to use than
many people think.)  LISP can be thought of as a "high-level
machine language" in which other languages can be written,
an attribute that has proved important in research.

C @\ Simple, clean, terse.

Pascal @\ Pascal is for classroom use.  It is precise
and mathematical.  A Swiss professor thought it up.  He should
have taken a sabbatical.

Ada @\ The future, formally certified by the Department of
Defense.  Ada is the government's attempt to negotiate a
computer language nonproliferation treaty with itself.  But,
sources say, the parties are still far apart.>
```

(2b)

```
FORTRAN         The great progenitor.  A real step forward in its
                day, but it has had a tendency to hold back
                progress ever since.

COBOL           Is prolix.  Reminds me of what Abraham Lincoln
                once said about a fellow lawyer: "He can compress
                the most words into the smallest ideas of any man
                I ever met."

BASIC           You can love it or you can hate it, but you can't
                ignore it.  BASIC is characterized by the best
                acronym of the lot: "Beginner's All-purpose
                Symbolic Instruction Code."

PL/I            Is to computer languages what Texas is to states:
                smaller than Alaska but bigger than everything
                else.

LISP            Can be most clearly described in LISP.
                ((Parenthetically, LISP is considerably easier to
                use than many people think.)  LISP can be thought
                of as a "high-level machine language" in which
                other languages can be written, an attribute that
                has proved important in research.

C               Simple, clean, terse.

Pascal          Pascal is for classroom use.  It is precise and
                mathematical.  A Swiss professor thought it up.
                He should have taken a sabbatical.

Ada             The future, formally certified by the Department
                of Defense.  Ada is the government's attempt to
                negotiate a computer language nonproliferation
                treaty with itself.  But, sources say, the parties
                are still far apart.
```

Figures 2a and 2b: *An example of Scribble's @description environment, which formats a series of items in a way that permits them to be listed and then elaborated individually. Figure 2a is the input file. The @ \ characters are typewriter-style tabs that instruct Scribble to place the next printing character at the @description environment's preset tab position. Figure 2b shows the result.*

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Reason #4 Wordstar.™
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(3a)

```
@begin<level>
Scribble provides facilities for automatic numbering of
sections and paragraphs of documents.

A number of different formats are available.
@begin<level>
For example, you could number the sections of a document
but not the individual paragraphs.

Different levels of numbering are automatically provided.
This paragraph, for example, has two levels of numbering.

Indentation can also be controlled to a considerable extent.
@end<level>

This feature greatly simplifies the creation of documents
that have a complex and explicit structure, such as technical
manuals.
@end<level>
```

(3b)

```
1.  Scribble   provides   facilities   for   automatic   numbering   of
    sections and paragraphs of documents.

2.  A number of different formats are available.

    2.1.  For example, you could number the sections of a document
          but not the individual paragraphs.

    2.2.  Different   levels   of   numbering   are   automatically
          provided.  This paragraph, for example, has two levels of
          numbering.

    2.3.  Indentation  can  also  be  controlled  to  a  considerable
          extent.

3.  This feature greatly simplifies the creation of documents that
    have  a  complex  and  explicit  structure,  such  as  technical
    manuals.
```

Figures 3a and 3b: *An example of Scribble's @level environment, which is one of several ways provided by the program to automatically structure and number sections of text. Note that one instance of the environment is nested within another to improve readability. The @begin<level> and @end<level> instructions in the source text of figure 3a are synonyms for the @level< and > syntax that would normally enclose the text of the environment if you weren't nesting instructions. Figure 3b shows the result.*

flush left but all subsequent lines are indented. Somewhat more unusual is the @description environment, which formats text into two columns (see figure 2 on page 306.)

Structured Text

Scribble includes a variety of environments that make it easy to structure text into a series of indented and sequentially numbered paragraphs of the kind commonly found in textbooks and technical manuals. Sections and subsections of a document are automatically set apart and numbered. This makes it easy to create or change a complex document composed of numbered sections and paragraphs. You can insert new material knowing that the indentation and numbering of the document will be preserved and, where necessary, updated automatically (see figure 3).

Environments are what distinguish Scribble from other text-processing programs. The only real problem is that the average user will have to accept each environment as it was defined by Scribble's authors. Fortunately, the stylistic choices that the authors have made are reasonable. Source code for most of the program, written in the C computer language, is supplied as part of the package. The authors explain the program logic in some detail in the Scribble manual, and an experienced C programmer should have no great difficulty modifying the program. There is even a Scribble users group to distribute extensions to the program. Still, it would be nice to be able to redefine the existing environments without programming. Ideally, it should be possible to create entirely new environments, each composed of primitive text-formatting commands or even other environments.

Other Commands

In addition to environments that format an entire block of text, Scribble provides 10 *inline* environments to determine how individual characters are printed. These provide familiar features such as underlining, boldface, subscripts, and superscripts. Even though these operations are common to most text-processing programs, Scribble's attention to detail is impressive. For example, Scribble includes three different underscore commands: underscore all printing characters, underscore only alphanumeric characters, and underscore continuously. Two separate italics commands—regular and boldface—provide insurance, the authors say, against the day when printers with italics capability are more commonly available.

In many cases, you can nest Scribble environments and inline environments. That is, you can give one command inside another. For example, one element in an itemized list can be underscored, or the @level environment depicted in figure 3a can be invoked within itself to produce multilevel structures (the second level in figure 3b was produced this way).

The remaining category of Scribble commands, which the program's authors refer to as *directives*, is composed of instructions that, for the most part, cannot contain other Scribble instructions. Some directives are similar to inline environments in that they provide commonly available text-processing functions. You will find directives to define page headings and footings, to skip lines or start new pages, and to read and insert other files into the running text. Footnotes are automatically numbered, and one directive specifies whether the notes are to be printed within the text, at the bottom of each page, or at the end of the document.

The @style Directive

The @style directive takes a variety of arguments. It is used to specify margins, paper size, the extra space (if any) between paragraphs, the amount of indentation for new paragraphs, whether the text is to be justified, and other fundamental stylistic characteristics. One nice feature of the @style directive is that, where it requires numeric arguments (such as in specifying paragraph indentation), the argument can be entered in just about any unit of measure that is handy. The @style directive will accept arguments expressed in characters, lines, centimeters, millimeters, points, picas, ems (these last three are printer's measures), and micas. A mica is the internal unit of measurement used by Scribble. It corresponds to 10 microns, or about 1/2540 of an inch. Unfortunately, relative values are not permitted. So, for example, it is impossible to issue a command to increase the line spacing by one.

A number of other Scribble directives concern various types of automatic numbering. You can have the *sectioning* directives number portions of the text. There are six of them, corresponding to chapters, sections, subsections, and paragraphs for the main body of the text, and chapters and sections for appendixes. Each sectioning directive creates a subtitle or heading in the document. Every time you invoke a sectioning directive, an entry is automatically made in the document table of contents. Similarly, an @index directive automatically creates an index for the document. The instruction @index<message> within a Scribble text creates an index entry composed of the message and a reference to the current page.

The remainder of the directives deal mostly with string and numeric variables. Section numbers and headings are automatically maintained by Scribble, as is the current page number. Other variables can be defined by the user. For example, a commonly used string, such as an address, can be defined once in a document and introduced repeatedly into the text simply by referring to a single-word variable name. You can change variables or set them to the value of other string variables. You can add or subtract numeric variables.

Printing Scribble Files

Scribble itself can display formatted documents on the system console or on a simple Teletype-style printer (i.e., one that does not need any special control codes). Scribble can also write a formatted document to a disk file. If a more sophisticated printer is available—for example, one that has a proportionally spaced type font or one that can move up a fraction of a line to provide properly superscripted footnotes—a second program must be used to put the finished document on paper. Splitting up the formatting and printing jobs introduces an extra step, but it keeps the size of the Scribble program manageable without sacrificing flexibility.

For all but the simplest printers, Scribble produces an intermediate, formatted file. This file contains a minimum of information about the actual device on which the document will be printed. A second program, called Crayon, reads the intermediate file and prints the finished document. Crayon knows the details of different printers and produces the required control sequences to make the most out of each printer's specific hardware capabilities. You can make a rough draft quickly on a high-speed, dot-matrix printer. Then a finished copy can be made on a letter-quality printer, using proportional spacing, special type fonts, or whatever sophisticated features are available.

Different printers, by the way, don't really have to be literally different machines. The user can create several *logical* device specifications for the same *physical* machine. For example, a formfeed could move the forms one distance for printing out mailing labels and a different distance for printing correspondence. The same physical printer might be used in both cases, but the meaning of *formfeed* would depend on the particular application.

Configuration

The Scribble/Crayon system is delivered with the ability to drive the most common small-system printers. It comes with a configuration utility that makes customizing the programs for many other printers and creating "logical" printers fairly simple. It may be necessary to write new driver code for a printer with unusual control sequences.

The configuration program has several other functions. It can reset the default style parameters for such features as margins, line spacing, paragraph indentation, and the like. (Of course, these can be set by @style directives inside the text of each document as well.) The configuration program also enables the user to define certain input and output characteristics of the host computer system. In most cases, installing Scribble should pose no obstacle even to a nontechnical user.

The Scribble manual is complete and well organized. Mark of the Unicorn provides a tutorial introduction along with an extensive user's manual. I found the user's manual difficult to follow in a few places, but for the most part, the writing is clear if undistinguished. Scribble takes a bit of getting used to precisely because it is different from most other text-processing programs. But that, of course, is why it is worth the effort. Separate documentation is provided in the manual to explain the source code modules. As might be expected, these sections are written for the programmer, not the casual user. Incredibly—because it could have been produced so easily using Scribble—the manual has no index.

Scribble is fun to use, even on a relatively simple document such as this article, but it is at its best when used to produce complex or long documents, especially highly structured, technical ones. Scribble would be an excellent program to use to write computer reference manuals, by the way. Too many manuals lack clarity, regardless of the quality of the writing, because of poor organization and format. Scribble's automated sectioning, footnoting, indexing, and table-of-contents features should greatly simplify the creation of complex, multilevel texts.

Conclusions

- Scribble can be described as a high-level language for text processing that encourages users to concentrate on the structure of the document.
- Scribble environments deal with relatively large sections of text. The program also provides conventional commands for instances where a predefined environment is not appropriate.
- Scribble comes with source code for most program modules, making it possible to alter or extend its capabilities.
- Scribble is capable of using the sophisticated hardware features of the most common small-system printers.
- Scribble is at its best when it is used to produce long or complex documents.

[Mark of the Unicorn is now selling version 1.4 of Scribble, which is advertised as being substantially the same as version 1.3 with a few bugs worked out. . . . **Ed.]** ■

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Problem Oriented Language

Part 3: Assembling the Modules

The modules are assembled into a complete programming system.

Mark Finger
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In parts 1 and 2 of this series (see the December 1982 and January 1983 BYTEs), the concept of Problem Oriented Language (POL) was introduced. POL uses input that incorporates terms normally used in describing a particular problem. These terms are organized into phrases and sentences that resemble English sentences. The input is relatively free of the format restrictions normally associated with question-and-answer or menu input. Much more information can be input with a single entry. A typical entry such as "Draw an XY graph, X from 0 to 4, Y from −2 to 3, Title 'Contour Plot,' Execute" would replace dozens of responses required for other types of input. POL-type input is normally used in technical or graphics applications, where many possible parameters can be changed, but only a few need to be set at any given time.

The Problem Oriented Language Programming System (POL/PS) was introduced to provide microcomputers with the capability of handling POL, especially in terms of solving technical problems. The series of routines (POL-80) for handling POL input was presented and the capabilities were examined.

The actual use of the routines within POL/PS was discussed, showing the steps involved in writing a module to find the root of an equation.

Modularity

I have heretofore covered in some detail the concept of POL and how to program using POL-80 routines. The real key to success in using the POL/PS, however, lies in modular programming.

What Is a Module?

We often hear that good computer programs are modular. Every programming course and textbook stresses that point. But what makes a program modular? Would you recognize a module if you saw one?

The dictionary definition of a module is "any of a set of units designed to be arranged or joined in a variety of ways." This shows that the key concepts of modularity are *flexibility* and *similarity at the boundaries*. A functional definition of a module is simply this: "A module should do one thing and do it well."

The idea in modularity is that units can be chosen and linked together *in order to reach a goal*. One example of this is the way most kitchens are built using modular cabinets. Each type of cabinet handles a specific task well, and we choose a certain combination of types to best achieve our overall objectives.

When a programmer writes a modular program, a number of units, segments, or sections will be in the program, each having a specific task to perform in achieving the program's goal. These units are linked together by a mainline program (the highest level of control). This concept of modular programming is a tremendous aid in debugging but is very difficult to learn. To get some idea of how modules can be used in programming, let us examine some of the different types.

Programming modules differ mainly in the *level* at which they do their "one thing." The first, and lowest, level is best shown by the one-line functions (or modules) of FORTRAN and BASIC. These modules use a single equation to return a single value. Obviously, they do just one thing.

The best example of second-level modularity is the FUNCTION subprogram in FORTRAN. It does more complex work on its input, but it

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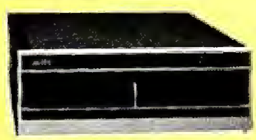

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should, essentially, do just one thing because it returns just one value. A good example of this type of module in POL-80 is subroutines 750, 800, 850, and 950 (see part 1). Their one thing is to test for a certain situation and return one primary value, the value of FLAG, which indicates a successful or an unsuccessful test. Certainly, they perform a number of actions (especially subroutines 850 and 950, which must carry out a variety of tasks to extract and examine numbers), but they do only as much as is needed to accomplish their one thing.

The third level of modularity involves the return of multiple values, as is often done in subroutines in FORTRAN or BASIC. Examples include subroutines to do the inversion of a matrix or to solve a series of simultaneous equations. These modules still do just one thing.

At higher levels of modularity, the module may be a section of a major program. In my field—chemical engineering—we speak of thermodynamic modules, meaning a group of subroutines that compute temperature, pressure, and other values according to some set of equations. There will be a module for each different model (set of equations) that we use. Some large engineering systems may have five or more thermodynamic modules. The one selected will depend on the chemicals being used or on some similar criteria.

These four levels of modules should cover most ordinary programming. It should be possible to write any given program by simply linking together various levels of modules to accomplish a desired task.

Why Use Modules?

What good are modules? Why is there all this stress on them? Why should you bother to spend all this extra time writing modular programs if all you get is a little less time spent on debugging? Modular programming has several advantages:

- It can reduce a program's size. Calls to a single module from different places in a program are preferable to writing the same lines of code again and again.
- A good module will be portable. This can reduce the amount of writing that a programmer will need to do because major portions of code are available from previous programs. This is especially true when using graphics and numerical methods.
- A library of standard functions may be available, again reducing the load on the programmer.
- A good module will provide ease of insertion into a program, reducing the programming load.
- Good modular programming eases debugging because the modules have definite boundaries and only certain pieces of information cross the boundaries. A programmer can be reasonably sure that if one value is being changed, another value 500 lines away is not accidentally being changed.
- Modular programming's main advantage is *to reduce the total programming time to solve a problem*—often making the difference between solving a problem on time or not solving it at all.

The main advantage of modularity is to reduce the total programming time to solve a problem.

The trouble with using a module is discovering how to make it fit in your own program. The major cause of this trouble is controlling the number of parameters that must be passed back and forth between the mainline program and its modules. I have often written my own code rather than use a module I have in my library simply because I must keep track of 12 or more parameters, half of which are not needed in my application. The heart of the trouble lies in the amount of information interchanged. The more information that passes across the module's boundary, the more the rest of the program has to handle. One, two, or three pieces of information are desirable. Twelve to twenty are not, because you have to ensure that each of these values is set properly *every* time you call the module. In addition, nearly all the information is numerical, and it's difficult to remember whether FLAG=1 means invert the matrix or solve simultaneous equations. Or is it NINV=1? Many lines of code are required to set parameters or check them each time a module is used. This can be a burden to any programmer.

In addition, the mainline program is forced to do nearly all the input, output, and decision making. Setting all the parameters for each subroutine call can mean lots of program lines. Handling input and output adds more lines. Because most mainline programs are written to solve only one problem at one time, very little of the mainline program is reused after all the effort put into it.

Introducing Extended Control Structure

A solution to this problem is *extended control structure.* This involves putting some of the input, output, and decision making in the modules or subroutines rather than in the mainline program. The input for a graphics module should be in the graphics module, the input for a root-finding module should be in that module, etc. This is seldom done in question-and-answer input, and infrequently done in menu input. However, POL input can excel at this. In part 2, I showed that nearly all the input for the root-finding module ROOTs could be placed within the module. This means that only a call to ROOTs is needed in the mainline program—just a couple of simple, standard statements. Other modules for numerical analysis and graphics are constructed in a similar manner. Now, writing code to handle the input is no longer a major concern of the programmer. Output is handled in a similar manner, thus reducing even more of the load. The programmer's only concern with output will be if text output to the printer is to be formatted in a specific manner.

All that remains for a mainline program to do is link modules together and handle decision making. Therefore, let us see how a program for doing numerical analysis can be arranged. The program in listing 1 appears short compared to ROOTs and star war

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Listing 1: *Functioning as the mainline program, NUMRANAL will perform a numerical analysis by calling other modules to handle input, output, and decision making. Lines beginning with an asterisk (used for illustrative purposes only) can be eliminated unless those modules are used.*

```
******************************************************************************
3000 REM MAINLINE NUMERICAL ANALYSIS(NUMRANAL)
3010 GOSUB 1450
3020 PRINT "Type VOCAbulary if you want a list of command words."
3100 FART=1
     :AART(0)="A "
     :AART(1)="AN "
     :AART(2)="THE "
     :AART(3)="IS "
     :AART(4)="ARE "
     :AART(5)="EQUALS "
     :AART(6)="EQUAL "
     :AART(7)="AND "
     :AART(8)="FOR "
     :AART(9)="OF "
     :NART=9
     :FCOM=1
     :ACOM(0)=","
     :ACOM(1)="="
     :NCOM=1
     :GOSUB 1050
3110 AM=AP
     :NLET=1
     :GOSUB 750
     :IF FLAG=1
         THEN IRET=9100
             :GOTO 100
******************************************************************************

Graphics Routines Calls (standard calls)

******************************************************************************
*3200 AM="DRAW"
     :NLET=4
     :GOSUB 750
     :IF FLAG=0
         GOTO 3300
*3210 GOSUB 3800
     :IF FLAG=0
         GOTO 3100
*3220 AM="CONTINUE"
     :NLET=4
     :GOSUB 750
     :IF FLAG=1
         THEN ISTART=3004
         ELSE ISTART=3000
*3230 GOSUB 9000
     :CHAIN MERGE APLT+ACOOR,ISTART,DELETE 3000-9999
*3300 AM="REDRAW"
     :NLET=4
     :GOSUB 750
     :IF FLAG=0
         GOTO 4000
*3310 GOSUB 3800
     :IF FLAG=0
         GOTO 3100
*3320 AM="CONT"
     :NLET=4
     :GOSUB 750
     :IF FLAG=1
         THEN ISTART=3004
         ELSE ISTART=3002
*3330 GOTO 3230
*3800 AM="XY "
     :NLET=3
     :GOSUB 750
     :IF FLAG=1
         THEN ACOOR="XY"
             :RETURN
*3810 AM="POLAR"
     :NLET=4
     :GOSUB 750
     :IF FLAG=1
         THEN ACOOR="POL"
             :RETURN
*3820 AM="CARTESIAN"
     :NLET=4
     :GOSUB 750
     :IF FLAG=1
         THEN ACOOR="CAR"
             :RETURN
*3990 NERR=1501
     :GOSUB 1200
     :RETURN
******************************************************************************

Numerical Methods Module Calls

******************************************************************************
4000 AM="ROOT"
     :NLET=4
```

Listing 1 continued on page 320

the multiple-page graphics modules. Much of the program is just a series of calls to modules that can then handle the input, output, and decision making. Each of these calls is a standard sequence of statements. The call to ROOTs is in line 4000 and is in the standard format. Additional numerical methods are easily added to this mainline program. Line 4010, for example, is the entry for the CONTour plotter module. Other planned modules for this general-purpose numerical-analysis package include numerical integration, differential equation solving, simplex optimization, and regression (curve fitting). Inserting these modules into this mainline program (or any other) can be as simple as the lines calling for ROOTs and CONTours.

The graphics section (lines 3200-3990) may look long and messy, but this is because it handles three different types of axes (XY, Cartesian, and polar) and three entry points for each type of axis (DRAW, REDRaw, and CONTInue). These statements would be the same for any package that this graphics module would be added to.

The mainline program I have presented treats numerical methods in a general manner. It simply makes the different methods available in one package that includes two-dimensional graphics. It links the modules but does not provide any decision-making or information-passing capabilities; these will be added later. Such capacity is sufficient to solve the majority of problems encountered.

These modules can be easily inserted into a new POL/PS mainline program by lifting the program sections to the new mainline program (lines 3200-3990 for graphics, line 4000 for ROOTs, and line 4010 for CONTours). This simple method of adding capability to a program can tremendously decrease programming time and is the main part of what initially attracted me to POL input. It makes my overall job much easier.

ROOTs as a Module

I have been calling ROOTs a module, but is it really a module? ROOTs has definite boundaries; all

Listing 1 continued:

```
      :GOSUB 750
      :IF FLAG=1
          THEN GOSUB 9000
               :CHAIN MERGE ADISK+"NUMRROOT",3000,DELETE 3000-9999
*4010 AM="CONTOURS"
      :NLET=5
      :GOSUB 750
      :IF FLAG=1
          THEN GOSUB 9000
               :CHAIN MERGE ADISK+"NUMRCONT",3000,DELETE 3000-9999
8970 AM="STOP"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN STOP
8980 GOSUB 1250                                   **Standard call for HELP
      :IF FLAG=1                                    and VOCAbulary (include
          GOTO 3100                                 in every mainline)
8990 NERR=1502
      :GOSUB 1200
      :GOTO 3100
*****************************************************************************

Standard Subroutines for Calls and Returns

*****************************************************************************
9000 IRET=9010
      :ARET=ADISK+"NUMRANAL"
      :GOSUB 1400
      :RETURN
9010 GOSUB 1450
      :GOTO 3100
9100 GOSUB 1480
      :GOTO 3100
*****************************************************************************

Remember--all modules (including the mainline) must end with line number 9999

*****************************************************************************
9999 REM END APPLICATION PROGRAM
```

Listing 2: *The ROOTs program module is used to find the root of a polynomial equation.*

```
*****************************************************************************

Module ROOTs

*****************************************************************************
3000 REM MODULE ROOTS(NUMRROOT)
3001 REM COPYRIGHT MARK FINGER 1981
*3010 GOSUB 7100                                    **Stores return addresses and
      :ON FRUN+1 GOTO 3020,5100,4435                  initializes parameters
*3020 FCD=0
      :FART=1
      :AART(0)="A "
      :AART(1)="AN "
      :AART(2)="THE "
      :AART(3)="IS "
      :AART(4)="ARE "
      :AART(5)="EQUALS "
      :AART(6)="EQUAL "
      :AART(7)="AND "
      :AART(8)="FOR "
      :AART(9)="OF "
      :NART=9
3030 FCOM=1
      :ACOM(0)=","
      :ACOM(1)="="
      :NCOM=1
*****************************************************************************

Matching on the highest level of the tree structure below ROOTs

*****************************************************************************
3200 AM="USING"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          GOTO 4000
3210 AM="START"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          GOTO 4100
3220 AM="MAXIMUM"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          GOTO 4200
3230 AM="EPSILON"
      :NLET=4
      :GOSUB 750
```

Listing 2 continued on page 323

contact with the calling program has an entry point at line 3000 and a return at line 3300. All interaction with a *calling* program flows through these two points. ROOTs does just one thing—it finds the root of an equation. The level of this program is approximately that of a FORTRAN subroutine. This program (listing 2) is much bigger than the FORTRAN subroutine doing the same thing, but the entry in the calling program (see listing 1, line 4000) is much simpler than would normally be the case in FORTRAN or BASIC. The module itself is long simply because all the input and most of the output are handled inside it, and there is considerable checking of values before execution. It is important to remember that this module has to be written only once; then it can be placed in a library until the next time it is needed. Thus, the length of this module is not a burden to the person who uses it. Rather, it helps by not requiring as much effort to insert the module into a program.

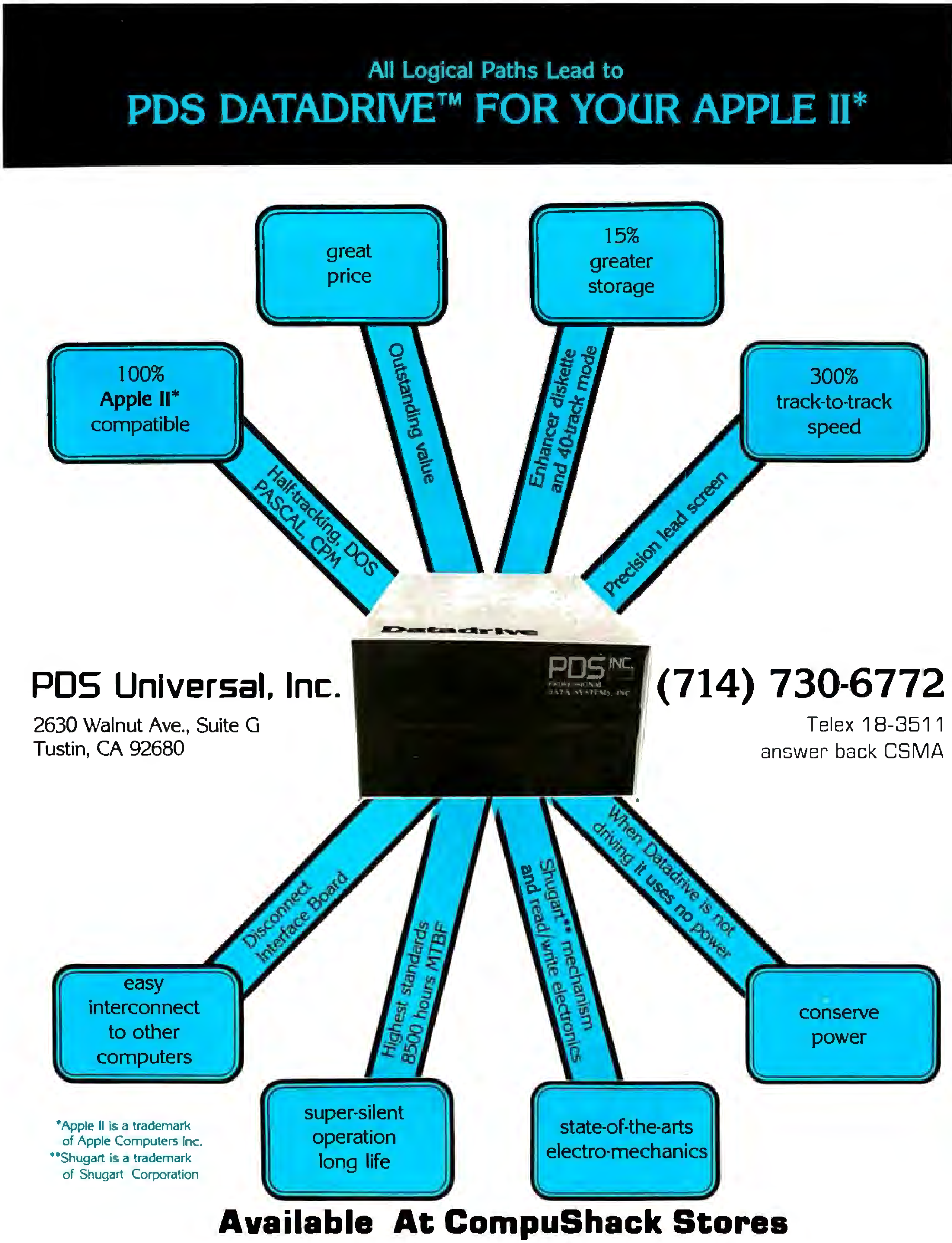
Improving ROOTs

ROOTs has one major limitation as presented here: the equation to be solved cannot be more than 230 characters long. This limitation affects less than 10 percent of the possible applications, but solving this problem will present a second major aspect of the extended control structure.

Let us begin by examining the normal methods used to enter the equation under various types of programming. The most typical situation (used in many scientific subroutines packages) requires the programmer to write a subroutine (in BASIC) or a function (in FORTRAN) and insert it into the overall program. ROOTs can then reference this subroutine whenever a value is required. (Note all the GOSUB 9000 references in listing 4 in part 2.) This method has one major problem. In order to change the equation, the programmer must stop the execution of the program, go to an editor, modify the program, and then restart it. This process is undesirable due to the load it places on a programmer, but, unfortunately, it is the most frequently used method.

In ROOTs, I have gone one step

Text continued on page 332



Circle 348 on inquiry card.

Listing 2 continued:

```
      :IF FLAG=1
          GOTO 4300
3240 AM="VALUE"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN FVA=0
                :GOTO 4400
3250 AM="EQUATION"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          GOTO 4600
3260 AM="DYDX"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          GOTO 4700
3270 AM="EXECUTE"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          GOTO 5000
3280 AM="CLEAR"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          GOTO 4800
3290 IF FCD=0
        THEN NERR=1521
              :GOSUB 1200
3291 IF FCD=1 AND IEOC=0
        THEN NERR=1541
              :GOSUB 1200
3295 FERR=1
3300 GOSUB 7000
      :CHAIN MERGE ARET, IRET, DELETE 3000-9999
*************************************************************************************

Matching for the method under USINg

*************************************************************************************
4000 FCD=1
      :AM="NEWTON"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN METHOD%=1
                :GOTO 3200
4010 AM="APPROXIMATE"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN AM="NEWTON"
                :NLET=4
                :GOSUB 750
                :METHOD%=2
                :GOTO 3200
4020 AM="SECANT"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN METHOD%=3
                :GOTO 3200
4030 AM="INTERVAL"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN AM="HALVING"
                :NLET=3
                :GOSUB 750
                :METHOD%=4
                :GOTO 3200
4040 AM="REGULA"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN AM="FALSI"
                :NLET=4
                :GOSUB 750
                :METHOD%=5
        :GOTO 3200
4050 NERR=1522
      :GOSUB 1200
      :GOTO 3295
*************************************************************************************

Setting the number of STARting POINTs and their values

*************************************************************************************
4100 FCD=1
      :FT=1
      :GOSUB 950
      :IF FLAG=1
          THEN X1=DV
                :FSP=1
                :GOTO 4150
```

Listing 2 continued on page 324

Listing 2 continued:

```
4110 AM="POINT"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
           GOTO 4100
4120 AM="AT "
      :NLET=3
      :GOSUB 750
      :IF FLAG=1
           GOTO 4100
4140 NERR=1523
      :GOSUB 1200
      :GOTO 3300
4150 FT=1
      :GOSUB 950
      :IF FLAG=0
           GOTO 3200
4160 X2=DV
      :FSP=2
      :IF X2<>X1
           GOTO 3200
4170 FSP=1
      :NERR=1524
      :GOSUB 1200
      :GOTO 3295
*********************************************************************************

Setting the number of MAXImum EVALuations

*********************************************************************************
4200 FCD=1
      :FT=3
      :BB1=2
      :BB2=10000
      :GOSUB 850
      :IF FLAG=1
           THEN NUMEVAL=IV
                :GOTO 3200
4210 NERR=1525
      :GOSUB 1200
      :GOTO 3295
*********************************************************************************

Setting the value of EPSIlon

*********************************************************************************
4300 FCD=1
      :FT=3
      :BB1=1E-20
      :BB2=10
      :GOSUB 950
      :IF FLAG=1
           THEN EPSILON=DV
                :GOTO 3200
4310 NERR=1526
      :GOSUB 1200
      :GOTO 3295
*********************************************************************************

Returning the value(s) of Y at the requested X('s)

*********************************************************************************
*4400 FCD=1
*4430 AM="AT "
      :NLET=3
      :GOSUB 750
      :FT=1
      :GOSUB 950
      :IF FLAG=1
           THEN FRUN=2
                :FLAGROOT=1
                :X=DV
                :IF FEXT=1
                     THEN GOTO 3300
                     :ELSE GOSUB 9000
*4435 PRINT "The value at ";X;" is ";Y
      :FVA=1
      :GOTO 4430
*4440 FRUN=0
      :FLAGROOT=0
      :IF FVA=1
           GOTO 3200
4450 NERR=1527
      :GOSUB 1200
      :GOTO 3295
*********************************************************************************

Entering the EQUAtion

*********************************************************************************
*4600 FCD=1
      :GOSUB 800
      :IF FLAG=0
           THEN GOTO 4640
4610 AEQ="9000 "+AB+":RETURN"
      :FEXT=0
```

Listing 2 continued on page 326

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Listing 2 continued:

```
      :FDX=0
4620 OPEN "O",#7,"EQUATION.BAS"
      :PRINT#7,AEQ
      :CLOSE#7
      :CHAIN MERGE "EQUATION",4630,ALL,DELETE 9000
4630 GOSUB 1480
      :GOTO 3200
*4640 AM="EXTERNAL"
      :NLET=4
      :GOSUB 750
      :IF FLAG=1
          THEN FEXT=1
                :FDX=0
                :GOTO 3200
*4650 NERR=1533
      :GOSUB 1200
      :GOTO 3295
****************************************************************************

Entering the derivative of the equation
    (required by Newton's method)

****************************************************************************
*4700 IF FEXT=1
         THEN NERR=1539
               :GOSUB 1200
               :GOTO 3295
         :ELSE FCD=1
               :GOSUB 800
               :IF FLAG=0
                    THEN NERR=1534
                          :GOSUB 1200
                          :GOTO 3295
4710 AEQD="9001 "+AB+":RETURN"
      :FDX=1
4720 OPEN "O",#7,"EQUATION.BAS"
      :PRINT#7,AEQD
      :CLOSE#7
      :CHAIN MERGE "EQUATION",4630,ALL,DELETE 9001
4730 GOSUB 1480
      :GOTO 3200
****************************************************************************

CLEAring the parameters to default values

****************************************************************************
4800 FCD=1
      :METHOD%=3
      :X1=0
      :X2=1
      :FSP=2
      :NUMEVAL=20
      :EPSILON=.1
      :AEQ="9000 Y=X:RETURN"
      :AEQD="9001 YPRIME=1:RETURN"
      :FDX=1
      :GOTO 3200
****************************************************************************

EXECution of root-finding

****************************************************************************
*5003 FCD=1
      :FRUN=1
      :NEXTSTEP=0
5010 IF METHOD%<>1 AND FSP<>2                        **Checking for 2 starting
        THEN NERR=1535                                 points for methods that
              :GOSUB 1200                              require 2
              :GOTO 3295
5020 IF METHOD%=1 AND FDX=0                          **Checking for derivative
        THEN NERR=1536                                 update if Newton's method
              :GOSUB 1200                              is used
              :GOTO 3295
*5030 (deleted)
5050 NUM=0
*5100 ON METHOD% GOSUB 6000,6200,6400,6600,6800     **Computation loop
*5110 Y=0
      :IF FLAGROOT=-1
          GOTO 3295
 5200 IF NUM>NUMEVAL                                 **Checking if too many
        GOTO 5400                                      evaluations
*5210 IF FLAGROOT<>3                                 **Checking if done
         THEN IF FEXT=0                              **If not done, get value
                 THEN IF FLAG=1                        for next calculation
                        THEN GOSUB 9000
                              :GOTO 5100
                        :ELSE GOSUB 9001
                              :GOTO 5100
                 :ELSE GOTO 3300
5220 PRINT "The root is ",XLAST                      **The desired root has been
      :PRINT NUM;" Evaluations were required."         found
*5260 FRUN=0
      :GOTO 3200
*5400 PRINT "The root was not found in ";NUMEVAL;" attempts."
      :FLAGROOT=-1
      :NERR=1540
```

Listing 2 continued on page 328

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Listing 2 continued:

```
5410 PRINT "The last values were X =";XLAST;" and Y =";YLAST
5420 GOTO 3200
*******************************************************************************

Methods Subroutines

*******************************************************************************
*6000 IF NEXTSTEP=0                                **Newton's Method
        THEN X=X1                                  **Get first point and ask for Y
             :NEXTSTEP=1
             :FLAGROOT=1
             :RETURN
*6010 IF NEXTSTEP=1
        THEN YOTHER=Y                              **Save Y and ask for YPRIME
             :YLAST=Y
             :NEXTSTEP=2
             :FLAGROOT=2
             :RETURN
*6020 XLAST=X                                      **Compute new X value, check
     :XOTHER=X                                       if done
     :X=XLAST-YLAST/Y
     :NEXTSTEP=1
     :NUM=NUM+1
     :IF ABS(YLAST)<=EPSILON
         THEN FLAGROOT=3                           **Done
              :RETURN
         :ELSE FLAGROOT=1                          **Ask for new Y
              :RETURN
*6200 IF NEXTSTEP=0                                **Approximate Newton's Method
        THEN X=X1                                  **Ask for first Y
             :FLAGROOT=1
             :NEXTSTEP=1
             :RETURN
*6210 IF NEXTSTEP=1                                **Store Y and ask for second Y
        THEN XOTHER=X
             :YOTHER=Y
             :X=X+(X2-X1)
             :NEXTSTEP=2
             :FLAGROOT=1
             :RETURN
*6220 NUM=NUM+1                                    **Compute new X
     :XLAST=X
     :YLAST=Y
     :X=X-Y/((YLAST-YOTHER)/(XLAST-XOTHER))
     :IF ABS(Y)<=EPSILON                           **Check if done
         THEN FLAGROOT=3                           **Done
              :RETURN
         :ELSE FLAGROOT=1                          **Ask for first new Y
              :RETURN
*6400 IF NEXTSTEP=0                                **Secant Method
        THEN X=X1                                  **Ask for first Y
             :FLAGROOT=1
             :NEXTSTEP=1
             :RETURN
*6410 IF NEXTSTEP=1                                **Store Y and ask for second Y
        THEN YLAST=Y
             :XLAST=X
             :X=X2
             :NEXTSTEP=2
             :FLAGROOT=1
             :RETURN
*6420 NUM=NUM+1                                    **Calculate new X
     :XOTHER=XLAST
     :YOTHER=YLAST
     :XLAST=X
     :YLAST=Y
     :X=X-Y/((YOTHER-YLAST)/(XOTHER-XLAST))
     :NEXTSTEP=2
     :IF ABS(Y)<=EPSILON                           **Check if done
         THEN FLAGROOT=3                           **Done
              :RETURN
         :ELSE FLAGROOT=1                          **Ask for new Y
              :RETURN
*6600 IF NEXTSTEP=0                                **Interval-Halving Method
        THEN X=X1                                  **Ask for first Y
             :FLAGROOT=1
             :NEXTSTEP=1
             :RETURN
*6610 IF NEXTSTEP=1                                **Store Y and ask for second Y
        THEN YOTHER=Y
             :XOTHER=X
             :X=X2
             :FLAGROOT=1
             :NEXTSTEP=2
             :RETURN
*6620 IF NEXTSTEP=2                                **Determine if two X values
        THEN YLAST=Y                                 bracket the root
             :XLAST=X
             :IF YLAST*YOTHER>0
        THEN NERR=1538                     No, error
             :GOSUB 1200
             :FLAGROOT=-1
             :RETURN
        :ELSE X=(XLAST+XOTHER)/2           Yes, so ask for next Y
             :FLAGROOT=1
             :NEXTSTEP=3
             :RETURN
```

Listing 2 continued on page 331

Circle 256 on inquiry card.

Listing 2 continued:

```
*6630 IF ABS(Y)<=EPSILON                                 **Check if done
        THEN FLAGROOT=3
              :YLAST=Y
              :XLAST=X
              :RETURN
*6640 NUM=NUM+1                                          **Check which interval the root
     :IF Y*YLAST<=0                                        lies in, update X and ask for
         THEN YOTHER=Y                                     a new Y
              :XOTHER=X
              :X=(X+XLAST)/2
              :FLAGROOT=1
              :NEXTSTEP=3
              :RETURN
*6650 YLAST=Y
     :XLAST=X
     :X=(X+XOTHER)/2
     :FLAGROOT=1
     :NEXTSTEP=3
     :RETURN
*6800 IF NEXTSTEP=0                                      **Regula Falsi Method
        THEN X=X1                                        **Ask for first Y
              :FLAGROOT=1
              :NEXTSTEP=1
              :RETURN
*6810 IF NEXTSTEP=1                                      **Store Y and ask for second Y
        THEN YOTHER=Y
              :XOTHER=X
              :X=X2
              :FLAGROOT=1
              :NEXTSTEP=2
              :RETURN
*6820 IF NEXTSTEP=2                                      **Determine if the X values
        THEN YLAST=Y                                       bracket the root
              :XLAST=X
              :IF YLAST*YOTHER>0
                   THEN NERR=1538                          No, error
                        :GOSUB 1200
                        :FLAGROOT=-1
                        :RETURN
                   :ELSE X=(XLAST+XOTHER)/2                Yes, ask for next Y
                        :FLAGROOT=1
                        :NEXTSTEP=3
                        :RETURN
*6830 IF ABS(Y)<=EPSILON                                 **Check if done
        THEN FLAGROOT=3
              :YLAST=Y
              :XLAST=X
              :RETURN
*6840 IF NUM=NUM+1                                       **Check which interval the
     :IF Y*YLAST<=0                                        root lies in, update X and
         THEN YOTHER=Y                                     ask for a new Y
              :XOTHER=X
              :X=XLAST+((0-YLAST)/(YOTHER-YLAST))*(XOTHER-XLAST)
              :FLAGROOT=1
              :NEXTSTEP=3
              :RETURN
*6850 YLAST=Y
     :XLAST=X
     :X=XLAST+((0-YLAST)/(YOTHER-YLAST))*(XOTHER-XLAST)
     :FLAGROOT=1
     :NEXTSTEP=3
     :RETURN
****************************************************************************

Subroutine for saving variables when leaving

****************************************************************************
*7000 OPEN "O",#6,ADISK+"SAVEROOT"
     :WRITE#6,AEQ
     :WRITE#6,AEQD
     :WRITE#6,EPSILON,FCD,FDX,FSP,FVA,METHOD%,NUMEVAL,X1,X2
              ,NEXTSTEP,XLAST,YLAST,XOTHER,YOTHER,FPATH,FEXT,FRUN
     :CLOSE#6
*7010 OPEN "O",#6,ADISK+"ANSWER"
      :WRITE#6,FLAGROOT,X,Y
      :CLOSE#6
*7020 GOSUB 1400
     :RETURN
****************************************************************************

Subroutine for restoring variables when returning

****************************************************************************
*7100 OPEN "I",#6,ADISK+"SAVEROOT"
     :INPUT#6,AEQ
     :INPUT#6,AEQD
     :INPUT#6,EPSILON,FCD,FDX,FSP,FVA,METHOD%,NUMEVAL,X1,X2
              ,NEXTSTEP,XLAST,YLAST,XOTHER,YOTHER,FPATH,FEXT,FRUN
     :CLOSE#6
 7110 OPEN "O",#7,"EQUATION.BAS"
     :PRINT#7,AEQ
     :PRINT#7,AEQD
     :CLOSE#7
     :CHAIN MERGE "EQUATION",7120,ALL,DELETE 9000-9001
*7120 GOSUB 1450
     :IF FRUN<>0
```

Listing 2 continued on page 332

Listing 2 continued:

```
          THEN OPEN "I",#6,ADISK+"ANSWER"
               :INPUT#6,FLAGROOT,X,Y
               :CLOSE#6
*7130 RETURN
******************************************************************************

Equation subroutines will be inserted here

******************************************************************************
9000 REM
9001 REM
******************************************************************************

Remember--
  Line 9999 must be present in the module, even if only as a remark.

******************************************************************************
9999 END
```

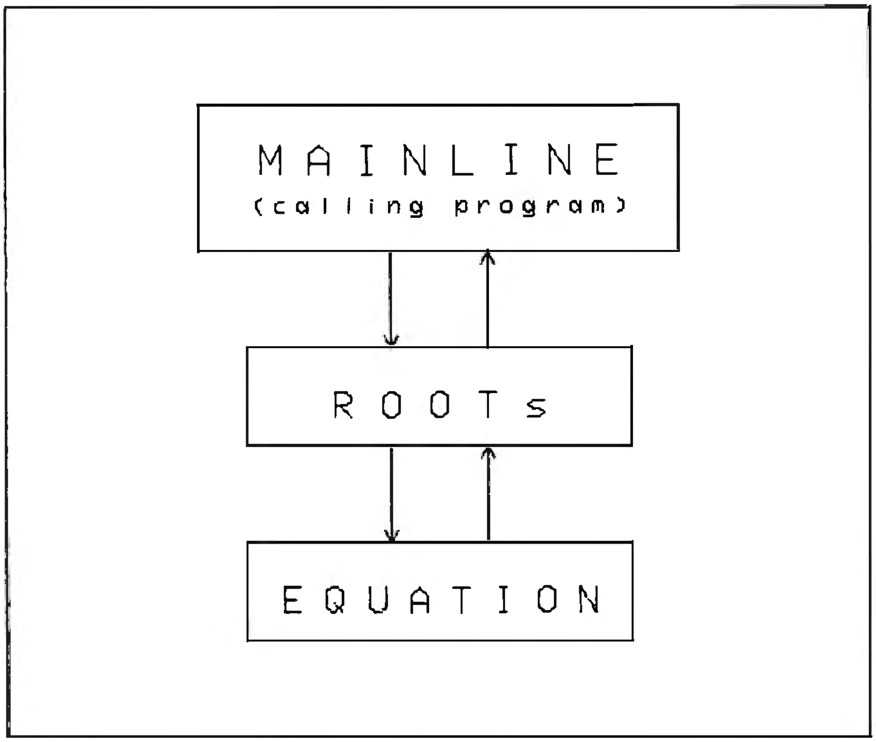

Figure 1: *A typical hierarchical program structure.*

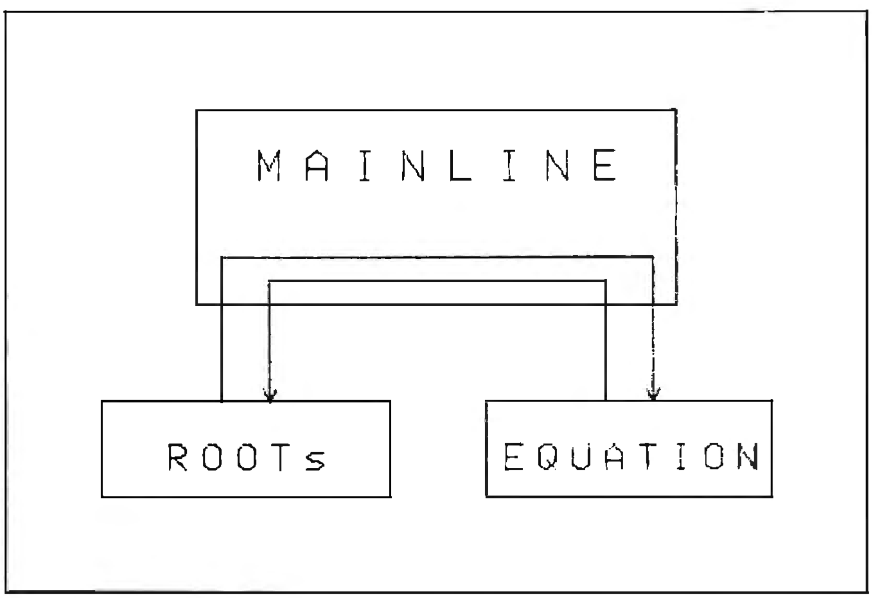

Figure 2: *Interchange between modules in a program with extended control structure.*

Text continued from page 320:

further and used the capabilities of Microsoft BASIC, allowing a program to modify a portion of itself (see lines 4600-4630 in listing 4 in part 2).

Both methods just presented have a hierarchical structure, as presented in figure 1. The calling program (usually the mainline program) calls ROOTs, and does not want to hear from it until the subroutine has done its job. ROOTs calls EQUATION whenever it needs a new value. This structure is straightforward and is almost the only structure taught in most programming courses.

We have seen the need, however, for a better structure to eliminate the problems cited above. This structure is presented in figure 2. In this procedure, EQUATION is a module at the same level as ROOTs, and information is passed between the two modules through the mainline program. This can be seen as a subroutine driving (or controlling) the mainline program, instead of vice versa. Such a structure gives us the capability of using ROOTs in such large programming situations as determining the rate of return on a proposed chemical plant. But a price must be paid for this flexibility through increased programming in the ROOTs module. The price is acceptable, however, if the module will be reused often in other programs.

Listings 2, 3, 4, and 5 show the revisions in the ROOTs module, reflecting the changes required to implement this increased flexibility. First, let us consider what information crosses the boundary of ROOTs. In the first version of ROOTs, given in part 2, no information was exchanged between the mainline program and ROOTs. We now need to pass three pieces of information—a value for X, a value for Y or YPRIME, and a flag (FLAGROOT) indicating what action is required by the mainline program. Remember, as ROOTs operates, it will need new values of Y and YPRIME for the new Xs. Instead of calling subroutines 9000 and 9001, we can now ask the mainline program to furnish these values. (We still have the same capability of entering an equation as before—the current presentation con-

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Listing 3: *HELP messages for ROOTs.*

```
The ROOTs module is used to find the real roots of any equation.

The following words are always skipped over at any place in the line:
   A
   AN
   THE
   FOR
   AND
   EQUALS
   EQUAL
   IS
   ARE
   OF
Commas(,) and equivalence signs(=) are also skipped.

The options of ROOTs are:

  USINg method

     where the methods are:

     NEWTon                  (Newton's method)
     APPRoximate NEWTon      (Approximate Newton's method)
     SECAnt                  (Secant Method)
     INTErval HALving        (Interval Halving Method)
     REGUla FALSi            (Regula Falsi Method)

  STARTing (points) ##.# (##.#)

     sets the starting points for the methods.
       Newton's method requires 1 point.
       Approximate Newton's method requires 2 points close together(4.99 & 5)
       Secant Method requires 2 points.
       Interval Halving and Regula Falsi require 2 points that bracket the
            root between them.

  MAXImum (EVALuations) ##

     ## is the maximum number of evaluations before reporting failure to
       meet convergence requirements.

  EPSIlon ##.#

     When ABS(Y)<##.#, the root is considered to be found.

  VALUe (at) ##.#,##.#,....

     will give the value of the current equation at the values of X entered

  EQUAtion
          'Y=function of X'
          EXTErnal

      If an equation is furnished, it must be in correct BASIC syntax.
     EXTErnal means that ROOTs will get the values it requires from the
     calling program.

 DYDX 'YPRIME=function of X'

     used to enter the derivative of X needed by Newton's Method.
     enter using correct BASIC syntax.  If EXTErnal is the option under
     EQUAtion, entering a derivative will cause an error.

 CLEAr

     used to set values of variables to their default values
     equivalent to the following commands

        USINg SECAnt
        STARting 0 1
        MAXImum EVALuations 20
        EPSIlon 0.1
        EQUAtion 'Y=X'
        DYDX 'YPRIME=1'

 EXECute

     causes the root to be found.
```

Listing 4: *Variables used in the ROOTs module.*

```
ACOPY                Temporary variable for copying files

AEQ                  Internal equation containing the root   Default is "Y=X"
                     to be found
```

Listing 4 continued on page 339

cerns the situation where the calculations are too long for one line.) At this point, the subroutine is making all the decisions, and the mainline program's job is only as a "slave," doing *exactly* what ROOTs tells it to do.

The commands (values of FLAGROOT) returned to the mainline program are:

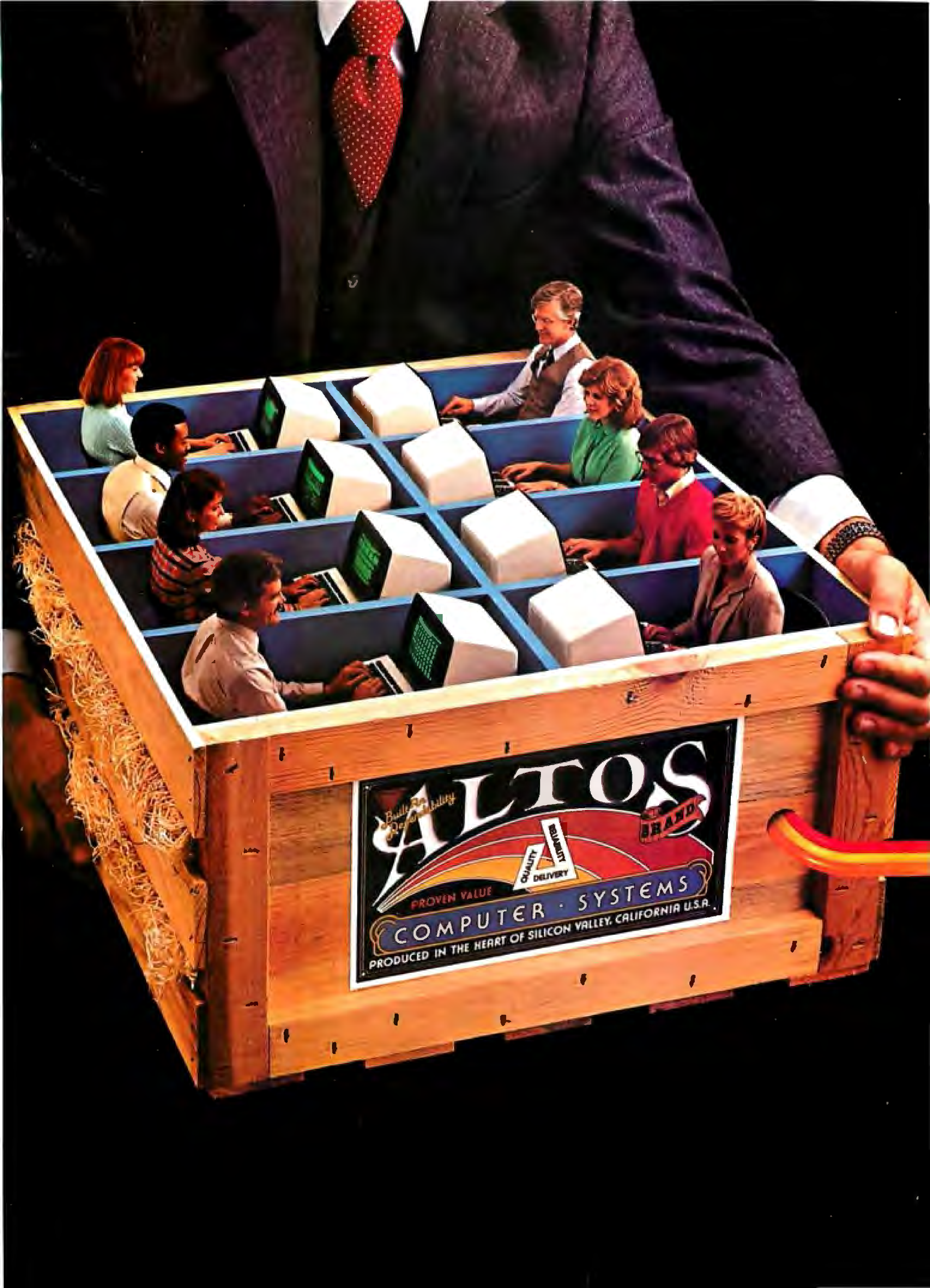
0 Program not activated. ROOTs is not actually executing in order to find the root of an equation "external" to itself. Continue with normal mainline program processing.
1 Furnish a value of Y to the subroutine for the given X.
2 Furnish a value of YPRIME to the subroutine for the given X.
3 Execution completed normally. The value of X is within specified limits. Continue with normal mainline processing.
−1 Execution terminated abnormally, the result of an error. Handle the error (given in NERR) as desired.

As with most other parameter passing in the POL/PS, these parameters will be in a file (ANSWER). Note that only 3 values cross this boundary instead of a more normal 10 to 15. This is the advantage of extended control structure; because all the other values are needed only *within* ROOTs, they stay there.

Several changes are made in ROOTs to implement extended control structure. (The changed lines have an asterisk in front of them; see listing 2.) The basic changes are as follows:

- An option has been added, allowing specification of an external "equation" (see listing 2, lines 4600-4650).
- All requests for Y or YPRIME values (when executing to find a root) are now directed to a *single* point in ROOTs (line 5120). This required some significant rewriting, especially of lines 6000-7000.
- Additional internal flags (NEXTSTEP and FEXT) have been added to control the internal flow of the program.

Text continued on page 340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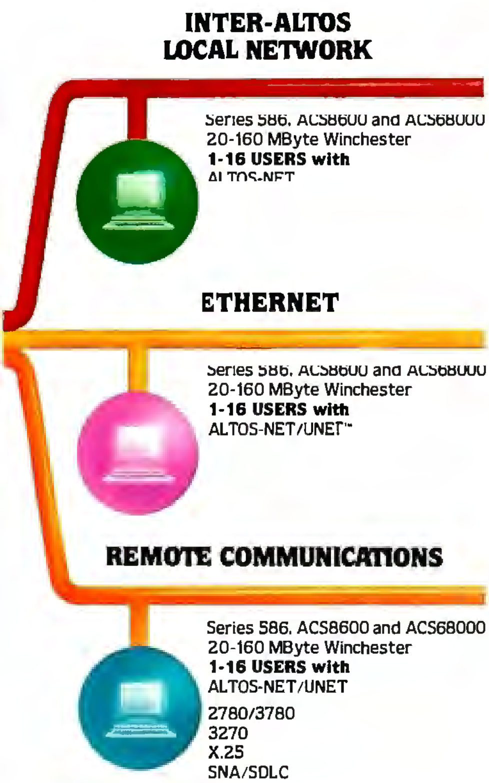

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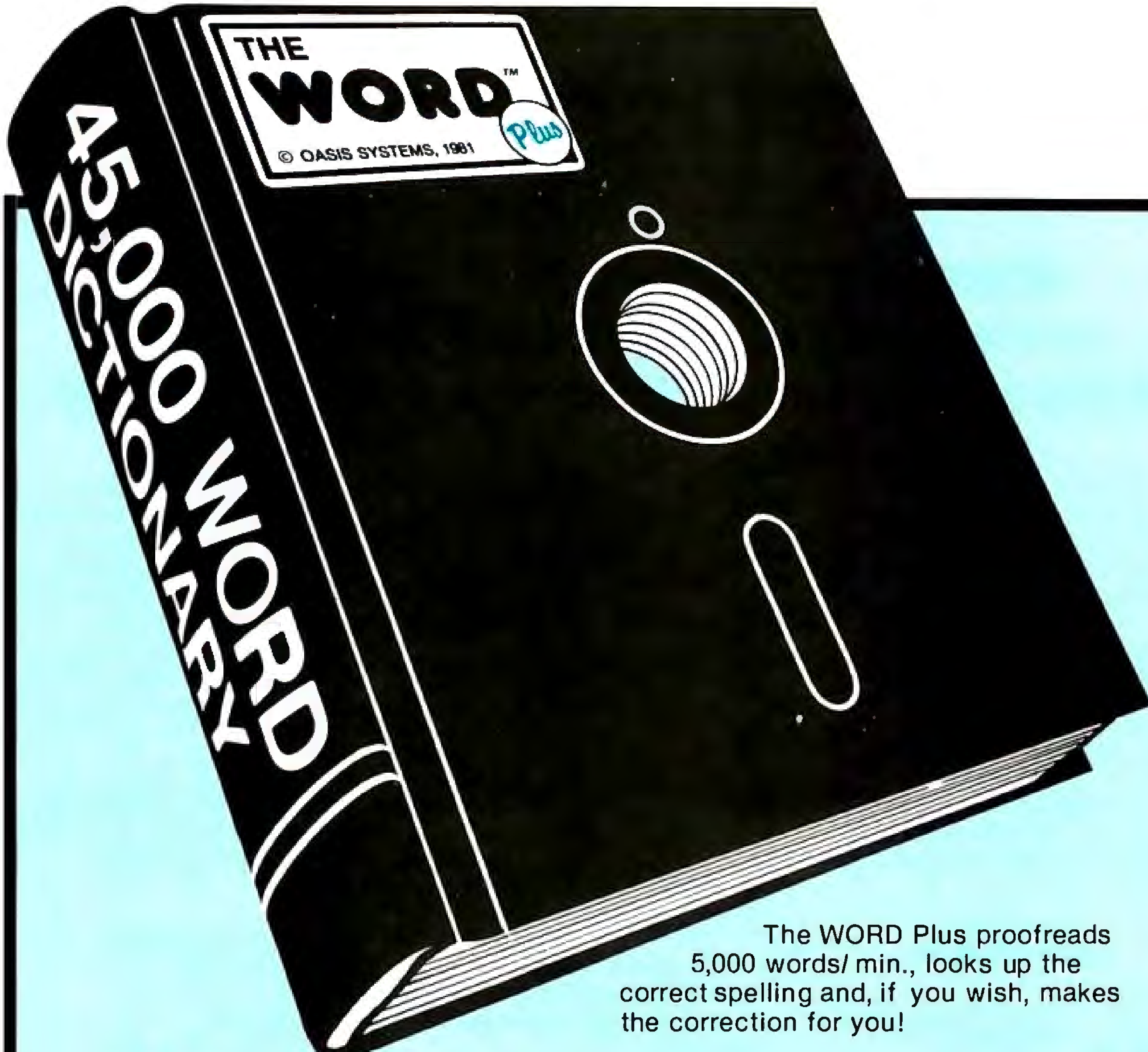

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Listing 4 continued:

AEQD	Contains the derivative of AEQ	Default is "YPRIME=1"
EPSILON	The value for determining success of finding root--success if ABS(Y)<=EPSILON	Default = .01
FCD	Flag for checking command syntax	
FDX	Flag for making sure a new AEQD is entered if AEQ is changed (required for Newton's Method)	
FEXT	Flag showing whether to use external (furnished by calling program) or internal values (from AEQ and AEQD)	0=internal 1=external
FLAGROOT	Flag to the calling program 0=program not executing 1=furnish Y for current X 2=furnish YPRIME for current X 3=normal completion of rootfinding; root is in X -1=abnormal completion; error	
FRUN	Internal flag indicating status of the module	0=normal execution 1=finding root 2=plotting equation 3=getting numerical values
FSP	Number of starting points entered	Default = 2
FVA	Flag for syntax after VALUe (AT)	
IRET1	Temporary storage of calling program return point	
METHOD%	Flag for method to be used	Default=3 (Secant)
NEXTSTEP	Internal flag set by computational subroutines to indicate the next step	
NUMEVAL	Maximum number of attempts (to find root) before failure is declared	Default=20
X	Independent variable in AEQ and AEQD	
X1	Starting point 1	Default = 0
X2	Starting point 2	Default = 1
Y	Dependent variable in AEQ	
YPRIME	Dependent variable in AEQD	
XOTHER	A previous X value attempted	
YOTHER	Y value at XOTHER	
XLAST	Another previous X value attempted	
YLAST	Y value at XLAST	
XNEW	X value for next attempt	

Listing 5: *Error messages for the ROOTs module.*

```
1501,"Missing axes type after DRAW or REDRaw"
1502,"Unexpected first entity in command"
1521,"Unexpected entity after ROOTs"
1522,"Unexpected name of method after USINg"
1523,"Missing first number after STARt"
1524,"Both starting numbers are equal"
1525,"Expecting integer (between 2 and 10000) after MAXImum EVALuations"
1526,"Expecting real number (<10) after epsilon"
1527,"Expecting a number after VALUe"
1533,"Missing string after EQUAtion"
1534,"Missing string after DYDX"
1535,"Missing 2 starting values when method requires 2"
1536,"Did not redefine DYDX after changing EQUAtion"
1538,"Starting points do not bracket the root"
1539,"Attempted to enter DYDX when EQUAtion EXTErnal is declared"
1540,"Root not found in maximum number of attempts"
1541,"Failed to decode remainder of line"
9999,"******Last entry in an error list must always be Line 9999*******"
```

Listing 6: *Sample changes in a section of the NUMRANAL mainline program. This illustrates the changes required for using the extended control structure.*

```
4000 AM="ROOT"
     :NLET=4
     :GOSUB 750
     :IF FLAG=0
         GOTO 4010
4001 IRET=4002
     :ARET=ADISK+"NUMRANAL"
     :GOSUB 1400
     :CHAIN MERGE ADISK+"NUMRROOT",3000,DELETE 3000-9999
4002 GOSUB 1450
     :OPEN "I",#6,ADISK+"ANSWER"
     :INPUT#6,FLAGROOT,X,Y
     :CLOSE#6
     :IF FLAGROOT=0 OR FLAGROOT=3
         GOTO 3100
4003 IF FLAGROOT()1
        THEN GOTO 4005
        ELSE OPEN "O",#6,ADISK+"ANSWER"
             :WRITE#6,1,X,Y
             :CLOSE#6
             :IRET=4004
             :ARET=ADISK+"NUMRANAL"
             :GOSUB 1400
             :CHAIN MERGE ADISK+"NUMRECON",3000,DELETE 3000-9999
4004 GOSUB 1450
     :OPEN "I",#6,ADISK+"ANSWER"
     :INPUT#6,FLAGROOT,X,Y
     :CLOSE#6
     :OPEN "O",#6,ADISK+"ANSWER"
     :WRITE#6,FLAGROOT,X,Y
     :CLOSE#6
     :GOTO 4001
4005 IF FLAGROOT()2
        THEN GOTO 4007
        ELSE OPEN "O",#6,ADISK+"ANSWER"
             :WRITE#6,2,X,Y
             :CLOSE#6
             :IRET=4006
             :ARET=AD1SK+"NUMRANAL"
             :GOSUB 1400
             :CHAIN MERGE AD1SK+"NUMRECON",3000,DELETE 3000-9999
4006 GOSUB 1450
     :OPEN "1",#6,ADISK+"ANSWER"
     :INPUT#6,FLAGROOT,X,YPRIME
     :CLOSE#6
     :OPEN "O",#6,ADISK+"ANSWER"
     :WRITE#6,FLAGROOT,X,YPRIME
     :CLOSE#6
     :GOTO 4001
4007 FERR=1
     :GOTO 3100
```

Text continued from page 334:

The relationship between the computational subroutines (lines 6000-7000) and the computational loop (lines 5100-5210) is similar to the one between ROOTs and the mainline program, with the computational subroutines actually setting the values of FLAGROOT.

The hardest part in using extended control structure is visualizing how the control is handled. The easiest way to explain this is by analogy. Imagine a typical company—the president makes all the major policy decisions. The vice-presidents make decisions on how to implement the policies of the president and so on down the chain of command. Each person further down the line has less control over decision making. This is analogous to the typical computer program—*the control is concentrated at the top.*

Compare this to extended control structure in POL/PS-type programs. It is like an engineer or administrator in a department temporarily taking control over all decisions concerning the production of product X. All the top brass are *temporarily* taking orders from her because she knows more about making product X than anyone else. The concept is similar to delegation of authority, and the benefits are equally great, especially in reducing the work load at the top.

I talked about the functions of a mainline program earlier. It typically handles input and output, links major modules or subroutines together, and handles decision making. In ROOTs, we have seen that most of the input and output can be handled in modules. I have just shown how much of the decision-making logic can also be placed in these modules. This leaves the mainline program with one principal function—linking the modules together. This is the reason the sample mainline program given in listing 1 is so much shorter than ROOTs, which is itself a small module.

The mainline program can be easily modified to pass the information between modules. Listing 6 gives an example of how this can be done using a module called ECONomics (for calculating the rate of return). These lines can quickly be rewritten to link ROOTs with any other acceptable module.

Where Do We Go From Here?

There is a problem with the present concept of extended control structure as implemented in POL/PS. All the links between modules must currently be written before the program is run and cannot be changed during the program's execution. It is desirable to be able to modify the module links interactively. To be able to define the links interactively would allow the use of modules in response to results different from the ones foreseen. One example is the fitting of a complex curve relating the energy of an object to temperature and pressure. Simple equations may be done by using a standard linear-regression package (curve fitting using the least-squares method) that will handle computations internally. More complex equations may require an optimizer and a contour plotter in order to find the desired values. Because there are several types of optimizer programs, each requiring a different module, we must be able to switch between different optimizers if the first does not do the job well enough. Being able to do that interactively means we do not have to exit the program, modify the linkages in the mainline program, and restart the program. Rather, we can simply change a few specifications from within the program.

This capability is currently being developed and tested in the GRIP program by Rick Hilst. His papers (see the references) show the growth of these concepts. The idea of extended control structure was conceived to aid in interactive linkage of modules. Because a mainline program

Putting It All Together

Now you can put the files on the disks in order to use them. Be sure to store all BASIC programs in unprotected ASCII format, or the CHAINs will not work. The following files are needed:

1. *POL-80.BAS—remove the comments from listing 3, part 1, and put the program on disk.*
2. *POLERR—the error-message file for POL-80. Put listing 6, part 1 on disk, and then run the program from listing 7, part 3, placing the results in POLERR on the disk.*
3. *NUMRANAL.BAS—remove the comments from the program in listing 1, part 3, modify as desired (add other modules), and save it in ASCII format on the disk.*
4. *NUMRROOT.BAS—remove the comments from listing 2, part 3, and save it in ASCII format on the disk.*
5. *VOCANUMR—(VOCAbulary list) save listing 8, part 3 on the disk.*
6. *NUMRVOCA, NUMRHELP, NUMRROOT, NUMRSTOP—these are the help messages. Set them up as sequential files on the disk. See listings 3, 9, 10, and 11 in part 3.*
7. *NUMRERR—enter listing 6, part 1, and listing 5, part 3 on the disk, and then run listing 7, part 3 as many times as needed, placing the results in NUMRERR on the disk.*
8. *SAVEROOT—enter listing 12, part 3 on the disk as a sequential file.*

The disk is now set up and ready to go. To run the program, get into BASIC and set up eight file buffers (MBASIC5 /F:8 for the Vector Graphic· computer). Then load POL-80 and run the program (LOAD "POL-80",R). Bring up NUMRANAL as the current mainline program (@PRG 'B:NUMRANAL'). Now you can begin using POL commands. Try this sample: "ROOTS, USING SECANT, EQUATION = 'Y=SIN(X)', START AT .5 AND 1, EXECUTE".

Several steps are required to add a module to NUMRANAL. First, enter the module onto the disk as NUMR____.BAS (replace the underlined portion with the module name). Be sure to use the ASCII format. Next, modify NUMRANAL.BAS to access the new module and add the keyword to VOCANUMR. Then enter the HELP message as NUMR____ on the disk as a sequential file. Run MAKEERR with the error list (see listing 5, part 3 for the format of the error list). Save the output of NUMERR on the disk. Put any special module file (such as SAVEROOT for ROOTs) on disk b. Once the programs are already on a disk, the actual process takes only 5 to 10 minutes.

Listing 7: *The MAKEERR program converts sequential files containing error lists into random files required by POL-80 programs.*

```
100 INPUT "SOURCE FILE FOR ERRORS";A$
200 INPUT "DESTINATION FILE FOR ERRORS";B$
300 OPEN "I",#1,A$
400 OPEN "R",#2,B$,80
    :FIELD#2,80 AS C$
500 INPUT #1,E%,E$
600 IF E%=9999
        THEN CLOSE #1
             :CLOSE #2
             :PRINT "DONE"
             :STOP
700 LSET C$=E$
800 PUT #2,E%
900 GOTO 500
```

Listing 8: *The VOCANUMR file contains the main command words for NUMRANAL.*

```
"HELP"
"VOCAbulary"
"ROOTs"
"CONTours"
"STOP"
```

Listing 9: *NUMRVOCA file.*

```
VOCAbulary gives the list of command words for
this particular module  This mainline module
ignores the following words
      A
      AN
      THE
      FOR
      IS
      ARE
      EQUAL
      EQUALS
      OF

It also ignores (considers as a space) commas and
the equivalence (=) sign.
```

Listing 10: *NUMRHELP file.*

```
HELP gives formats and assistance on the command
words.

The acceptable format is:

      HELP WORD

          WORD is one of the words listed by VOCA.
          ALL may be used after help to get
assistance on              all of the command words.

The format to get a printout on the list device
(typewriter, etc.) is:

      HELP WORD

Do not use this command (HELPL) if you have a
plotter hooked to the list devices or if you have
begun drawing using a Diablo-type printer
```

Listing 11: *SAVROOT file.*

```
"1508 Y=X*X*X:RETURN"
"1507 YPRIME=3*X^2:RETURN"
.0001,1,0,0,0,3,100,0,1,0,0,0,0,0,0,0,0
```

Listing 12: *NUMRSTOP file.*

```
STOP is used to terminate NLP-80.
```

is effectively modified (although not actually in FORTRAN), most decision making must be done in the modules. If there is sufficient interest, some of the results of this research can be included in a module for POL-80 to do the interactive linking.

Summary

Consider the advantages of the POL/PS system that have been presented:

- The mainline program can often be much shorter and easier to write and debug than other typical programs that are not POL/PS-compatible.
- A library of technical and graphics modules can easily be built up. Extended control structure gives these modules more flexibility, yet allows easier insertion into other programs.
- Packages of programs (such as numerical analysis or statistics with graphics) can be used by a person with little programming experience, yet the packages may be more powerful than similar non-POL/PS packages.
- Plotter compatibility is planned. Adapting the graphics modules to a new plotter requires only revising about four input/output routines and changing four parameters. Most plotters are supported.
- Input using POL is faster and more powerful than question-and-answer or menu input.

Conclusion

In presenting the POL/PS series, I have tried to develop a framework for technical programs that will offer advantages not only for the programmer, but the end user as well. The concepts of a problem oriented language, modularity, and the use of mainline programs are applicable to almost any technical field. The use of POL can encourage the use of microcomputers in scientific and technical areas, much as microcomputers are used in business and word-processing applications.

I intend to support and upgrade the system and encourage others to write their own applications using the POL/PS framework presented here. The Problem Oriented Language can become the problem-solving solution for you.■

References

1. Hilst, R. W. *Development and Use of GRIP, the Generalized Routine for Interactive Processing, in the Computer Solution of Chemical Engineering Problems.* Master's thesis, University of Kansas, August 1982.
2. Hilst, R. W. and K. A. Bishop. "Recent Advances in the Development and Use of GRIP—A Problem Oriented Language." *Summer Computer Simulation Conference*, pp. 29-35, Seattle, August 1980.
3. Hilst, R. W. and K. A. Bishop. "The Use of GRIP, a Problem Oriented Language, in Chemical Engineering Education." Presented at the 87th National AIChE Meeting, Boston, August 1979.

The following items are available from the ***author:***

1. *The* POL/PS User's Manual *and the* ROOTs User's Manual *for $20. These manuals generally supplement but do not duplicate the material presented here. Topics include detailed rules of input, theory and examples of operation, and programming rules and hints.*
2. *The two manuals above and a disk containing all the appropriate files for $30.*
3. *The items listed above and the graphics package (which includes the contour plotter module) for $200. The ROOTs module in this package will have additional graphics capabilities, such as plotting the equation and graphically following the root-finder as it seeks the root.*

These items will be offered on several disk formats (CP/M 8-inch, Osborne, and others as I can make arrangements). A user's group will be set up, and I will sell software written by others for the POL/PS on a royalty basis. For more information, or to order items, contact:

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Confessions, Pascal Prime, Wescon, and Perfect Writer

Our resident critic comments on Wescon and text editors.

Jerry Pournelle
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First a confession: I don't really hate Pascal. Indeed, I never did, as will become clear shortly. I have tried to keep an open mind about languages. Apparently that's not enough for some of my correspondents; just as LISP addicts don't want to hear about Pascal, Pascal lovers don't want to be told that anyone might consider CB-80—a form of *BASIC* for God's sake!—to be in competition with their beloved.

Nor, apparently, are they willing to believe there may be defects in the language. Sigh. But there are, and in a later section we'll look at something practical that can be done about them.

Second, a problem: BYTE has a long pipeline. I'm writing this in late September, for publication in the February issue. Much of the mail I've received (bundles and bundles of it; ye gods!) is in response to the September issue. But when you read this, most of you will have seen the October, November, December, and January columns and have totally forgotten about the issues raised in September: which is why I must ignore much of my mail. I haven't time to answer very many individual letters (John Carr does some, but he hasn't a lot more time than I do), and, given the pipeline, many of the questions asked will be moot before an answer can appear in BYTE.

E'en so, there's much of importance in my unanswered mail file; later on, I'll deal with some of that.

The BYTE pipeline is longer than I like; but there is a bright side. About two months before the magazine comes out, I get galley proofs of my articles; and provided that I'm not *too* wordy, I can insert a couple of last-minute announcements, letting these columns stay reasonably up to date. It's not an ideal system, but it's about the best we're going to get.

Zeke Lives!

Mark Twain had the extraordinary experience of reading his own obituary, after which he said, "The reports of my death are greatly exaggerated."

Fortunately, Ezekial, my friend who happens to be an ancient Cromemco Z-2, can say the same. After his trip to Tony Pietsch's place, he returned nearly as good as new.

Nearly: a faulty cable managed to short out an input/output board, which in turn rendered one of his bus slots inoperable; and we do have an annoying problem with the B disk drive. Tony says the disk problem could probably be fixed by lowering the entire drive system into a vat of TCE (a dry-cleaning solvent) and agitating it for a couple of hours; in the absence of that, we just live with "Please Close Drive Door" the first few times we try to access the B drive. The problem goes away after a few minutes' warm-up.

Update: last night Zeke died again, clobbering all his disks as he did. Today, in despair, I took apart the old iCOM disk system. Lo! I found that there's a bad cable that conveys the 5-volt power; this causes all kinds of weird results, including write operations when the computer is supposed to be reading. Tony Pietsch thinks this is fixable, and thank heaven! I'm just now writing this on the Televideo 950 terminal, and that misplaced Delete key, plus the obscene Back Tab key, will soon drive me out of my mind.

I mention Zeke's revival in part because my mail indicates considerable interest in his health, but in fact there's an illustrative lesson here.

This ancient machine—he was built some five years ago—is still plenty good enough for me to write this article with. When I first got Zeke, we had dying chip problems and a mysterious gremlin that required exorcism; but after the first couple of months, there just weren't any problems at all. Even now, the central machine is in good shape; all our recent problems have been caused by faulty cables.

This seems to be typical: once past the first few months, you shouldn't have any problems for several years. Then, all at once, like the wonderful one-horse shay, everything may collapse. Actually, the electronics could last for decades; it's mechanical stuff—disk drives, switches, fans, cables, connectors, etc.—that goes.

The problem is that five years isn't long in the life cycle of a typewriter; but it's an eternity for a microcomputer. By the time you need repairs on your ancient equipment, the manufacturer will no longer be making it, and it's likely that none of the technicians will ever have heard of it. This may change when machines begin to sell in hundreds of thousands per model; but just now it seems true enough.

I've no regrets. I've got a lot out of old Zeke, and he may yet last another couple of years; but computer purchasers should be warned: things are moving very fast, and that has consequences.

Meanwhile, I know of only one way to avoid the early (infant mortality) glitches, and that's to buy "used" equipment; that is, either stuff that's been burned in a lot, like Compupro's rather expensive CSC grade, or literally used equipment, if you can find someone reliable to buy it from. (One outfit sends out evaluation hardware with the understanding that they'll swap every month or so: that way they get back a thoroughly tested machine.)

The Pascal Prime Project

As I've mentioned before, one of our major projects was Alex's Pascal Intro. It was intended to be a simple little job, but it ended up taking most of the summer. It also had interesting fallout: in order to test it, I had to write a couple of fairly hairy programs in Pascal. One, a game called Imperial Trader, got out of hand, but eventually I finished it. While writing it, I learned more about Pascal than I'd intended to.

Conclusions first: once you get the hang of it, there's a lot to like about Pascal. My game, for instance, darned near wrote itself once I dreamed up the structure for keeping track of all the important game entities, such as players, planets, products including arms and drugs, prices of products on each planet, police and customs officers, etc. Pascal lets you define your own variable types; in particular, you can define *records* that let you put about 20 different items—some strings, some integers, some real numbers, and some arrays of other stuff—all in one variable. Thus, it's a cinch to get at all the vital data you want: read it, update it, play with it . . .

The best BASIC in the world can't do that. BASIC requires you to have a bunch of arrays, and you can't mix string, character, integer, real, and Boolean variables in the same array—much less can you have an array that contains subarrays the way Pascal records can.

I probably ought to quote Marvin Minsky (MIT computer expert) here: Marvin says that Pascal sacrifices programmer options in order to force programmers to write readable code. He's right, too; the question is whether the gain is worth the cost. I think so. Marvin doesn't.

Of course, Minsky is primarily interested in artificial intelligence, in particular in programs that modify themselves (and thereby are *intentionally* unpredictable in their results), while this column is mostly directed to people who want to use their computers to accomplish some definable result. For AI and hefty experiments in computer science, you need to learn a list-processing language, which in practice means LISP or a derivative; but for getting today's work done, I'm coming to the

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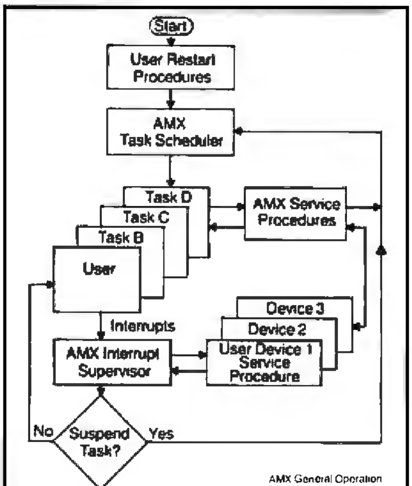

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conclusion that Pascal is my first choice.

However: for all its attractive features, Pascal has some very severe limits. I've discussed many of these before. The I/O system doesn't make sense, and Pascal thinks that the ideal file is a reel of magnetic tape; it has no provision for the kind of random access you can do with disks.

Some of Pascal's worst theoretical limitations have been overcome in practice, as compiler writers tuck in various nonstandard extensions. The problem with that is we're getting many dialects of Pascal, which severely limits our ability to transfer programs from one machine to another.

Fortunately, though, it isn't hard to overcome many of those limits. Compiler writers tell me they can continue to extend Pascal with little difficulty. The problem is to come up with a "standard" set of extensions, so that programs will remain more or less portable: and that brings us to Project Pascal Prime.

I've put together some extensions that look interesting; added to "standard" Pascal they create Pascal Prime, a user-oriented language. There will be a discussion of Pascal Prime during the West Coast Computer Faire; as a default case I'll be chairman, although I'm willing to hand that over to anyone better qualified who wants the job. Mostly, I want to bring together people interested in microcomputer Pascal and have a serious discussion of a "standard" extension package.

The meeting has already drawn promises of attendance from several of the major publishers of microcomputer Pascal compilers; if just those who say they're coming can agree, we'll have Pascal Prime de facto.

Candidate Pascal Prime Features

For those uninterested in Pascal, my apologies if the following gets more technical than you've come to expect from me; I wouldn't do it if I didn't think it important.

The first criterion for Pascal Prime is that we don't do *much*. One of Pascal's best points is that it isn't a complex language. We do *not* want to end up with something like the Department of Defense's new language, Ada. Ada was designed by a committee, and it shows; it has hundreds of "features," some absolutely obscure. Pascal Prime will, we hope, stay within the spirit of the original language.

Second, we want programs written in previous Pascals to compile under Prime.

Third, Prime is intended for microcomputers; but we'd like Prime programs to compile on larger systems. Changes will be needed, but we want to keep them to a minimum.

Here are some candidate extensions; discussion is invited.

1. STRING and LONG STRING data types. Most Pascal implementations have type STRING, which stores the string length as the first byte (BYTE 0). This can become standard (certainly type STRING is vital), but this method of implementation limits string lengths to 255 characters

on 8-bit machines. This is often annoying, and makes it difficult to work with text. If we had type LONG STRING, which would use 2 bytes for the string length, it would make things easier. (For larger machines, you make things portable by changing all the LONG STRING variables to type STRING—a moment's work.)

2. A default for the CASE statement. Again, almost all implementations have this feature although it was not defined in the standard. We suggest the reserved word OTHERWISE to follow the last case; OTHERWISE rather than ELSE to avoid confusion with IF statements.

3. The compiler should ignore the underbar (_) character, so that you can use variable names like fist_of_god and first_boy for clarity, but not have to remember the underbars when you just want to write firstboy.

4. Static variables: variables local to a procedure, but which don't go away when you exit the procedure. Seed for a random-number system is a perfect example: nothing outside the procedure needs to get at the seed, so seed shouldn't be global; but clearly it must stay around between calls to the random function.

5. Allow functions to return REAL and STRING values. Why shouldn't they?

6. The lack of a BREAK statement needs discussion; see my November column. It's desirable to have a way out of a loop without keeping track of dummy variables, but BREAK can be abused. We probably need one, but it should be tamed considerably. Design of a BREAK that fits into the spirit of Pascal needs some thought.

7. Ucase and lcase, which convert strings to uppercase and lowercase respectively, ought to be standard procedures (or functions if we can get functions to return strings). They're often needed, and the usual function writer slows things down a lot when writing these.

8. Do we want dynamic arrays (redimensionable during run time)? They are convenient, but they're somewhat against the spirit of the language. The lack of redimensionable arrays has annoyed me from the time I first began to study Pascal.

9. We definitely need standards for separate compilation and for "include" statements. Using pseudocomments, such as {$I+} and the like, is currently done in most microcomputer Pascal implementations, and although a bit ugly, is acceptable; what's needed is a standard way of implementation.

10. The ISO Standard Pascal permits files almost anywhere. They are particularly necessary in records. Of the microcomputer implementations, Pascal MT+ allows files in records, while most, including UCSD Pascal, don't. It's important to have files in records, because it makes disk operations so much easier.

11. Constant definitions ought to permit elementary arithmetic. Complex arithmetic in the CONST declarations shouldn't be allowed, but foo = 5; foobar = foo + 3; definitely ought to be permitted. You certainly should be able to say bell = chr(7).

12. Pascal should permit you to read and write enumeration types. That is:

```
TYPE
     day = (monday, tuesday,
            wednesday, thurs-
            day, friday, satur-
            day, sunday);
VAR
     today : day
```

and later in the program, the operation

```
today := tuesday;
write(today);
```

will fail. This is monstrously inconvenient, requiring you to have an array of day names (which you can name dayname), and then write dayname[ord(today)], which is awkward at best.

13. There ought to be ways for a programmer to set up a stack and get at it. This needs thought lest it make

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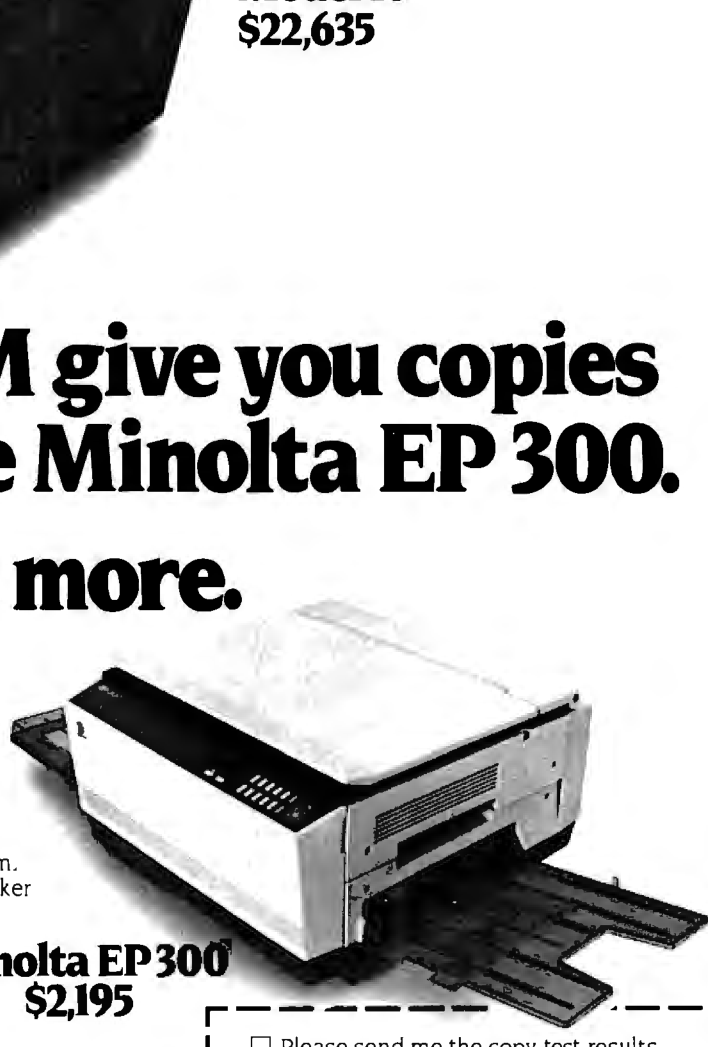

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14. We need a way to put variables in a specific place in memory and to reserve blocks of memory. This will of course be machine-dependent, but it's very desirable, especially if you have memory-mapped video.

There are probably other desirable Pascal extensions. The criteria are that they stay within the spirit of the language, that they be easy to use, and that they don't make the programs unreadable. They should also be reasonably easy to implement.

The above have received widespread agreement among those I've spoken with, including compiler writers. Other candidate extensions, particularly some that would make Pascal more suitable to use for writing operating-systems programs, are likely to be more controversial and will need considerable thought. Some of those will be detailed next month. The idea is to get an agenda for the meeting at the West Coast Faire.

Wescon and Mini/Micro

Wescon, September 14-16, filled the Anaheim Convention Center with more than 70,000 attendees. The Mini/Micro conference was held at the same time in the Disneyland Hotel. It attracted better than 10,000, plus a large number of Wescon attendees.

Wescon features high-technology components; I didn't spend much time there, although if I were trying to predict the future of the microcomputer world, I might have gotten some insights. I suppose the equipment on display will be in next year's systems, and I expect Ciarcia would have been fascinated.

I spent what little time I had at Mini/Micro, where several systems stood out. For me, the hit of the show was the new Heath/Zenith Z-100 computer. Readers may recall that I'm not much enamored of the IBM Personal Computer (incidentally, IBM wasn't at Mini/Micro). I don't like the Personal Computer because the bus isn't standard and the keyboard is badly designed.

Comes now Heath/Zenith: its product is what amounts to the Personal Computer on a six-slot (five slots free in the 128/192K-byte system) S-100 bus and with a good keyboard. The Z-100 is a dual-processor 8085/8088 system. It has both black-and-white and color display drivers (no monitor) built in as standard features; all this for slightly more than $4000. You have to buy your own monitor, from a $150 green-and-black to about $800 for color.

The keyboard is very nice: an IBM Selectric layout with enough extra keys to make the full ASCII (American National Standard Code for Information Interchange) character set, plus Control and Escape keys and programmable Function keys. All keys have automatic repeat but with a twist: a "hyperspace" key makes auto-repeat *really* fast.

There's more. The Z-100 comes with dual 5¼-inch disks that read and write IBM Personal Computer format (as does my Compupro); the Z-100's disk controller will also talk to 8-inch disks, meaning that all you need do is connect 8-inch drives with a standard cable and you have both disk-drive sizes up and running, and you can copy files from one to the other using PIP.

There's not a lot new in the Z-100; but it's an excellent implementation of what it is. (Bill Godbout was overheard to mutter that the Z-100 is one of the nicest machines his Compupro team ever designed.)

Heath will sell you both CP/M-86 and MS-DOS in a package with some other programs for about $500. It also gives you extensive documentation about the machine. I'll have more to say on the system next month; I'm strongly thinking of getting one, and we're talking to Steve Calkins of the Central Los Angeles Heath Electronic Center. The only negative feature I noticed was that there's no detachable keyboard; that is, the monitor is separate, but the machine itself has the keyboard built onto the main computer. In profile, it reminds me a bit of the old Sol computers. That can make for mild space allocation problems, especially here in Chaos Manor where we're up to our clavicles in computers.

I also saw the new DEC Rainbow Personal Computer. Like the IBM, the DEC keyboard has those extra keys between the Shift and the "Z" and "/?" keys. The DEC salesman said, "There's a standard about to be adopted, and we *do* try to be reasonably standard." This "standard" comes from Europe. If it really took over here, every American touch-typist would have to learn all over again. I refuse. Fortunately, I suspect I can trust the marketplace to give me a "nonstandard" keyboard I can live with.

The Rainbow has a lot of extra keys, but no Escape key; the salesman said this was to avoid intimidating secretaries. I find that attitude, combined with use of a non-American keyboard, rather interesting.

I didn't get to spend a lot of time with the Rainbow. I'm sure there were a lot of things to like about it.

Adelle Again

One reason I went to the Mini/Micro show was that Greg Decoteau of CTI Data Systems had promised to fix Adelle, my Otrona Attache. She wasn't working because I'd foolishly exposed her to an inadequate voltage converter in Rome.

"Bring it to the show," he'd said. "I'll take care of it there."

This didn't seem very reasonable, but it did promise to be interesting, so I brought the Attache to the show.

Set the scene: a booth with about 20 feet of frontage and 8 feet of depth. Several Attache computers, plus a Mannesmann Tally line printer, on display. Hundreds of people wandering past, looking over Greg's shoulder, asking questions.

And in 16 minutes, 14 seconds, Greg took the Attache apart, disconnected the power-supply unit, installed a new power-supply module, reassembled the computer, and turned it on. It worked fine. And he did all that using a Phillips screwdriver from one of those 89-cent tool sets.

Incidentally, the Otrona still knew the time and date, which had been set back at Chaos Manor before I went to Italy. There's a battery backup for that part of the Attache, so loss of

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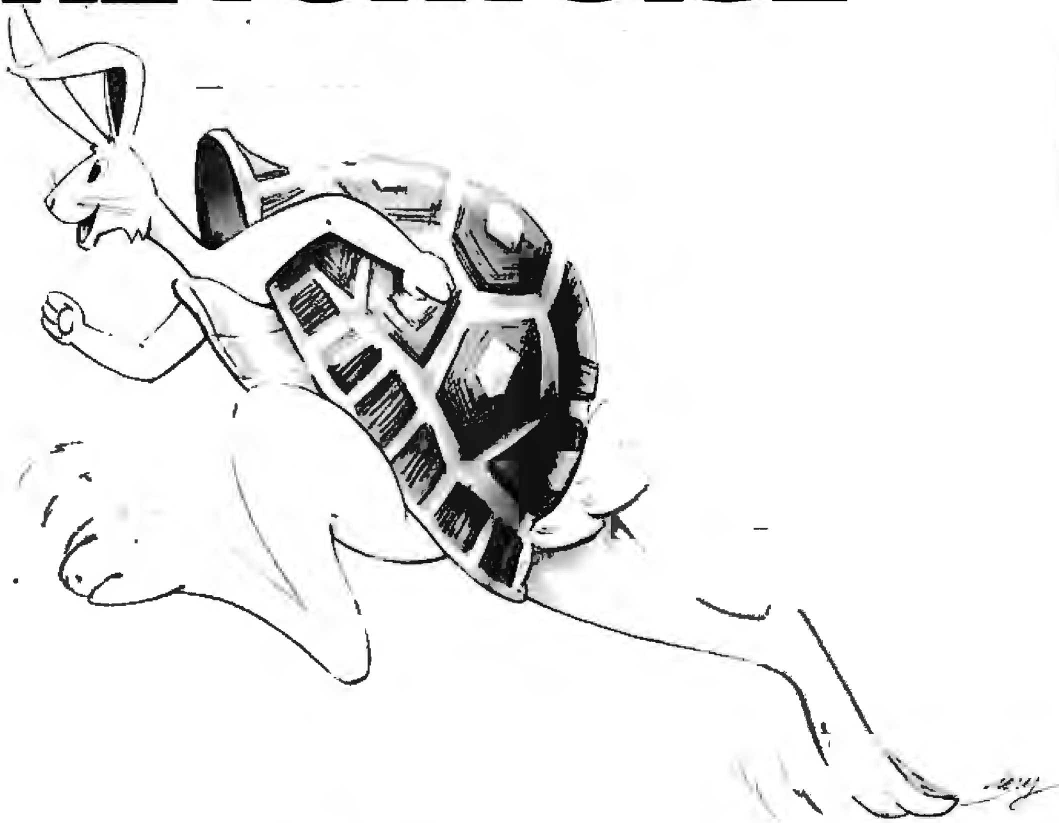

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power (or of the whole power supply) doesn't cause it to forget.

The machine was under warranty, so any dealer was authorized to repair it. (CTI isn't actually a dealer, it's in charge of marketing the Attache, and a number of other high-quality products, in Southern California; but in this case CTI acted as a dealer would.) The Attache is built in modules (it was quite interesting to see the innards); dealers have modules, and service consists of replacing modules until the machine works. The dealer doesn't have to know much about electronics—Greg Decoteau doesn't. He's a marketing man.

The results are impressive.

Now that I've got it running again, I've found more to like about the Otrona. The Valet alarm feature is very handy, the graphics are really lovely, and one of these days I'll find a use for the Greek-letter character set that's hidden in there underneath one of the nicest Roman-letter sets I've seen.

There's even a calculator pad. If you hit Control-Shift Lock, the "U," "I," and "O" keys become number keys, while the "P" becomes a "plus," and other interesting transformations take place. You can get key tops that show this (although I don't have them yet). I suspect this is more a gimmick than a feature I'll use often, but it does make it very clear; the Otrona's keyboard can be completely reprogrammed. You could, I suppose, even introduce a Dvorak keyboard as an alternate feature.

Of course, the Kaypro II comes with a full number pad as extra keys.

Yeah, But You're Different . . .

One chap at Mini/Micro said he reads my columns and likes them, but wonders if I don't get better service than the average customer.

That may be; although I try to have my machines taken in by one of the boys, or a student, many of the dealers know my equipment, and I'd be naive if I didn't suspect that a BYTE columnist is likely to be given more attention than a walk-in.

There's not much I can do about that. I have to report what happens to me, and I can't do much more than that. I don't have the resources to run undercover investigations.

I do pay a lot of attention to *detailed* accounts of problems with software and equipment I've recommended in this column. I can't be the microcomputer world's ombudsman, but I can sometimes be the next best thing because I do know a lot of people in the computer business, and if I forward a letter it will usually be read. More than that I can't do.

Text Editors and Perfect Writing

This started as a review of Perfect Writer, and ended up with a lot about editors in general.

I've mentioned EMACS before. That's the text editor developed at MIT for use on its PDP-11s and other "big" machines. Many years ago, about the time Larry Niven and I got computers, we visited MIT and were given copies of the EMACS documentation. It included pages and pages of commands, so many that I was a bit intimidated. I showed it to my mad friend, who shuffled through it for a few moments and laid it aside without comment.

"Not interested?" I prompted.

"What's the point?" Mac Lean asked. "You won't get that running on *our* machines."

That situation has changed. At least two EMACS-like editors are now available for microcomputers: MINCE (MINCE is not complete EMACS), which I reviewed last year, and Perfect Writer, which isn't complete EMACS either, but is a pretty healthy subset of it.

What Took You So Long?

I'm probably not the best person to evaluate text editors for several good reasons. First, I'm not really the typical user of editor programs. I use text editors for three purposes: writing programs, writing letters, and creative writing. I spend most of my time on the third task, and if a program doesn't work for *that*, I don't really care much about how good it is at writing letters.

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For programming I use Wordmaster, and I've yet to see a better editor for that purpose. For letters I use whatever editor I use for creative writing, which may be a mistake, because my favorite editor isn't designed primarily for writing letters, and there may be some that are better for that purpose. (Tony says not so: that his latest version of WRITE will do the job beautifully.)

But my major need is for a "creative writer's editor." Indeed, the reason I bought a computer in the first place was that I'd seen Electric Pencil in operation down at a company that then called itself Computer Power and Light (it's now known as COMPAL). When I saw Electric Pencil, it was love at first sight. Pencil was shot through with terrible problems, but I didn't care. You can't imagine the joy I felt when I realized that I would *never have to retype a whole page again!* I could put up with all of Pencil's misfeatures (and plain bugs) forever just for that.

When I introduced my collaborator Larry Niven to the joys of writing with computers, he felt the same way. What did we care if Pencil wasn't very well written? For us it worked.

Fortunately, Mac Lean and Tony Pietsch weren't so easy to satisfy. They persuaded us to keep a log of things Pencil did that we didn't like and things we wished it would do that it didn't do. After about two years, Tony began writing a program that would take care of our problems, and in another year he had one he was willing to give us. That was WRITE 0.3; I am now using WRITE 1.6, while Larry, more conservative than I, is still using WRITE 1.51 or thereabouts. Either beats the stew out of Electric Pencil, and for a number of reasons WRITE is, in my judgment, the best *creative writer's* editor in existence—and that includes all machines, mainframes and minicomputers as well as microcomputers.

Just about a year ago, Tony was persuaded to market WRITE, and after he spoke to a number of companies, settled on Ashton-Tate. Now being published by Ashton-Tate is a big deal. It doesn't do things by halves. It doesn't release stuff that isn't pretty solid, nor will it publish something that isn't expansible. It wants to compete with *everyone*.

Ashton-Tate can probably do that, too; but in order to make WRITE compete with all the other editors, it had to have features that neither Larry nor I ever dreamed of. That has taken time. Lots of time, more time than I ever thought it could take. Eventually I got worried, because I've mentioned WRITE in these columns and I get lots of mail about it, and all I can say is real soon now, which isn't much of an answer. So I have tried to persuade Ashton-Tate to release an early version of WRITE, one not so studded with features but intended primarily for creative writers. I hope this will happen, and maybe by the time this is in galley I'll know when.

What Do You Mean, Writer's Editor?

For me, the primary requirement is that an editor must be *transparent*. When I'm writing I don't need distractions. I don't want my editor telling me things I don't need or want to know. In fact, I don't want to see *anything* up on that screen except my text. In particular, I *hate* it when the editor natters at me. Wordstar, for example, wants to tell me the line and column number every time I press a key. Why, I don't know. It isn't information I often need, and surely if I do need it I can ask for it.

Next, I want the editor to be like an "electric pencil"; that is, I want to be able to move the cursor *rapidly* across the page and write over the wrong words, insert new words, move stuff around, exactly as I did when I used a red pencil on my paper typescripts. (Then I had to retype the page. Ugh.) And I want to do all this without thinking about it.

That means I want *cursor-oriented* commands. When I'm editing on paper, I don't move the pencil forward by sentences, I just move it. And I particularly don't want to have to remember a huge slew of commands in order to get my work done. It's nice to have a lot of special features, but I want the simple, easy-to-remember commands reserved for the stuff I do all the time.

Of course, I've described the "philosophy" of Electric Pencil and WRITE, which works like Pencil with the bugs removed.

There are, however, different views of what makes a perfect editor.

Perfect Writer

At long last, then, we can look at Perfect Writer.

Perfect Writer has many of the strengths and weaknesses of its parent EMACS. However, one of EMACS' strengths is not present: EMACS has online HELP features. If you're fairly sure there's a command that will do what you want, you can always ask, and generally EMACS will tell you. Alas, that's not present in Perfect Writer. I'm not sure why. WRITE has extensive HELP features.

Perfect Writer has cured one of EMACS' problems. At least in early versions of EMACS, the carriage return and linefeed that together make a NEWLINE character in the ASCII character set were treated as two different characters; and since commands in EMACS and Perfect Writer are *character-oriented* rather than position-oriented, the Control-f (move cursor forward one character) command did strange things at line ends, as did backspace. Perfect Writer doesn't have that problem, and the cursor moves at line ends exactly as it does anywhere else.

However, Perfect Writer retains all those character-oriented commands. You move forward or backward by lines, and because you must explicitly reformat your text (Perfect Writer, EMACS, and Wordstar are alike, and unlike Pencil and WRITE, in this regard), if you've made insertions, deletions, and changes in a line of text, what Perfect Writer thinks is a line can surprise the heck out of you. I have no doubt you can get used to it, but I'm not keen to.

One other thing I don't like about Perfect Writer is that it uses the kill buffer to move text. That is, whenever you delete anything larger than a single character, Perfect Writer stores that in a last-in/first-out stack, and the command Control-y (for yank) will get it back out for you. This makes undo or unkill easy in

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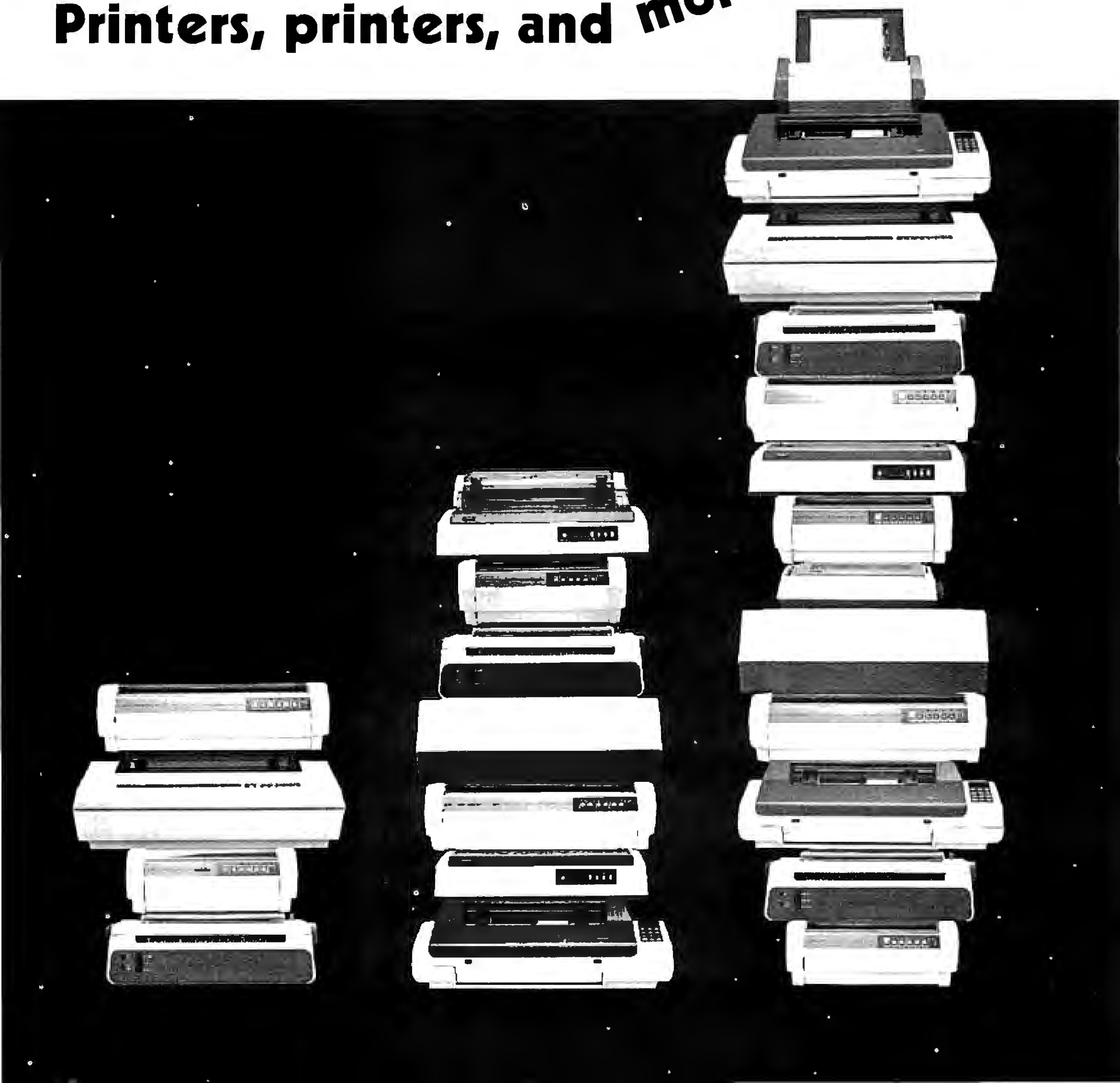

both EMACS and Perfect Writer, so that if you've accidentally deleted something it's no problem; a feature we don't have in present versions of WRITE, and one I've sometimes wished I had.

I don't wish for unkill enough to pay the price, though: which is that you can't easily move text about, because the buffer is often jammed with "killed" text that refuses to stay dead. This, however, is a personal preference, and I understand that a lot of people *like* using the kill buffer as a text mover.

The final blow, though, is that Perfect Writer natters at me worse than Wordstar. Now it *may* be a function of my Televideo 950 terminal, but I don't think so. Perfect Writer keeps track of all kinds of stuff, and every time you give it a command, before it goes off to execute it, it has to tell you down on a status line what it's about to do; it also tells you what percent of your text is below the cursor, and it updates that with *every keystroke* so that it flickers like a madman's dreams.

That cursor jumps around like a kangaroo, more than enough to discourage any signs of creativity in me. Of course, I'm always looking for a good excuse not to write; like most professional writers, I hate writing. (I love to *have written*, but that's a different matter entirely.) But I tell you, that jumping cursor is enough to drive me stark, staring mad.

It gets worse, too. Perfect Writer, like EMACS, is normally in the Insert mode: when you type text in the middle of a line, it moves everything to the right each time you type a letter, rather than overstriking the text. It says it has an "Overwrite" mode, which you can get to by going Control-x m and then writing the word overwrite. (In both WRITE and Electric Pencil, you simply toggle from Overstrike to Insert mode by doing Control-f; in WRITE, the cursor changes to show what mode you're in.)

Perfect Writer not only makes it darned hard to get from Overwrite to Insert mode—and I tend to use Overwrite a *lot* because it's very convenient for touch-typists—but in fact the Overwrite mode doesn't even work. That is, I go Control-x m overwrite and the display changes (Perfect Writer always tells you what mode you're in whether you want to know it or not; there's no way to suppress the annoying Mode Line and "Echo Line"); but although the display now tells me I'm in Overwrite mode, what happens next isn't very predictable. For one thing, backspace, which used to backspace, is now destructive, although there are places within the text where the destruction doesn't show up until later.

I don't want my keys to change their functions. I like consistency.

There are other problems. For instance, suppose you are in Insert (normal) mode, and you type a couple of extra spaces. Those spaces are now in your text. You can't see them, but they're there. And if you backspace, the cursor jumps around

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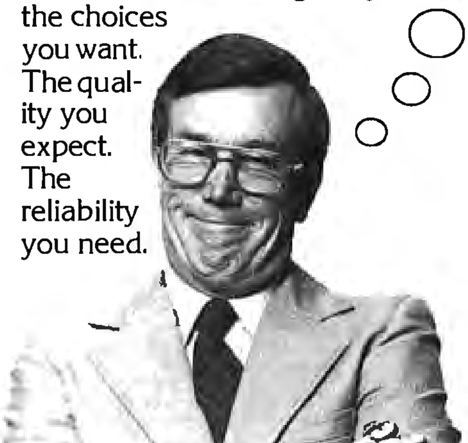

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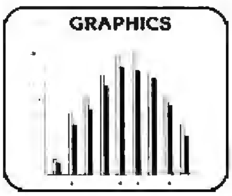

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with a funny monkey motion that won't go away until you've done a carriage return, or maybe killed to end of line (putting those superfluous backspace characters into the kill buffer, I suppose) . . .

In other words, I don't much care for Perfect Writer, for the same reasons I didn't like MINCE and I don't like EMACS. Yet for many of the same reasons I *don't* like EMACS-type editors, there are those who very much *do* like them. Some people want character- and word-oriented commands, text movement by kill buffer, Insert as the normal mode, and all the rest.

I don't like the editor because it's distracting. Perhaps I haven't given it a fair chance, but I don't think that's true. I've worked with it—and with EMACS—enough to have a pretty good feel for that kind of editor, and my conclusion is that I have to pay too much attention to the *editor*, so that I don't pay enough attention to my writing. I don't want to think about my editor and its features; I want to think about the sentences I'm writing.

Those who'll use an editor primarily for programming, or for writing letters, might well have a different view.

There are plenty of features to Perfect Writer. It has far more commands than I have with WRITE (more than I'd ever bother to learn). It has split-screen capability, whereby you can look at and edit more than one file at a time.

It has very clear documentation. It took me almost no time to get Perfect Writer up and running on my system and get to editing a file. Now of course I know text editors in general, and I've used EMACS rather often, so perhaps that isn't surprising, but in fact the Perfect Writer documents are impressive.

There's also a spelling program that comes as an option with Perfect Writer. I haven't tried it, but it looks clean and easy to learn and I'm sure it's efficient. The documents are clearly written.

There are also lots of print-format features; I can't really compare them with WRITE (or any other editor)

Items Reviewed

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Heath/Zenith Z-100 Computer Heath Company Benton Harbor, MI 49022 (616) 982-3200	**$4099**
Pascal Prime Project Alexander Pournelle c/o Workman & Associates 112 Marion Ave. Pasadena, CA 91106	If you are interested in this project, you can write to this address.
Perfect Writer Perfect Software Inc. 1400 Shattuck Ave. Berkeley, CA 94709 (415) 644-3644	**$495**

because I don't use those much. Most of my printing is pretty standard-60-character lines, double-spaced, identifying header, and page number; hardly a proper test for a text formatter's capabilities. From what I get out of reading the manuals, most of the text editors have some pretty fancy format capabilities.

They tell me that a number of new computer-system manufacturers are considering Perfect Writer as the text editor to provide with their hardware. They could make a worse choice.

The Things My Postman Brings Me . . .

I mentioned last month my friend Max, who sent his CCS boards back to the factory only to be told that while the boards were in transit, CCS had changed its policy and no longer sends loaners. I've found out why: according to a source at CCS, it sold the loaner boards at a swap meet.

CCS did fix Max's machine; but it wouldn't send his boards back to him until it had his payment for repairs in its office. (His machine had only about 20 hours in operation, but because of all the delays in trying to get it running, the warranty had expired.) Eventually he got his boards, and the machine works.

Max isn't happy. He says, "The more I thought about it, the more I became sure that I should stand up for my rights as a consumer. I called CCS one more time and asked to speak with the president of the company. According to the CCS receptionist, CCS has no president . . ."

When we got our CCS machines (for Alex and Dr. Possony), we dealt with systems consultant Colin Mick, whom I've mentioned before; and we've had no real problems. I know of many other CCS installations that run smoothly. Alas, though, Max's horror story is not the only one I've heard about what can happen if your CCS doesn't work.

And now, finally, my hate mail, typified by letters from Cherry Davis of Chicago and Ward Harold of Pennsylvania. Why, they (and others) ask, do I not learn the "spirit" of Pascal? Don't I know that "a significant teaching of the structured-programming movement was that the programmer should not even try to compile a program until he has convinced himself that it is free of bugs"? Obviously, I have not "given Pascal much of a chance. If you are still making trivial errors . . . you probably have not spent enough time with the language to really be comfortable with it."

Ms. Davis goes on to inform me that "you tend to confuse evaluation of a language with evaluation of an implementation of a language . . ." She concludes that I ought to "turn over the project [Alex's Intro package] to someone who has enough experience in Pascal and with microcomputers to write a book from the ground up for teaching Pascal on microcomputers."

Meanwhile, Mr. Harold tells me that I exaggerate when I say Pascal has obscure errors and faults, because "all possible errors for an ISO, or Jensen and Wirth, standard implementation of Pascal are listed in the *Pascal User Manual and Report* . . ."

Yeah. They sure are. Unfortunately, there is no ISO, or Jensen and Wirth, implementation for microcomputers; furthermore, every compiler I know of tends to have pet error messages for the cases when the compiler was just plain confused; and often those messages have no relationship at all to the real error.

In fact, one of the most significant parts of my son Alex's Pascal Primer (down at UCSD it's becoming known as the survival kit) is that he goes through the error messages and shows examples of what might have caused them. Without that, I'd have given up on the language long ago.

Davis and Harold want me to consider the language separately from the implementations—but I just can't do that. Despite a lot of flack to the contrary, this is the User's Column. It has to be, because I'm no computer scientist. I *use* these machines, and I try to record my experiences; once in a while, those experiences may lead me to some theoretical insights, and they certainly tend to generate strong opinions; but there's no way I can evaluate Pascal—or any other language—separately from my experiences in trying to *use* it, which means I'm inevitably going to confuse the language with its implementation.

However: for a User's Column, that's not a bug, it's a feature. I like little computers, I've been using them for a long time, and I like talking about what you can do with the little beasts. I leave computer theory to Edsger Dijkstra and others far more qualified than I am. ■

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LDOS Utilities

Expand the capabilities of this popular disk operating system.

Tim Daneliuk
T & R Communications Associates
4927 North Rockwell St.
Chicago, IL 60625

In this article, I'll review six utility programs that were designed specifically to run under LDOS (Logical Systems' disk operating system). FED, Filter Disk, Partitioned Data Sets, I/O Monitor, Memdisk, and Discater all enhance LDOS significantly, making it by far the best-supported DOS for the TRS-80 Models I and III. This is in part because the original authors of LDOS wrote most of the programs (FED, Filter Disk, and Partitioned Data Sets).

FED

FED (File Editor from Logical Systems Inc.) is a general-purpose file-oriented disk editor, which does not manipulate the disk at a sector or track level but rather at the file level. FED enables the advanced programmer to deal with disk files directly as they reside on the disk.

On entering the FED environment, you can choose between seeing a full-sector (256-byte) or a half-sector (128-byte) display. Either display is available at any time, but I prefer the half-sector display because it is more readable. These displays show each byte in a selected record of the disk file in both hexadecimal and ASCII (American Standard Code for Information Interchange). The displays include such information as the record number of the file being examined and the relative byte position within the file at which the cursor is pointing. The current command and any related information such as search strings are also displayed.

Each utility program helps make LDOS the best-supported DOS for the TRS-80.

Once you have named the file to be edited and selected the display mode, you will have available a variety of commands. FED offers a full complement of record position controls. You may move forward or backward one record, set the display to the beginning or end of a file, or go to a specific record number within the file. Once the record has been found, you can position the cursor over the specific byte and modify it by typing over the existing value with either hexadecimal or ASCII data. You can also have the program search for a specific hexadecimal or ASCII string, thereby enabling you to find one or more occurrences of a particular string in the file.

FED also has provision for explicitly dealing with the *load module format* found in LDOS-executable (/CMD) files. You may locate and calculate a hexadecimal load address and go to the next load block in a file. You can also convert a user-specified word in the file to its binary representation. Finally, FED has several printer-related commands: an entire file may be dumped to the printer, a top-of-form command may be sent to the printer, or just the contents of the screen edit buffer may be sent to the printer.

About the Author
Tim Daneliuk is an electrical engineer involved in research and product development for the medical electronics industry. T & R Communications Associates is a company he founded to provide technical writing and consulting services for the electronics industry.

At a Glance

Name
FED

Type
General-purpose file-oriented editor

Manufacturer
Logical Systems Inc.
11520 North Port Washington Rd.
Mequon, WI 53092
(414) 241-3066

Price
$40

Format
5¼-inch floppy disk

Language
Z80 machine language

Computer
TRS-80 Models I or III running under LDOS

Audience
LDOS owners

FED will be popular with the assembly-language programmer who wishes to make minor modifications to an assembled file. FED is efficient and user-friendly.

Filter Disk

Though LDOS comes with several useful I/O (input/output) path filters, these do not even begin to fully exploit LDOS. The Filter Disk package (from Logical Systems Inc.) provides you with 14 filters and, as an added bonus, assembly-language source code.

The most impressive filter is XLATE/FLT, which is a complete translation filter system and can be used for both input and output filtering. With XLATE, you can translate any or all of the ASCII characters to any other code by building a translation table using either the LDOS BUILD command or a word processor capable of generating ASCII files. You can enter the translation table values as hexadecimal numbers (e.g., 1F=2D) or as literal characters (e.g., W=r). You can also specify whether the translation in the I/O path is to take place during output, input, or both. You could, for example, write a translation filter that converts the ASCII character set to the BCD (binary-coded decimal) codes used in an IBM Selectric typewriter.

Logical Systems included two tables with this filter. One performs a translation from ASCII to the EBCDIC (extended binary-coded decimal interchange code) used in many mainframe computers. You might use this filter on the communications line to enable a TRS-80 using the LDOS LCOMM communications program to access a mainframe computer. The second translation table implements the Dvorak keyboard on the TRS-80 instead of the common QWERTY.

Several filters are included that are useful for printing or listing data and programs. LISTBAS/FLT formats a BASIC program, so that each statement within a multistatement line is indented and listed separately. This will give you a better idea of program structure. STRIP7/FLT removes the high bit from each character, a feature that is useful in listing files created by some editors that use the high bit for control information. This changes all characters outside the normal ASCII range into ASCII characters. STRIPCNT/FLT removes all control characters in an I/O path. One application of STRIPCNT/FLT is in listing word-processor files on the video screen. By eliminating the control characters, the program makes the file more readable.

With TITLE/FLT you can place a title at the top of each page in a printed program listing. You may optionally have a time and date appended to the title. You can convert all lowercase characters to uppercase and vice versa with UPPER/FLT and LOWER/FLT. You could convert uppercase text files to lowercase and use a word-processor program to manually capitalize the beginning of sentences, proper nouns, etc. SLASH0/FLT will be popular with owners of daisy-wheel printers because it issues a backspace and slash (/) after every zero character to distinguish it from the letter O. Daisy-wheel users will also find PAGEPAWS/FLT useful; it causes the printer to pause at the end of each printed page to allow a new sheet of paper to be inserted. Though incorporated in the printer filter provided with LDOS, a separate linefeed filter, LINEFEED/FLT, is also included on the filter disk to add or remove a linefeed after a carriage return. The filter on the disk occupies less memory, an advantage for those who do not need all the features the printer filter offers.

At a Glance

Name
Filter Disk

Type
A set of 14 I/O software filters to supplement those included with LDOS

Manufacturer
Logical Systems Inc.
11520 North Port Washington Rd.
Mequon, WI 53092
(414) 241-3066

Price
$60

Format
5¼-inch floppy disk

Language
Z80 machine language (source code included)

Computer
TRS-80 Models I and III running under LDOS

Audience
LDOS owners

The remaining four filters serve a variety of purposes. MONITOR/FLT will change every control character in its I/O path to an alphanumeric symbol, and every character above hexadecimal 7F to an up-arrow (or left-bracket on some printers) character. MONITOR/FLT is similar to STRIPCNT/FLT except that MONITOR/FLT indicates which control characters are being sent to a particular device. The TRAP/FLT filter can prevent any one character from being sent through an I/O path. You might use this filter while listing disk files to trap a character that causes a dot-matrix printer to change the font sizes. Similarly, REMOVE/CMD will remove all occurrences of a particular byte in a disk file. Finally, the keyboard filter CALC/FLT will do hexadecimal/decimal/binary conversion and hexadecimal arithmetic while you are us-

At a Glance

Name
Partitioned Data Sets

Type
A file-management system that reduces the amount of disk space required for storage

Manufacturer
Misosys
POB 4848
Alexandria, VA 22303-0848
(703) 960-2998

Price
$40 plus shipping

Format
5¼-inch floppy disk

Language
Z80 machine language

Computer
TRS-80 Models I and III running under LDOS

Audience
LDOS owners

ing another program. I incorporated this filter into my normal LDOS operation and find it particularly useful when writing assembly-language programs. It permits me to do the necessary base conversions and arithmetic right from the editor-assembler environment!

It is no great surprise that the Filter Disk is an excellent piece of software since it comes from the manufacturer of LDOS. The documentation is thorough, and the filters very usable.

Partitioned Data Sets

Partitioned Data Sets (PDS, from Misosys) is an interesting add-on file-management package for LDOS. The basic idea for PDS comes from minicomputer operating systems in which many small programs or data files are stored together in one disk file. The entire file is called a *library*, and each program or data set in the library is called a *member*. If each member were saved as a separate file, a lot of disk space would be wasted because the DOS has a minimum file size of 1 granule (1.25K bytes on a Model I and 1.5K bytes on a Model III). By combining small programs into one library, you can conserve disk space.

With the implementation of PDS in LDOS systems, two types of files can be library members: executable (/CMD) or data files. The type of executable file PDS will accept is limited, however. First, a /CMD file must be in the proper LDOS load module format. If it is not, PDS will store it as usual, but when you try to execute that member, PDS will think it's a data file and generate the error message Load Module Format Error. The PDS manual mentions this problem but does not go into any real depth on fixing it. For this reason, PDS really should be regarded as a program for the more sophisticated user.

Another limitation of PDS is that LDOS filter programs that are stored in a library cannot be used. They must be copied from the PDS to a regular stand-alone filter file in order to be used in a FILTER command line. Similarly, data files are accessible only after they have been copied from the PDS into a standard LDOS data file.

PDS offers a great deal of versatility not normally found in microcomputer file management.

Despite these limitations, PDS is a very useful program. Its three main functions are to permit available disk space to be used more efficiently by combining files into a library, to simplify the process of making archival backups of crucial data, and to simplify and unclutter the disk directory by having files that are related stored in one PDS library. For example, I created a PDS library that contains my assembly-language development tools: an editor-assembler and two disassembler programs. They are all accessible to me as usual (all are /CMD-type files), and by putting them into one library, I freed up 1.5K bytes of disk space!

At a Glance

Name
I/O Monitor

Type
A program designed to intercept disk error messages and allow user-selected recovery options

Manufacturer
Logical Systems Inc.
11520 North Port Washington Rd.
Mequon, WI 53092
(414) 241-3066

Price
$25

Format
5¼-inch floppy disk

Language
Z80 machine language

Computer
TRS-80 Models I and III running under LDOS

Audience
LDOS owners

The PDS program is itself a partitioned data set with eight members, which constitute the necessary programs to create and maintain PDS structures under LDOS. The BUILD command is used to create new partitioned data sets. Once this is done, members are added using the APPEND command. It is possible to determine what files are in the PDS and whether they are data or /CMD by using the DIR command. The LIST command enables you to list any individual member in a PDS library in either hexadecimal or ASCII. The KILL command leaves the member in the PDS but makes it unavailable for access. The COPY command transfers a PDS member to a regular LDOS /CMD or data file. The RESTORE command is used with files that have been killed to make them available again, while PURGE is used to actually remove killed members and reclaim the disk space.

PDS offers a great deal of versatility not normally found in microcomputer file management. The thorough documentation and features of PDS make it useful for most intermediate and advanced TRS-80 programmers.

At a Glance

Name
Memdisk

Type
Creates a pseudodisk in memory that can be used like a physical floppy-disk drive

Manufacturer
Logical Systems Inc.
11520 North Port Washington Rd.
Mequon, WI 53092
(414) 241-3066

Price
$39

Format
5¼-inch floppy disk

Language
Z80 machine language

Computer
TRS-80 Models I and III running under LDOS

Audience
LDOS owners

I/O Monitor

This program (from Logical Systems Inc.) is an error monitor designed to intercept errors generated during disk read or write operations. Normally when these kinds of errors occur, the screen displays an LDOS error message, and the program currently running aborts. With I/O Monitor installed, the error is intercepted, and you are notified as usual. Then you are given four choices: abort the program, continue the program, ignore the error, or retry the disk operation that forced the error. In this way, you have some chance of recovering from the error, or at least minimizing the damage done.

This program will find particular favor with owners of the TRS-80 Model I expansion interface. The disk controller is notorious for I/O errors, and I/O Monitor will make handling these errors much simpler and efficient.

Memdisk

The program Memdisk (from Logical Systems Inc.) sets up a pseudodisk drive in the TRS-80 memory. That part of memory is then treated like a physical floppy-disk drive, and the normal LDOS library commands can be used to access the "memdisk." This capability offers two advantages: first, it provides an extra disk drive to back up and copy files from one nonsystem disk to another. Second, because the memdisk is in memory, disk accesses to this drive are very fast. Consequently, certain kinds of programs can be substantially speeded up by putting their files on a memdisk. An ISAM (indexed sequential-access method) sorting routine could be made faster by putting its index file on a memdisk where it could be sorted much more rapidly.

When the Memdisk program is first enabled, you may specify how many sectors per granule to use and how many RAM (random-access read/write memory) "tracks" this memdisk is to have. If insufficient memory is available for the desired memdisk configuration, an error message appears, and the procedure is aborted. Otherwise, the memory to be used for the memdisk is verified with a short memory-checking utility, and control is returned to LDOS when this is finished. Thereafter, the memdisk appears to the system as a normal disk drive. The memdisk may be disabled at any time so that the memory it uses is returned to the system for general DOS use.

I use Memdisk to simplify the day-to-day DOS "housekeeping" chores.

I use this program regularly to simplify the day-to-day DOS "housekeeping" chores. The documentation is good, and the program well designed.

At a Glance

Name
Discater

Type
A general-purpose disk-cataloging program

Manufacturer
Softerware
16007 Miami Way
Pacific Palisades, CA 90272
(213) 459-3414

Price
$39.95

Format
5¼-inch floppy disk

Language
Z80 machine language

Computer
TRS-80 Models I and III running under LDOS

Audience
LDOS owners

Discater

Discater (from Softerware) is a general-purpose disk-cataloging program for LDOS. After loading the program into the TRS-80, you insert the disks to be cataloged one at a time into the disk drive so their directories can be read. (The program also works with single-drive systems.) Once the catalog is compiled, you can elect to have the entire catalog listed on screen or sent to a printer. You can also search for a particular file to see on which disks it appears.

Discater is a useful program, but it has one deficiency: the documentation is rather sparse. This is not as severe a drawback as it might seem, however, because the program is menu-driven and self-prompting. In general, the program runs well, and I've found it to be a handy tool for locating files on my many disks.

Conclusion

Tandy has recently announced that LDOS will become Radio Shack's official programmer's DOS, as opposed to TRSDOS, which is the user's DOS. Radio Shack stores and computer centers may now display and sell LDOS, which will increase the already considerable popularity of this operating system. With the addition of the six utility programs reviewed here, you can substantially increase the usefulness of LDOS. ■

Book Reviews

68000 Assembly Language Programming

Gerry Kane,
Doug Hawkins, and
Lance Leventhal
Osborne/McGraw-Hill
Berkeley, CA, 1981
577 pages, softcover
$16.99

Reviewed by
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2109 Shattuck Ave.
Berkeley, CA 94704

As a programming manual, *68000 Assembly Language Programming* does an admirable job of teaching the basics of assembly language through the use of extremely clear charts and numerous examples. The book also presents a solid background in many of the computer concepts related to assembly-language programming.

With new 16-bit microcomputers appearing every month, it's important to have a manual that completely covers all aspects of programming the 68000. This book is one of the most complete assembly-language manuals available for any chip, and it's written so that a person experienced with other assembly languages can quickly grasp all the concepts unique to the 68000.

While many assembly-language manuals present a few program fragments used in conjunction with descriptions of specific operations, these authors decided to teach the language through complete programs. Because assembler directives are important to most assembly-language programming, the programs listed contain generalized directives. The authors teach the programming of the 68000 as a concrete skill, not an academic exercise.

After an overview of general assembly-language programming, the manual presents the principles of assemblers and provides examples of the common assembler directives. The book then jumps to the 68000 operations set. The set is divided into the categories of frequently, occasionally, and rarely used operations, so the beginner needn't think about too many different codes at a time. This separation makes the operations easier for the novice to learn and for the experienced programmer to remember.

The discussion of addressing modes is much more understandable in this book than in most others, and the drawings accompanying the text are excellent. Learning the concepts of the 68000's addressing modes is especially important for those of us who are more familiar with 8-bit processors. If you don't have a complete grasp of the addressing modes, you'll find it almost impossible to comprehend the concepts of programming in assembly language.

The manual provides over 50 programming examples. The requisite arithmetic manipulations are given, but also included are many examples of character- and string-handling programs. A chapter on handling lists and tables, which the 68000 does quite easily, is another excellent feature.

For the advanced programmer, chapters on parameter passing, subroutines, interrupts, and exceptions prove to be a useful resource. The manual also has a unique feature for assembly-language programmers—a long chapter on interfacing the 68000 with the 6821 peripheral interface adapter. (Most authors have avoided this discussion because of its highly technical nature.) The procedure is clearly explained, and most programmers, even those without I/O (input/output) programming experience, should be able to understand it.

The rest of the manual deals with the art of programming in general. The two chapters on problem definition and program design do not deal with assembly language at all, but the chapters on debugging, testing, and maintenance give clear examples and helpful hints for programming with the 68000. The chapter on documentation is outstanding and should be required reading for all assembly-language programmers. The manual also includes the usual appendixes and a full index.

Unfortunately, the authors did not explore the many differences and similarities between the 68000 and other common chips. Nevertheless, they have presented a complete and well-written manual for the 68000, one that will remain useful for the life of the chip. The manual is quite helpful for the experienced assembly-language programmer and basic enough for the novice.■

BYTE's Bits

Customs Service to Seize Bogus Apples

The U. S. Customs Service has warned international travelers that counterfeit Apple II computers and related materials violating recorded copyrights or trademarks of Apple Computer Inc. are subject to seizure if brought into this country. Custom agents have seized illegal copies of Apple computers and software entering the U. S. through several West Coast locations and Honolulu.

Customs officials note that suspect machines are identical in size and appearance to genuine Apples, are normally tan in color, and bear such names as Apple II, Orange, Apollo II, Golden, PET TK 1000, and AP II. Some of these units have no brand name, and foreign values of these machines vary from $100 to $450.

Only two overseas subsidiaries of Apple Computer are authorized to produce and sell Apple manuals and software: Apple Computer International of Singapore and Apple Computer Ltd. of the Republic of Ireland.

TI Computer Courses Earn College Credit

The American Council on Education has granted college credit recognition to eight computer training courses offered by the Texas Instruments Education and Development Center. Texas Instruments employees and customers can now earn from 1 to 3 semester hours of college credit while taking one of four software courses: Introduction to TI Pascal, Advanced TI Pascal, Database Management System, and TI Assembly Langauge. In addition, four courses on computer maintenance are available to Texas Instruments staff members for college credit.

For further information, contact Texas Instruments Inc., Education and Development Center, Attn: Registrar, M/S 2220, POB 2909, Austin, TX 78769.■

The Magic of the Monte Carlo Method

Roger C. Millikan
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The Monte Carlo method is a mathematical technique that uses sequences of random numbers to solve problems that might not be solvable otherwise. It is well-suited to microcomputers, especially because most language systems provide a random-number-generating function. Monte Carlo programs tend to be short and simple, yet they provide powerful tools for solving what would otherwise be difficult problems. In this article I will illustrate how the method works by using it to solve two different types of problems.

The first problem involves simulating a physical process with random behavior built into it. For example, consider the diffusion of neutrons through a solid. A given neutron moves in a straight line until it collides with an atom. Then it is deflected at some random angle and proceeds on to the next collision. The result is a zigzag path of random motions. This can easily be simulated by the Monte Carlo method. Applications such as this are fundamental to the design of atomic reactors.

The Monte Carlo method also offers a way to find the area of odd-shaped regions or the volume of odd-shaped solids. It is in this type of problem that the method seems truly magical. You start with random and unpredictable sets of numbers but soon arrive at a definite answer. This is possible because a collection of random processes may have some average behavior that is constant. Consider flipping a coin 10,000 times. If you flip it once more, no one can predict for certain whether it will come down heads or tails. But you can predict with confidence that approximately 5000 of the previous flips turned up heads. With the Monte Carlo method, you make use of the average behavior of your random numbers to provide the desired, definite result. Of course, averages are subject to some statistical fluctuation, hence the result is only approximate. But by using more and more random-number trials, you can make the Monte Carlo result more and more accurate. This is where the speed of computers becomes important. A microcomputer can go through a simple looping calculation 10,000 times without exhausting your patience. Nevertheless, you should keep in mind that Monte Carlo calculations give only approximate answers.

The Drunk and the Lamppost

The neutron problem I mentioned earlier has an interesting analogy. Picture a drunk man clinging to a lamppost for support. He decides to head for home and lurches off in a random direction. After staggering some number of steps (no more than 10, for he is quite far gone), a dizzy spell causes him to spin around and head off in a different direction. After 10 of these staggers, the poor fellow collapses to the pavement to sleep it off. (Figure 1 shows several possible paths of the drunk.) Now let's ask a curious question. On the average, how far from the lamppost is the drunk when he collapses?

This question can be answered easily by running a Monte Carlo simulation of the drunk's walk on a microcomputer. After each simulation, we record the distance of the drunk from the lamppost. Averaging the results for 1000 simulations gives a fair approximation for the

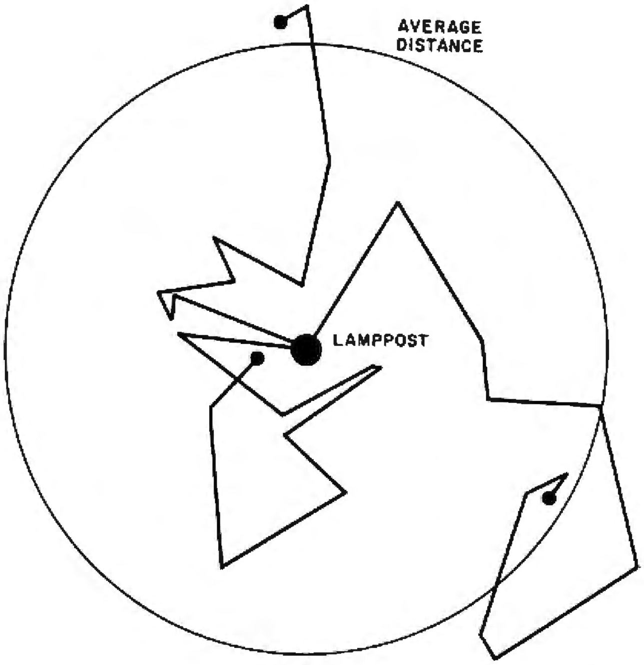

Figure 1: *Paths traveled by three drunks upon leaving a lamppost (central spot). Each staggers and lurches 10 times, ending at the location marked by the filled circle at the end of his path. The large circle marks the average radial distance such drunks would travel as calculated by the Monte Carlo program of listing 1.*

Listing 1: *The Staggering Drunk problem. This BASIC program uses the Monte Carlo method to calculate the average distance from the lamppost that a drunk will traverse before collapsing, after 10 lurches in random directions.*

```
1000 REM Monte Carlo demonstration
1010 D1 = 0
1015 N = 1000
1020 FOR J = 1 TO N
1030    X = 0: Y = 0
1040    FOR K = 1 TO 10
1050       GOSUB 2000
1060       NEXT K
1070    D1 = D1 + SQR((X * X) + (Y * Y))
1080    NEXT J
1090 PRINT "Avg radial distance is"; D1/N
1100 STOP
2000 REM
2010 REM Subroutine gives new x, y with
2020 REM  random direction and distance
2030 REM  (0 to 10) from old x,y
2040 REM
2050 R = 10 * RND(R)
2060 T = 2 * 3.14159 * RND(T)
2070 X = X + (R * COS(T))
2080 Y = Y + (R * SIN(T))
2090 RETURN
```

answer. Listing 1 shows a program in Microsoft BASIC that simulates 1000 drunken walks, each with 10 lurches, and averages the 1000 results. The circle in figure 1 shows the average distance from the lamppost as computed by the program.

Few people care how far the average drunk staggers from a lamppost, but many care how far neutrons travel in radiation shields, and the two are essentially the same problem. At first it may have seemed difficult to solve, but we have seen that the Monte Carlo method makes it easy. This example also exhibits a characteristic that many Monte Carlo programs share: they have a simple loop that is traversed many times. And because there is no need to store many intermediate results, memory requirements are fairly small.

Finding Areas and Volumes

The second type of Monte Carlo problem is well illustrated by the following example. Suppose we want to find the area under the curve $y = x^2$ when x varies from 0 to 1. This is the shaded area of figure 2. If you know integral calculus, you can find the exact answer at once. It is ⅓. But if you don't know calculus, the problem is extremely difficult.

The Monte Carlo approach to this problem is akin to throwing darts randomly at the boxed-in area of figure 2. Then we count the number of darts that land in the shaded area (under the curve $y = x^2$) and divide this number by the total number of darts thrown. This gives us an approximation of the area under the curve. The more darts thrown, the better the approximation.

The BASIC program shown in listing 2 follows this procedure, except that, instead of throwing darts, the program uses calls to the random-number generator to provide the x,y coordinates for the dart locations. In figure 2, black dots show the locations for 30 points generated in one run of the program. The approximate result for the area in this run was 0.37.

As I mentioned before, Monte Carlo results become more accurate as the number of trials increases. This is shown dramatically in figure 3, which shows the results of several runs of the program in listing 2 using varying numbers of darts or trials. When only 10 trials per run are used, the results for each run vary wildly. But for 10,000 trials per run, the results are reproducible to within 1 percent. Herein lies the major drawback of the Monte Carlo method. For each extra digit of precision in your result, you must do 100 times as many trials. Thus to get a result that has 100 times the accuracy of the result shown for 10,000 trials, we would need 1 billion trials. Even though computers are fast, running through a loop that many times could take weeks. This relationship between the number of trials and the statistical fluctuation of the results thus limits the precision of the Monte Carlo method.

Given this problem, why should anyone be interested in the Monte Carlo method? First, it is generally easy to apply, no matter how complex the problem of interest. The problem may not exhibit as simple a curve as $y = x^2$. Indeed, the curve may be so complicated that even the methods of integral calculus fail. Yet the same short Monte Carlo program can approximate the desired

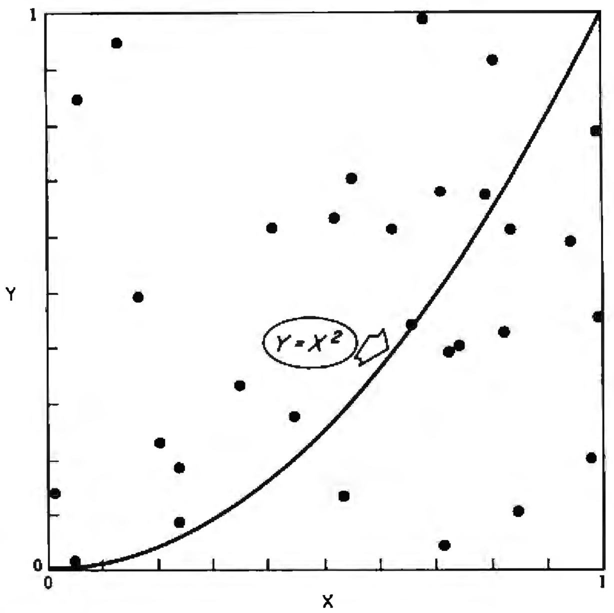

Figure 2: *Plot of 30 random x,y points giving a Monte Carlo approximation of the area under the curve $y = x^2$ in the unit square. The area (A) can be estimated as points under the curve divided by total points. In this instance $A = {}^{11}/_{30} = 0.37$. The true result is 0.333.*

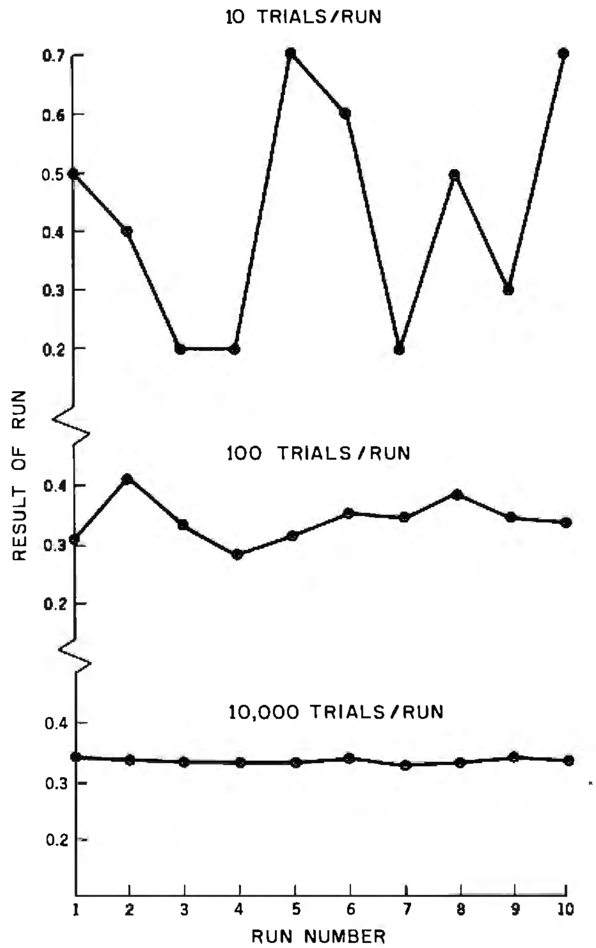

Figure 3: *Results of 10 different Monte Carlo runs to find the shaded area of figure 2 showing the statistical fluctuation for three different numbers of trials per run. The exact result is 0.333.*

Listing 2: *A BASIC program to calculate the area under a curve. In this case the curve is the function $y = x^2$. The program uses the Monte Carlo method with a varying number of tries, from 10 to 10,000. At the bottom of the listing is a sample of the output from the program.*

```
1000 DEF FNA(X) = X * X
1010 N = 10    : GOSUB 2000
1020 N = 100   : GOSUB 2000
1030 N = 1000  : GOSUB 2000
1040 N = 10000: GOSUB 2000
1050 STOP
2000 REM Monte Carlo integration
2010 REM   subroutine. "N" is the
2020 REM   number of points to try.
2030 REM   FNA(x) is the defined
2040 REM   function y = x * x.
2050 REM
2060 U = 0
2070 FOR I = 1 TO N
2080    X = RND(X): Y = RND(Y)
2090    IF Y <= FNA(X) THEN U = U + 1
2100    NEXT I
2110 PRINT "For"; N; "tries,"
2115 PRINT "  the integral is"; U/N
2120 RETURN
3000 END

Output:

For 10 tries,
  the integral is .4
For 100 tries,
  the integral is .35
For 1000 tries,
  the integral is .341
For 10000 tries,
  the integral is .3415
```

result. Second, the Monte Carlo method can be extended to three- and higher-dimensional cases with ease. Last, the accuracy and memory of microcomputers are well matched to the natural accuracy and memory requirements of the Monte Carlo method.

Looking toward the future, I see an exciting prospect: Monte Carlo programs have a natural parallelism that might be implemented on clusters of microcomputer chips. This could reduce, in some cases, the excessive amount of time needed for precise results. For example, in a problem where random *x*, *y*, and *z* coordinates are needed for two particles, 1 and 2, we might have six 1-chip computers generating all these random numbers in parallel. For more particles, we could plug in more chips. On a sequential machine, the time requirements for problems with many particles tend to explode. The Monte Carlo method and its natural parallelism offers a possible way around this. Perhaps we can look forward to systems where you plug in a new processor for each new particle or dimension in a problem.■

A Practical Introduction to Computer Graphics

Ian O. Angell
Halstead Press
New York, 1981
146 pages
softcover, $16.95

Reviewed by
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In the few short years that microcomputers have been around, many books have been written about computer graphics. Unfortunately, most of them have focused on game applications or specific computers. *A Practical Introduction to Computer Graphics* by Ian Angell takes a different approach. In addition to addressing the various aspects of computer graphics, the author offers insight into the theory and mathematics behind their creation.

As its title implies, the book is a primer on methods of creating computer graphics. The text is accompanied by examples of graphics routines that you can easily alter to suit your needs. Angell also provides the basic information you'll need to generate such complex graphics structures as detailed machine patterns, various data presentations, and diagrams.

The book has twelve chapters that progress in a logical order and increase in difficulty in terms of the concepts and the examples they present. The first chapter includes such useful information as an informal introduction to two-dimensional graphics and definitions of some of the terms and routines you will encounter throughout the book.

The author addresses graphics by way of an introduction to the mathematics of two-dimensional geometry, and his presentation is logical and easy to understand. Still, you must be somewhat familiar with the mathematical precepts he presents; the detailed derivation found in a typical mathematics text, for example, is omitted. The precepts are essential because they form a basis for the underlying theory that Angell delineates throughout the remainder of the book. He uses cleverly designed examples to develop and reinforce each precept.

Angell explains each of the two-dimensional space transformations—translation, change of scale, and rotation—clearly and concisely. In addition, he develops the matrix representation necessary to achieve each transformation. He also gives you a method that combines transformations by multiplying transform matrixes.

After discussing the tools for producing complex graphics structures, he explains how you can clip a graphics picture to fit within the boundaries of a physical device. He also describes how to cover a certain area of the graphic surface to allow for the addition of text or other information without interference from the graphic pattern.

Another chapter introduces the reader to coordinate geometry in three-dimensional space. Here, too, Angell makes a point to introduce new mathematical concepts as warranted to explain the principles involved.

The concepts of coordinate transformation are explained through a discussion of three-dimensional geometry. Once the author establishes these transformations for three-dimensional space, he explains how to create orthographic projections of three-dimensional objects onto a two-dimensional viewing surface.

Angell also includes a discussion of perspective and stereoscopic views. The orthographic projection of an object in three-dimensional space does not reflect real-world perspective, in which all parallel lines seem to meet on the visual horizon. Stereoscopic views, on the other hand, account for the slight differences in perspective seen by the right and left eyes.

One of the book's most interesting sections concerns the development of hidden line removal algorithms. The author calls the examples he uses "wire figures." The function of hidden line removal algorithms is to make these wire figures resemble solid objects by removing the lines that would not normally be visible.

The remainder of the book focuses on the procedures you would need to produce complex graphic structures, frame-by-frame animation for computer movies, and other more ambitious projects.

In general, *A Practical Introduction to Computer Graphics* is both well written and well conceived. The graphics examples, which are explicit and well documented, could easily be integrated into a sophisticated graphics package. The book is also an excellent refresher in the mathematics that graphics projects require.

This review would be incomplete, however, without mention of the serious flaws that detract from the book's usefulness. To begin with, the graphics examples are in FORTRAN-IV. In addition, the author has used the Calcomp graphics package, which has limited use among microcomputer users.

FORTRAN-IV clearly restricts the use of the graphics examples to the small number of microcomputer users who have access to a FORTRAN compiler. Even if you converted the FORTRAN source text to BASIC or Pascal, the lack of access to generalized plotting routines used in the examples would require a considerable amount of programming.

Having worked with the graphics capabilities of a high-resolution system like Techtronics 4052, I fully appreciate the flexibility that the Calcomp plotting routines offer. Unfortunately, only a few high-resolution graphics systems offer such flexibility, so the excellent examples in this book will probably remain untested by many readers. ■

Circle 106 on inquiry card.

A High-Resolution Analog-to-Digital Converter for the TRS-80

James Cameron
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Port Aransas, TX 78373

Interfacing the typical 8-bit microcomputer with the real world often involves the conversion of constantly varying (analog) signals to digital form through some sort of converter and I/O (input/output) circuitry. ADCs (analog-to-digital converters) can be based on readily available 8-bit converter ICs (integrated circuits), such as National Semiconductor's MM5357.

An 8-bit converter IC is an easy and natural match for the 8-bit data bus and the 8-bit architecture of most common microcomputers. However, you'll quickly discover that 8-bit resolution is quite coarse. If you're interested in applications requiring a wide measurement range, or in accuracy better than ±0.5 percent, the 12-bit ADC interface described in this article and the principles that allow extension of the interface to 14- and 16-bit converters may be what you've been looking for.

The resolution or ability to distinguish digitally between slightly different signals is determined by the number of bits in the conversion. For example, an 8-bit binary scale can be used to count to 256 (0 through 255, actually), or to divide a measurement scale into 256 equal parts. Let's say you were making a Fahrenheit thermometer to read in the range of −44 to +212 degrees. An 8-bit converter would give you an output in 1-degree increments, ±½ degree of accuracy—there is ±½ bit uncertainty in any 8-bit conversion. This is acceptable for some applications, but to obtain a reading in tenths of a degree, at least 12-bit resolution (which divides the scale into 4096 intervals, or about 1/16-degree intervals) is needed. Of course, it's impossible to simultaneously read 12 bits onto an 8-bit data bus. The trick is to make the 12-bit conversion, hold the data, read the low bits first, then the high bits, and put them together with software. All this, plus some status, over-range, and polarity information can be obtained with the 12-bit Datel/Intersil ICL7109 ADC and four other common ICs.

The Circuit

Figure 1 on page 380 shows the complete interface circuit for a Radio Shack TRS-80 Model I in block diagram form. The ADC is connected to the data bus through an input port and an output port, both of which are enabled by the $\overline{\text{IN}}$ and $\overline{\text{OUT}}$ lines and an address decoder. The output port is used to control the flow of data and information onto the data bus via the input port. Two latches are used: one configured as the output port with address 1, and the other as the input port with address 0. The three least significant address lines (A0 through A2) are decoded by a 3-to-8 line decoder to select the port. The selected lines are activated by gating the $\overline{\text{IN}}$ and $\overline{\text{OUT}}$ signals from the TRS-80. The $\overline{\text{IN}}$ and $\overline{\text{OUT}}$ are NANDed so that if either goes low, the decoder's active-

(1a)

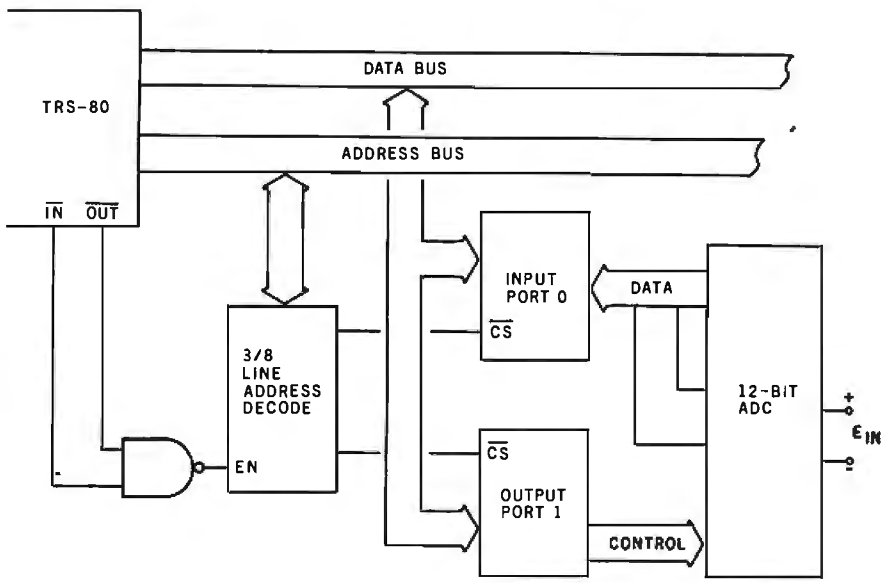
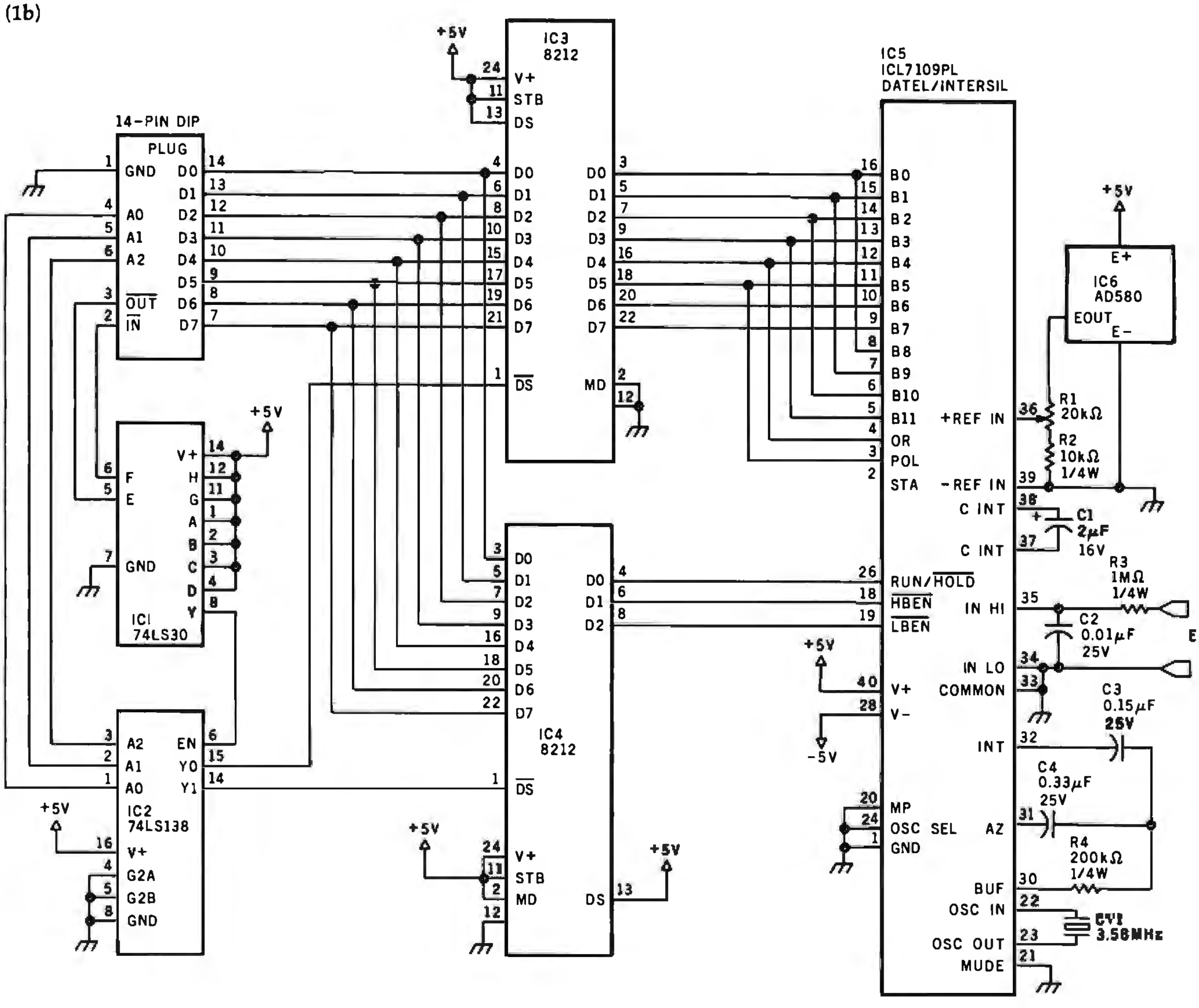


Figure 1: *Diagrams of the complete interface circuit. In figure 1a, a block diagram of the circuit shows how the I/O port address is decoded and how the eight data lines are partitioned into an input bus and into an output bus. Figure 1b is a schematic diagram developed from figure 1a. Note that all eight data lines are used when transferring data to the computer and only three lines are used by the computer to control the ADC.*

(1b)



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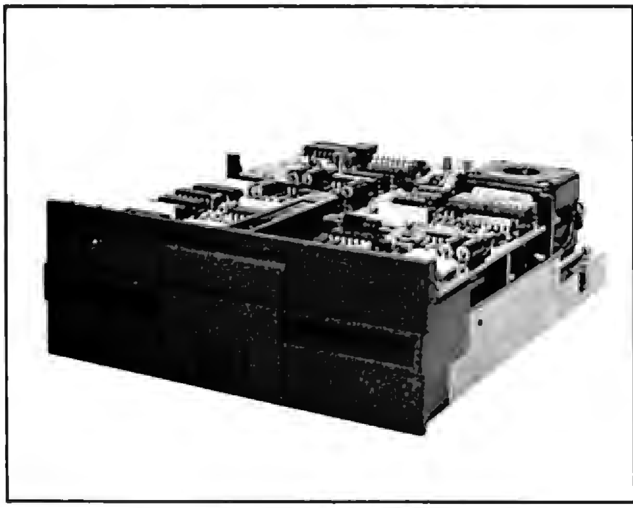

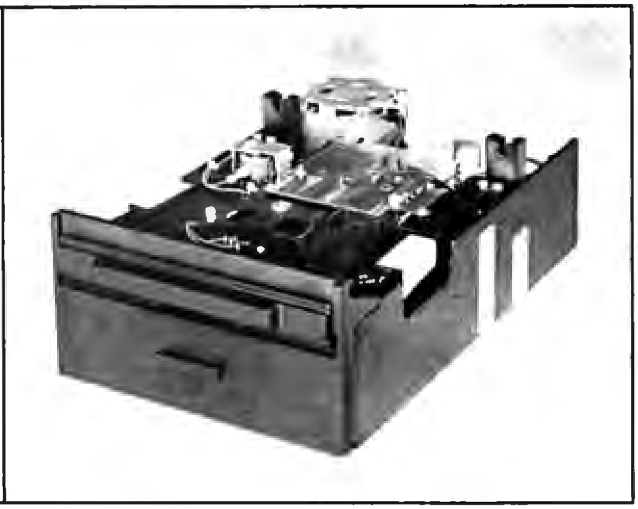

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high enable pin goes high, allowing the selected output line to go low to turn on the right port.

The address decoding shown in figure 1 is only partial, and if other I/O devices are connected, some additional decoding must be provided. Line Y7 on IC2, the decoder, will be activated when, for example, the cassette recorder of a TRS-80 is used, because its address of 255 (hexadecimal FF) will cause A0, A1, and A2 to go high, activating Y7. For complete address decoding, each line from A2 through A7 could be inverted and NANDed to the A2 connection of the decoder (requiring the addition of two more ICs, a 74LS04 hex inverter, and another 8-input 74LS30 NAND gate). By a variety of other rearrangements, the I/O ports may be located anywhere within the 256 possible I/O addresses, except for those reserved by other devices.

This interface extends the 8-bit microprocessor's power into the realm of serious measurement.

Operation

The key to understanding the circuit's operation is in the arrangement of control and data lines on IC5, the ICL7109 ADC. Several options are provided for in the device's design, but as employed here, the device is enabled like this: a control byte is sent to the output port to put a 1 on the RUN/$\overline{\text{HOLD}}$ line (pin 26) of the ADC. After a brief delay, this pin is returned low by sending a second control byte to port 1. A high on the RUN/$\overline{\text{HOLD}}$ pin starts a conversion. When the conversion is finished, the ICL7109 signals with a low on the status pin (STA, pin 39). To read the output data from the ICL7109, a third control byte is sent to port 1, this time putting a low on the high-bits-enable pin ($\overline{\text{HBEN}}$, pin 19). This activates bits 8 through 11 of the converted signal, an overrange indication (bit 12), and a polarity signal (bit 13). During this cycle, the low-order bits (0 through 7) are in a high-impedance state, which means those pins are "invisible" to the data bus.

To get the low bits, another control byte is sent to port 1, putting a low on the low-bits-enable pin ($\overline{\text{LBEN}}$, pin 18). After that, an INP(0) statement reads the low bits through the input port, 00H. A new conversion cycle takes about 33 ms (milliseconds) with the circuit shown. The last completed conversion is held as long as a low is present at pin 26 of IC5.

Circuit Construction

The schematic diagram for this circuit is shown in figure 1b. The diagram also shows the proper pin connections for the DIP (dual-inline package) plug-to-edge-card connector that's required to hook the circuit to either the back of a TRS-80 keyboard unit or an Expansion Interface. (I recommend wire-wrap construction on perfboard.)

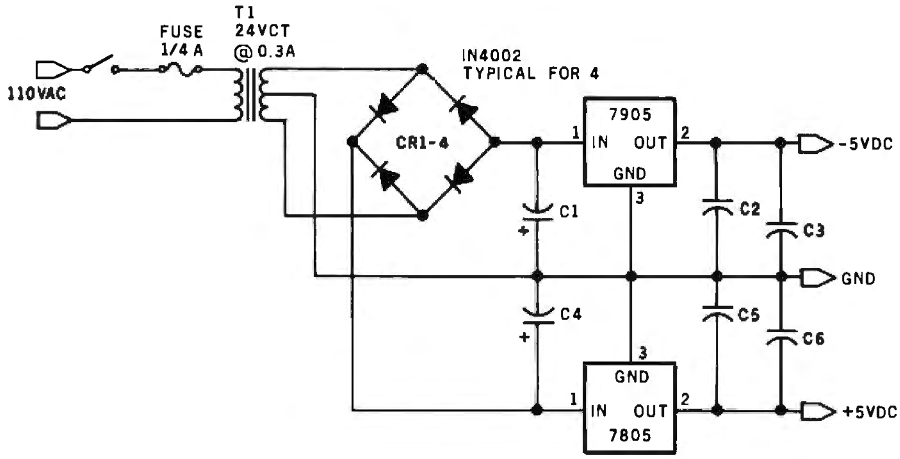

Figure 2: *Design of a suggested power supply. The power must be extremely stable if the unit is to live up to its potential.*

DIP Plug	Function	TRS-80 Edge-Card Connector
1	Gnd	8
4	A0	25
5	A1	27
6	A2	40
2	$\overline{IN}$	19
3	$\overline{OUT}$	12
14	D0	30
13	D1	22
12	D2	32
11	D3	26
10	D4	18
9	D5	28
8	D6	24
7	D7	20

Table 1: *Connections necessary to hook the ADC board to the edge-card connector of a TRS-80 Model I.*

Address binary	decimal	
xxxxx000	0	Input port activated; otherwise tri-state
xxxxx001	1	Output port active; otherwise data latched
Control		
xxxxx111	7	Start conversion; output tri-stated
xxxxx110	6	Hold when finished; output tri-stated
xxxxx100	4	Enable high bits; low bits tri-stated
xxxxx010	3	Enable low bits; high bits tri-stated
High Bits		
xx1x xxxx		Positive polarity
xx0x xxxx		Negative polarity
xxx1 xxxx		Out of range signal
xxxx		High data bits

Table 2: *Useful codes for controlling, addressing, and reading the ADC.*

Optimum performance of the ICL7109 depends on a stable and accurate reference voltage and on good-quality capacitors. Although the ADC has an internal voltage reference, using it causes some reduction of circuit flexibility. The Analog Devices AD580 voltage reference shown in figure 1b has excellent thermal and aging characteristics, as does the Datel/Intersil ICL8069, which could be substituted. Good-quality resistors with low temperature coefficients (such as the metal-film RN55 type) should be used to divide the reference voltage. The values used in figure 1b are for a 4.096-V (volt) input scale, with a 2.048-V reference (details on setting the reference voltage for other input scales are given in the Datel/Intersil data sheet supplied with the ICL7109). The capacitors used should not be disc ceramic; polypropylene or Teflon are best, and Mylar is acceptable. A few 0.01-μF (microfarad) disc-ceramic capacitors should be placed on the board to bypass the power supplies.

Both +5-V and −5-V supplies are required, for which a good regulated bench supply or the circuit shown in figure 2 will do nicely. The total power drain is about 180 mA (milliamperes) at +5-V, and only a few mA from the −5-V supply. (The connections needed between the DIP plug and the TRS-80 Model I expansion connector are provided in table 1.)

Software

The software to generate the control signals and read and process the data may be written either as part of a BASIC program or as an assembly-language subroutine. Speed is not critical for this interface because the ICL7109 is a dual-slope, auto-zero, integrating converter, and its conversion time of 33 ms is relatively slow. Listing 1 on page 386 is a BASIC program that includes a delay for conversion, an over-range message, and polarity correction. Testing each individual bit in BASIC is somewhat clumsy because all data is converted to decimal by the in-

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Circle 199 on inquiry card.

Listing 1: *This simple BASIC program for the TRS-80 controls the ADC.*

```
100 DEFINT A,B,D
200 P = -1 : OUT 1,7
300 FOR X=1 TO 50: NEXT X
400 OUT 1,6
500 FOR X=1 TO 100: NEXT X
600 OUT 1,4
700 A = INP(0)
800 OUT 1,3
900 B= INP(0)
1100 IF A< 32 GOTO 1300
1200 A = A-32: P = 1
1300 IF A >= 16 GOTO 2000
1400 D = ((256*A)+B)*P
1500 PRINT D
1600 FOR X= 1 TO 200: NEXT X: GOTO 200
1700 END
2000 PRINT "OUT OF RANGE": GOTO 1600
```

terpreter. The series of steps shown at lines 1000 through 1300 is one way of handling the testing.

Controlling the ADC and testing the status bits is more straightforward in Z80 assembly language because the I/O functions are accomplished with IN and OUT commands and the testing uses the BIT command. For the TRS-80, this can be done as a USR(0)-called subroutine, with the op codes either loaded separately or with a POKE into high memory by a BASIC program. (A summary of control-byte, address, and input-bit patterns is given in table 2 as a quick reference for software design.)

Expansion to 14-Bit and 16-Bit Circuits

The I/O control scheme illustrated by this circuit is easily applied to the even greater resolution and accuracy provided by 14- and 16-bit ADCs. Substituting the Datel/Intersil 8068/7104-16 pair of devices for the ICL7109, for example, merely requires the following changes: the output bits must have three-state outputs on the input port's data lines in three overlapping groups, 0-7, 8-15, and OR and POL bits. Besides the three

(3a)

Analog-to-Digital Converter Parts

IC1	74LS30
IC2	74LS138
IC3,IC4	8212, Intel
IC5	ICL7109CPL, Datel/Intersil
IC6	AD580, Analog Devices (ICL8069 from Intersil may be substituted)
C1	2 μF, 16 V tantalum
C2	0.01 μF, 25 V polypropylene
C3	0.15 μF, 25 V polypropylene
C4	0.33 μF, 25 V polypropylene
R1	20 kΩ, 15-turn Cermet trimmer
R2	10 kΩ, ¼ W 1% RN55-type metal film
R3	1 MΩ, ¼ W 5% carbon film
R4	200 kΩ, ¼ W 1% RN55-type metal film
CY1	3.58 MHz TV crystal
Plug	14-pin DIP socket and mating insulation-displacement connector
Miscellaneous	Two 14-pin DIP sockets; one 16-pin DIP socket; two 24-pin DIP sockets; one 40-pin DIP socket (wire-wrap); 14-conductor ribbon or insulated cable; wire-wrap wire.

(3b)

Power Supply Parts

T1	Transformer, primary 110 V AC, secondary 24 V, C.T. at 0.3 A
CR1–4	1N4002, or suitable bridge rectifier
C1	470 μF, 16 V electrolytic
C4	1000 μF, 16 V electrolytic
C2,C5	1 μF, 16 V electrolytic
C3,C6	0.01 μF, 25 V ceramic
7805,7905	Three-terminal IC voltage regulators. LM320/340 series in T0-220 package are equivalent.

Table 3: *Parts lists for the converter (3a) and its power supply (3b).*

output-control lines (RUN/$\overline{\text{HOLD}}$, $\overline{\text{HBEN}}$, and $\overline{\text{LBEN}}$), a fourth, $\overline{\text{MBEN}}$, is added, and the middle bits are gated onto the data bus in their turn. A few extra lines of code in the software-driver routine, and you're in business.

A second ICL7109 converter could be added by using one of the six unused addresses from IC2, three of the unused output lines on port 01H, and by connecting the three-state output lines of the second ICL7109 onto the secondary data bus going into the 8212 input port. For more than two channels, however, this is probably not as economical as employing the ADC with a multiplexed analog input, which could also be controlled by unused lines on the output port. The circuit could be easily adapted for other popular microcomputers, such as the Apple II, or for S-100 systems, by picking up the appropriate equivalents of the $\overline{\text{IN}}$ and $\overline{\text{OUT}}$ signals from the bus.

This interface extends the 8-bit microprocessor's power into the realm of serious measurement. The principle of using three-state buffers to pass multiple output bytes through a single input port allows a degree of resolution and accuracy usually reserved for expensive equipment, at a total cost of a weekend and less than $100. ■

Circle 290 on inquiry card.

Shape-Table Graphics for the TRS-80

Draw complex shapes with a single command.

Dan Rollins
Apartment C
134 Olive St.
Glendale, CA 91206

In the fast-moving world of computer graphics, the TRS-80 Model I and III programmer seems to have been forgotten. When the local Apple users group meets, members admire each other's high-resolution graphics creations while discussing the details of vector plotting, video paging, and shape tables. And all the while, the TRS-80 owner carefully calculates SET/RESET/PRINT @ positions and curses the limitations of these commands.

Ever wish you could draw a complex shape on the screen of your TRS-80 with a single command? Could you use a command for magnifying the size of that shape by using a scaling factor? How would you like to be able to "build" a page of graphics and characters in memory, then move it to the screen at machine-language speeds? Well, the KWIKDRAW program will painlessly add these functions to your repertoire.

KWIKDRAW is a machine-language routine (see listings 1 and 2) that was developed to be used interactively with BASIC. This combination of machine-language speeds and BASIC flexibility allows freedom and ease found in neither medium independently. Additionally, the routine can be located on a BASIC program line. It need not be loaded separately as a SYSTEM tape nor will MEMORY SIZE ever need to be answered. It is loaded along with the BASIC application program.

The methods to accomplish this have been covered in a previous article (see "Vector Graphics for the TRS-80," BYTE, January 1983, page 371) and will not be repeated here. In essence, a BASIC program uses POKE commands to insert Z80 op codes into a prepared dummy string on a program line. The address of that string is used as the point to which control is passed via the USR command. Any such routine must be fully relocatable and contain no op-code bytes with values of 00 or 22 hexadecimal.

Vectors

In this article, the word *vector* will be defined as a control code used in moving a cursor for plotting points of a video-screen matrix. Using compass points as an analogy, a vector will be interpreted as motion north (up), south (down), west (left), and east (right), or as any combination of these motions, i.e., northeast (up and right).

Starting at a key position, a vector will advance this cursor in any of eight directions. The new screen position may then be turned on, turned off, or skipped. From this point, another vector will further advance the cursor and take the required action. A series of such vectors may be used to define a ***shape***—the basic building block for all graphics applications. A series of shapes, drawn rapidly on the screen, might be used to animate a figure.

Couple this shape-drawing function with the ability to change the shape's key position from drawing to drawing; add the options of enlarging or reducing the size and

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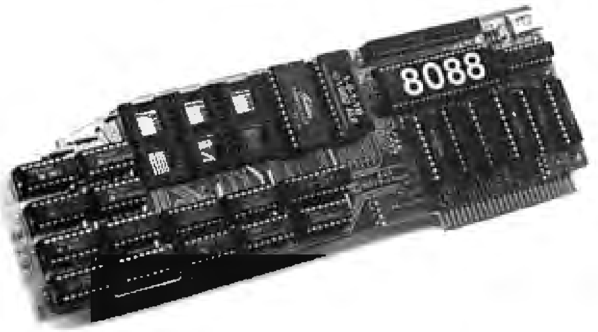

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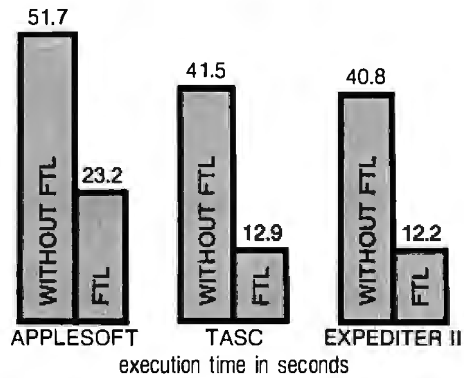
```
10 PRINT "2 3 ";
20 FOR B = 5 TO
    1000 STEP 2
30 FOR C = 3 TO
    SQR (B) STEP 2
40 IF B/C = INT
    (B/C) THEN 70
50 NEXT
60 PRINT B;" ";
70 NEXT B
```

Program to compute prime numbers from 2 to 1000.



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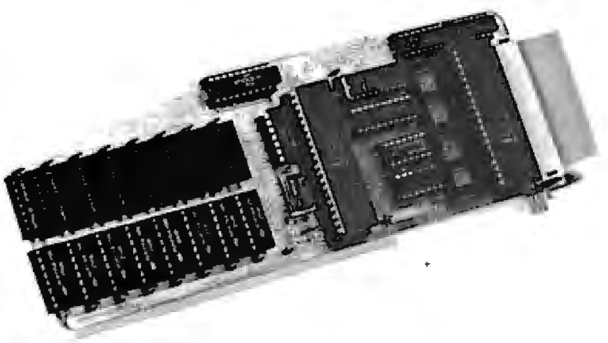

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Direction	Vector Character Move and Plot	Move Only
N	A	1
S	B	2
N then S	C	5
E	D	4
NE	E	5
SE	F	6
W	H	8
NW	I	9
SW	J	:

Table 1: *Shape-definition characters interpreted by the KWIKDRAW program. The letters A through J will move and plot the cursor position, while the numbers 1 through 9 and the colon will only move the cursor.*

changing the color of the shape; and we have motivation for the invention of shape-table graphics for the TRS-80 and the reason for KWIKDRAW.

KWIKDRAW interprets a BASIC character string as a series of vectors. Shapes are drawn using pixels or any displayable character. A shape may be enlarged by a scaling factor of 2 to 256 and may be drawn anywhere on or partially off the screen. *Pages* of shapes may be stored in memory for rapid sequential recall.

In writing KWIKDRAW, I decided that ease of programming was more important than using the memory-stringy "bit-stream" method employed in Applesoft.

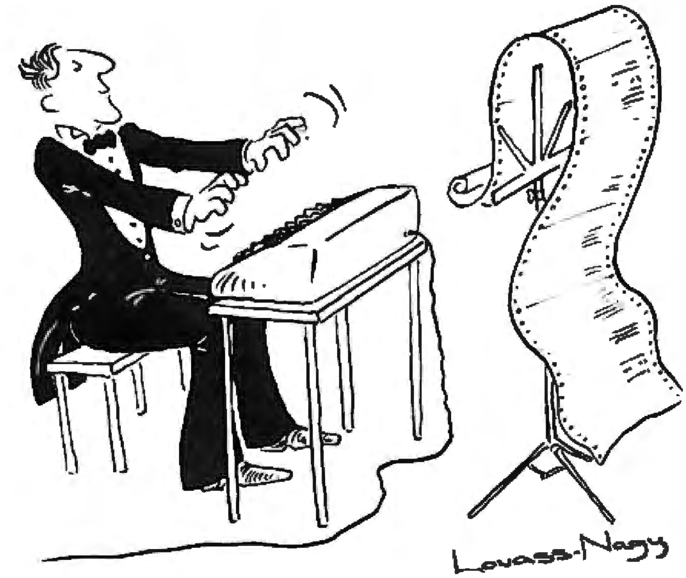
Shape-interpreters are notorious for being difficult to work with. Applesoft, for example, requires that a shape-table be created as a series of 3-bit codes. The first 2 bits indicate direction (up, down, left, right), and the third indicates a plot/don't-plot action. Byte boundaries are ignored except in defining the end of the shape. These rules tend to make shape defining a complex proposition.

Table 1 contains the shape-definition characters that are interpreted by KWIKDRAW. Notice that all characters may be entered from the keyboard. Though only 5 of the 8 bits of an ASCII (American Standard Code for Information Interchange) character are needed for defining a vector, I decided that ease of programming was more important than using the memory-stingy "bit-stream" method seen in Applesoft. Also, note that provisions are made for moving the cursor without changing the background upon which the shape is drawn.

Defining a Shape

The easiest way to explain how to define a shape is to

Text continued on page 418



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Circle 42 on inquiry card.

Listing 1: *KWIKDRAW assembly-language program.*

```
;          PROGRAM ID    :   KWIKDRAW
;          PROGRAMMER    :   Dan Rollins
;          DATE          :   09/24/81
;
;          Program Abstract :
;                  This program interprets a string of
;                  control characters as a graphics shape,
;                  placing it on the screen at the position
;                  defined as an X,Y coordinate, scaled to
;                  a given value and drawn with either lit
;                  or unlit pixels or any displayable
;                  character.
;
;                  KWIKDRAW requires a BASIC string of
;                  "vector definition" bytes and 6 control
;                  parameters.  These control parameters are
;                  passed to the routine by placing them in
;                  elements of an INTEGER array :
;
;                  PZ(0) = X ordinate (0-127 or 0-63)
;                  PZ(1) = Y ordinate (0-47  or 0-15)
;                  PZ(2) = VARPTR(shape definition string)
;                  PZ(3) = SET/RESET/CHARACTER byte :
;                          0=RESET, 1=SET, else=CHARACTER
;                  PZ(4) = scaling factor (1-255)
;                  PZ(5) = paging argument:
;                          0=page OUT, DRAW, page IN
;                          1=page OUT, DRAW (build a page)
;                          2=DRAW, page IN (display a page)
;                          3=DRAW only (don't page)
;              PZ(6-517) = working storage for screen
;
;          Once these values are defined, KWIKDRAW is
;          called via:
;
;                  UU=USR(VARPTR(PZ(0)))
;
;          The shape definition string is composed of
;          characters which are interpreted by KWIKDRAW
;          as motions of a cursor - where bits indicate
;          motion North, South, East, West or combinations
;          thereof.
;
;                          NORTH     = bit 0    (char AND 1)
;                          SOUTH     = bit 1    (char AND 2)
;                          EAST      = bit 2    (char AND 4)
;                          WEST      = bit 3    (char AND 8)
;              MOVE (don't plot)     = bit 5    (char AND 32)
;
;************* CHART OF CONTROL CHARACTERS *************
;**                                                    **
;**     direction         plot/move        move only     **
;**     ---------------/---------------/--------------   **
;**        N           /      "A"      /      "1"        **
;**        S           /      "B"      /      "2"        **
;**      (plot only)   /      "C"      /      "3"        **
;**        E           /      "D"      /      "4"        **
;**        NE          /      "E"      /      "5"        **
;**        SE          /      "F"      /      "6"        **
```

Listing 1 continued on page 398

Circle 287 on inquiry card.

Listing 1 continued:

```
                ;**         W           /       "H"       /       "8"          **
                ;**         NW          /       "I"       /       "9"          **
                ;**         SW          /       "J"       /       ":"          **
                ;**                                                            **
                ;*************************************************************
                ;
                ;                  These characters also have unused bits
                ;                  set, but allow for keyboard entry.
                ;
                ;                  Elements of the shape table cause the
                ;                  internal pointer to FIRST be adjusted,
                ;                  then the point is plotted.
                ;
                ;                  When bit 5 is ON, the pointer is moved
                ;                  without any character or pixel alteration
                ;
                ; *******   The program is fully relocatable and   *******
                ; *******    suitable for "packing" into a BASIC   *******
                ; *******      string within a program line.       *******
                ;
                ;<><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
                ;                                                        <>
                ;     offsets from USR        name of BASIC              <>
                ;    argument address-1         variable                 <>
                ;                                                        <>
0001            XPOS     EQU     +1               ;P%(0)                 <>
0003            YPOS     EQU     +3               ;P%(1)                 <>
0005            PTRLSB   EQU     +5               ;P%(2)                 <>
0006            PTRMSB   EQU     +6               ;                      <>
0007            SRBYTE   EQU     +7               ;P%(3)                 <>
0009            SCALE    EQU     +9               ;P%(4)                 <>
000B            PAGER    EQU     +11              ;P%(5)                 <>
                ;                                                        <>
                ;<><><><><><><><><><><><><><><><><><><><><><><><><><><><><>
                ;
0000                     ORG     0                ;relocatable code
0000 CD7F0A              CALL    0A7FH            ;set ARG from BASIC
0003 E5                  PUSH    HL         ;point IX index register to
0004 DDE1                POP     IX         ;  control parameter array
0006 DD2B                DEC     IX         ; Offsets from IX must not be 0
                ;
0008 110C01              LD      DE,010CH
000B 15                  DEC     D                ;DE = 12
000C 19                  ADD     HL,DE            ;HL => start of storage-
000D E5                  PUSH    HL               ; area (integer array)
000E FDE1                POP     IY               ;save in IY register
                ;
                ;These lines "page" OUT of video memory into the
                ;storage area within a BASIC integer array.
                ;The section is skipped if the paging argument--P%(5)--
                ;is 2 or 3  (bit 1 is ON).
                ;
0010 DDCB0B4E            BIT     1,(IX+PAGER)     ;paging arg = 2 or 3?
0014 200B                JR      NZ,POSKIP        ; then skip.  Else
                ;
0016 EB                  EX      DE,HL            ;use array as destination
0017 21013C              LD      HL,3C01H
001A 2B                  DEC     HL               ; HL => source (screen)
001B 01FF03              LD      BC,3FFH
001E 03                  INC     BC               ; BC is byte count (1024)
```

Listing 1 continued on page 400

Listing 1 continued:

```
001F EDB0                     LDIR                           ;store screen to memory
                        ;
0021 DD6E05         POSKIP    LD      L,(IX+PTRLSB)          ;point HL to BASIC's
0024 DD6606                   LD      H,(IX+PTRMSB)          ;  variables list
0027 46                       LD      B,(HL)                 ;get LENGTH of string
0028 23                       INC     HL
0029 5E                       LD      E,(HL)
002A 23                       INC     HL
002B 56                       LD      D,(HL)
002C EB                       EX      DE,HL                  ;HL => control characters
002D DD5601                   LD      D,(IX+XPOS)            ;DE register defines the
0030 DD5E03                   LD      E,(IX+YPOS)            ; current X,Y coordinates
                        ;
0033 2B                       DEC     HL         ;set up for main loop
                        ;
0034 23             MAIN      INC     HL         ;loop decodes each vector byte
0035 DD4E09                   LD      C,(IX+SCALE)
                        ;
0038 CB46                     BIT     0,(HL)                 ;motion NORTH?
003A 2803                     JR      Z,CHKSTH               ;bit not ON, so skip
003C 7B                       LD      A,E                    ;bit is ON, adjust the
003D 91                       SUB     C                      ; Y pointer NORTH by
003E 5F                       LD      E,A                    ; the scaling factor
003F CB4E           CHKSTH    BIT     1,(HL)                 ;motion SOUTH?
0041 2803                     JR      Z,CHKEST
0043 7B                       LD      A,E
0044 81                       ADD     A,C
0045 5F                       LD      E,A
0046 CB56           CHKEST    BIT     2,(HL)                 ;motion EAST?
0048 2803                     JR      Z,CHKWST
004A 7A                       LD      A,D
004B 81                       ADD     A,C
004C 57                       LD      D,A
004D CB5E           CHKWST    BIT     3,(HL)                 ;motion WEST?
004F 2803                     JR      Z,CHKPLT
0051 7A                       LD      A,D
0052 91                       SUB     C
0053 57                       LD      D,A
0054 CB6E           CHKPLT    BIT     5,(HL)                 ;plot/no plot flag ON?
0056 2815                     JR      Z,OKPLOT               ;bit is OFF so PLOT
                                                             ;else the following jump
                                                             ;sends control looping
                                                             ;back to get another
                                                             ;control character
                        ;
                        ;-=-=-=-=-=-=-=-=-=-=-
0058 10DA           JMPER2    DJNZ    MAIN                   ;span #2 of the "bridge"
                        ;-=-=-=-=-=-=-=-=-=-=-
                        ;
                        ;These lines "page" the updated video storage area
                        ;back IN to the screen.  The action is skipped
                        ;when the paging argument = 1 or 3 (bit 0 is ON).
                        ;
005A DDCB0046       EXIT      BIT     0,(IX+PAGER)           ;P%(5) = 1 or 3 ?
005E C0                       RET     NZ                     ; then back to BASIC
                        ;
005F FDE5                     PUSH    IY                     ;else  page IN to screen
0061 E1                       POP     HL                     ;HL => storage
0062 11013C                   LD      DE,3C01H
0065 1D                       DEC     E                      ;DE => screen memory
```

Listing 1 continued on page 402

Listing 1 continued:

```
0066 01FF03          LD      BC,3FFH
0069 03              INC     BC                 ;BC is byte count (1024)
006A EDB0            LDIR                       ;page memory to screen
               ;
006C C9              RET               ;<<<<< program EXIT <<<<<<<
               ;
               ;
006D C5        OKPLOT PUSH   BC                 ;save table byte counter
006E D5              PUSH    DE                 ;  and current X,Y
               ;
               ;     These nested loops draw a block of pixels (or
               ;     characters) which is SCALE wide and SCALE high.
               ;
               ;                         ##################################
               ;                                                          #
006F D5        YLOOP  PUSH   DE                 ;                         #
0070 DD4609          LD      B,(IX+SCALE)       ;                         #
               ;                                                          #
               ;                                            ************  #
0073 E5        XLOOP  PUSH   HL        ;save main registers            *  #
0074 C5              PUSH    BC        ;                               *
               ;                                                       *
0075 DD7E07          LD      A,(IX+SRBYTE)      ;if 5th  argument is   *
0078 FE02            CP      2                  ;1 or 0, mode is PIXEL
007A 3823            JR      C,PXMODE
               ;
               ;**********************************************************
               ;*      This section determines a screen address          *
               ;* at entry : D = column position (0-63)                  *
               ;*              E = screen row      (0-15)                *
               ;* at exit : HL => video memory at requested byte         *
               ;*      destroys HL and BC registers                      *
               ;**********************************************************
               ;
007C 7A        CHMODE LD     A,D       ;check X,Y coordinates to make
007D FE40            CP      64        ; sure that they are valid
007F 305C            JR      NC,PLTSKP          ;for CHARACTER mode.
0081 7B              LD      A,E
0082 FE10            CP      16
0084 3057            JR      NC,PLTSKP
               ;
0086 63              LD      H,E
0087 6A              LD      L,D                ;  set row and column
0088 CB25            SLA     L
008A CB25            SLA     L                  ;column = column * 4
008C CB2C            SRA     H
008E CB1D            RR      L
0090 CB2C            SRA     H
0092 CB1D            RR      L                  ;HL = HL/4
0094 FDE5            PUSH    IY
0096 C1              POP     BC                 ;BC => storage
0097 09              ADD     HL,BC              ;HL => byte to alter
0098 DD7E07          LD      A,(IX+SRBYTE)      ;get plot character
009B 183F            JR      SVBYTE             ;store the CHARACTER arg.
               ;
               ;-=-=-=-=-=-=-=-=-=-=-
009D 18B9      JMPER1 JR     JMPER2             ;span #1 of the "bridge"
               ;-=-=-=-=-=-=-=-=-=-=-
               ;
               ;
```

Listing 1 continued on page 404

Listing 1 continued:

```
                 ;*************************************************
                 ;* This is a relocatable SET/RESET routine :     *
                 ;* At entry : D = X  (0-127)                      *
                 ;*            E = Y  (0-47)                       *
                 ;*  (IX+SRBYTE) = SET/RESET code (0 = RESET, 1 = SET)*
                 ;*  destroys HL, BC, AF registers                 *
                 ;*************************************************
                 ;
009F 7A          PXMODE  LD     A,D        ;skip if invalid coordinates
00A0 FE80                CP     128
00A2 3039                JR     NC,PLTSKP
00A4 7B                  LD     A,E
00A5 FE30                CP     48
00A7 3034                JR     NC,PLTSKP
                 ;
00A9 26FF                LD     H,0FFH
00AB 7B                  LD     A,E
00AC 24          DIV3    INC    H          ;divide Y value by 3
00AD D603                SUB    3          ;leaving quotient in H reg.
00AF 30FB                JR     NC,DIV3    ;   H is 0-15
00B1 C603                ADD    A,3        ;and remainder in B reg.
00B3 47                  LD     B,A        ;   B is 0-2
00B4 6A                  LD     L,D
00B5 CB25                SLA    L          ;L = X * 2
00B7 CB2C                SRA    H
00B9 CB1D                RR     L
00BB CB2C                SRA    H          ;Divide HL by 4, leaving
00BD CB1D                RR     L          ;remainder (0 or 1) in Carry
00BF CB10                RL     B          ;determine pixel position by
00C1 04                  INC    B          ;B =DIV3 rmdr * 2 + DIV4 rmdr + 1
00C2 AF                  XOR    A
00C3 37                  SCF
00C4 8F          GETBIT  ADC    A,A        ;determine pixel value by
00C5 10FD                DJNZ   GETBIT     ; taking 2 to the Bth  power
                 ;
00C7 FDE5                PUSH   IY
00C9 C1                  POP    BC
00CA 09                  ADD    HL,BC               ;HL => byte to alter
                 ;
00CB CB7E                BIT    7,(HL)              ;check if currently
00CD 2002                JR     NZ,GFXOK            ; graphics, so if so
00CF 3680                LD     (HL),80H            ;   else clear the byte
00D1 DDCB0746    GFXOK   BIT    0,(IX+SRBYTE)       ;if SET/RESET flag is 0
00D5 2803                JR     Z,RESET             ;  then skip .... else
00D7 B6          SET     OR     (HL)                ;add a bit to screen byte
00D8 1802                JR     SVBYTE
00DA 2F          RESET   CPL
00DB A6                  AND    (HL)                ;mask bit from byte
                 ;
00DC 77          SVBYTE  LD     (HL),A              ;store the altered byte
                 ;
00DD C1          PLTSKP  POP    BC         ;restore registers used by
00DE E1                  POP    HL         ;   plot routines
                                           ;                      *
00DF 14                  INC    D          ;                      *
00E0 1091                DJNZ   XLOOP      ;plot SCALE horizontal points*
                 ;                                                *
                 ;                              *******************
                 ;
00E2 D1                  POP    DE         ;
```

Listing 1 continued on page 406

Listing 1 continued:

```
00E3 1C         03090          INC    E        ;                        *
00E4 0D         03100          DEC    C        ;                        *
00E5 2088       03110          JR     NZ,YLOOP;  plot SCALE vertical points   *
                03120 ;                                                 *
                03130 ;                 **********************************
                03140 ;
00E7 D1         03150          POP    DE              ;restore current X,Y
00E8 C1         03160          POP    BC              ; and shape table counter
00E9 18B2       03170          JR     JMPER1          ;go to MAIN via JUMPERS
0000            03180          END
00000 TOTAL ERRORS
25739  TEXT AREA BYTES LEFT


CHKEST 0046 01570   01530
CHKPLT 0054 01670   01630
CHKSTH 003F 01520   01480
CHKWST 004D 01620   01580
CHMODE 007C 02230
DIV3   00AC 02660   02680
EXIT   005A 01820
GETBIT 00C4 02810   02820
GFXOK  00D1 02910   02890
JMPER1 009D 02450   03170
JMPER2 0058 01750   02450
MAIN   0034 01440   01750
OKPLOT 006D 01960   01680
PACER  000B 01000   01210 01820
PLTSKP 00DD 03000   02250 02280 02590 02620
POSKIP 0021 01310   01220
PTRLSB 0005 00960   01310
PTRMSB 0006 00970   01320
PXMODE 009F 02570   02130
RESET  00DA 02950   02920
SCALE  0009 00990   01450 02050
SET    00D7 02930
SRBYTE 0007 00980   02110 02410 02910
SVBYTE 00DC 02980   02420 02940
XLOOP  0073 02080   03040
XPOS   0001 00940   01390
YLOOP  006F 02040   03110
YPOS   0003 00950   01400
```

Listing 2: *KWIKDRAW BASIC-language program. The assembly-language programming from listing 1 has been incorporated into the DATA statements in lines 500–670. This data will be packed into line 20. Lines 10–50 may then be used as a kernel for your own BASIC programs.*

```
5 '                          KWIKDRAW
          machine language shape drawing program
                     by DAN ROLLINS
                        11/10/81

6 '**
   ** This program sets up the machine language program
   ** for use as a USR routine.  After a successful RUN,
   ** RUN again for a simple demonstration.
   **
```

Listing 2 continued on page 408

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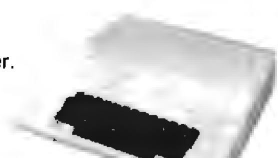

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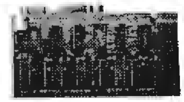

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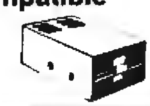

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Circle 174 on inquiry card.

```
10 CLEAR 2000 :DIM P%(517) :CLS  '* parameter & screen storage
20 KD$="------------234 or more dashes-----------------------
-------------------------------------------------------------
-------------------------------------------------------------
---------------------------------------------------"
30 V=VARPTR(KD$)
40 POKE 16526,PEEK(V+1) :POKE 16527,PEEK(V+2)
50 DEFUSR0=PEEK(V+1)+PEEK(V+2)*256   '* non-disk omit this line
99 '**
   ** This code reads the DATA lines and pokes the op codes
   ** into the dummy$ --KD$-- on line 20
   **
100 ADDR=PEEK(V+1)+PEEK(V+2)*256      '* starting address
110 IF LEN(KD$)<234 THEN CLS :PRINT "KD$ IS TOO SHORT" :EDIT 20
120 CLS :PRINT@ 975,"CODE IS BEING POKED INTO KD$"; :PRINT@ 0,;
130 READ A$ :IF A$="END" THEN 200
140     B$=LEFT$(A$,1) :C$=RIGHT$(A$,1)
150     M=ASC(B$)-48+(B$>"9")*7 :L=ASC(C$)-48+(C$>"9")*7
160     CS=CS+M+L                      '* calculate checksum
170     PRINT A$;"  ";                 '* display each byte
180     POKE ADDR,M*16+L :ADDR=ADDR+1  '* store an op code
190 GOTO 130
200 IF CS = 3330 THEN PRINT "*SUCCESSFUL* ";
     ELSE PRINT "** BAD DATA **" :STOP
210
   DELETE 99-670                 '** delete unwanted lines

500 DATA CD,7F,0A,E5,DD,E1,DD,2B,11,0C,01,15,19,E5,FD,E1
510 DATA DD,CB,0B,4E,20,0B,EB,21,01,3C,2B,01,FF,03,03,ED
520 DATA B0,DD,6E,05,DD,66,06,46,23,5E,23,56,EB,DD,56,01
530 DATA DD,5E,03,2B,23,DD,4E,09,CB,46,28,03,7B,91,5F,CB
540 '
550 DATA 4E,28,03,7B,81,5F,CB,56,28,03,7A,81,57,CB,5E,28
560 DATA 03,7A,91,57,CB,6E,28,15,10,DA,DD,CB,0B,46,C0,FD
570 DATA E5,E1,11,01,3C,1D,01,FF,03,03,ED,B0,C9,C5,D5,D5
580 DATA DD,46,09,E5,C5,DD,7E,07,FE,02,38,23,7A,FE,40,30
590 '
600 DATA 5C,7B,FE,10,30,57,63,6A,CB,25,CB,25,CB,2C,CB,1D
610 DATA CB,2C,CB,1D,FD,E5,C1,09,DD,7E,07,18,3F,18,B9,7A
620 DATA FE,80,30,39,7B,FE,30,30,34,26,FF,7B,24,D6,03,30
630 DATA FB,C6,03,47,6A,CB,25,CB,2C,CB,1D,CB,2C,CB,1D,CB
640 '
650 DATA 10,04,AF,37,8F,10,FD,FD,E5,C1,09,CB,7E,20,02,36
660 DATA 80,DD,CB,07,46,28,03,B6,18,02,2F,A6,77,C1,E1,14
670 DATA 10,91,D1,1C,0D,20,88,D1,C1,18,B2,END
799 '**
    ** This demonstrates the drawing and scaling
    ** features of KWIKDRAW
    **
800 FS$="IDDDFJHHHI"
810 M$(1)="D" :M$(2)="4D" :M$(3)="44D" :M$(4)="444D"
820 X=63 :Y=23            '** coordinates for shape
830 SR=1                  '** draw with LIT pixels
840 SC=1                  '** scale at minimum
850 PG=0                  '** page OUT and IN
```

Listing 2 continued on page 410

Listing 2 continued:

```
860 XD=-1 :YD=-1 :SD=1 '** X,Y and scale directions
870 M=M+1 :IF M>4 THEN M=1
880    A$=FS$+M$(M)
890    GOSUB 1000          '** draw the shape
900    SC=SC+SD*.4 :IF SC<1 OR SC>7 THEN SD=-SD :GOTO 900
910    X=X+XD*SC :IF X<-10 OR X>137 THEN XD=-XD :GOTO 910
920    Y=Y+YD*SC :IF Y<-5 OR Y>52 THEN YD=-YD :GOTO 920
930    FOR DELAY=1 TO 100 :NEXT
940 CLS :GOTO 870
997 '**
    ** Routine draws a predefined figure.
    ** On entry :
    **      X and Y  screen coordinates
    **           A$  holds shape characters
    **           SR  is SET/RESET/CHARACTER byte:
998 '**                   0 = draw with RESET pixels
    **                    1 = draw with SET pixels
    **                 else = CHARACTER for drawing
    **           SC  is scaling factor
    **           PG  is paging instruction:
999 '**                   0 = page OUT, draw, page IN
    **                    1 = page OUT, draw
    **                    2 = draw, page IN
    **                    3 = draw only
    **
1000 P%(0)=X :P%(1)=Y :P%(2)=VARPTR(A$)
   :P%(3)=SR :P%(4)=SC :P%(5)=PG
1010 UU=USR0(VARPTR(P%(0)))
1020 RETURN
```

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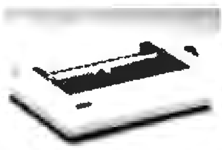

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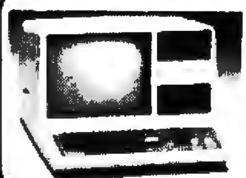

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Listing 3: *The CREATE program, used to design your own graphics shapes. It also creates a shape-definition string for use with the KWIKDRAW program.*

```
5 '**
   **                  CREATE
   **   This program is used in generating a
   **  shape definition string for display by
   **                 KWIKDRAW
   **                     .....by Dan Rollins
   **
10 CLS :INPUT"Need instructions";Q$ :IF Q$="Y" :GOSUB 9000
15 CLEAR 2000 :DEFINT A-Z :DIM V(255)
20 CK$=" /SCIDHLXAM"+CHR$(13)               '** valid command keys
25 VK$="123456789!"+CHR$(34)+"#$%&'()0"  '** valid vector keys
30 CL$=CHR$(30) :I=1
35 IM$="X:### Y:## offsets:#### ### @:#### P:### len:###"
40 FOR J=1 TO 9 :READ A$,DX(J),DY(J) :CH(J)=ASC(A$) :NEXT
45 DATA J,-1, 1,  B, 0, 1,  F, 1, 1,  H,-1, 0,  C, 0, 0
50 DATA D, 1, 0,  I,-1,-1,  A, 0,-1,  E,  1,-1
55 INPUT"coordinates for model (X,Y--defaults: 30,10)";X1,Y1
60 INPUT"coordinates for working shape (defaults: 30,30)";X2,Y2
65 PRINT :PRINT"String literal to edit or <ENTER> to start anew"
70 PRINT :SHAPE$="C" :INPUT SHAPE$
75 IF SHAPE$="" GOTO 85
80 FOR J=1 TO LEN(SHAPE$) :V(J)=ASC(MID$(SHAPES$,J,1)) :NEXT
85 LAST=LEN(SHAPE$) :X1=30 :Y1=10 :X2=30 :Y2=30
90 PTR=0 :GOSUB 700 :GOSUB 800     '** start in EXTEND mode
95 '**
    ** main loop interprets commands, displays data
    **
100 PRINT@ 0,"COMMAND: ";
105 PRINT USING IM$;X,Y,X-X2,Y-Y2,INT(X/2)+INT(Y/3)*64,PTR,LAST;
110 GOSUB 1000 :GOSUB 3000 :IF K2=0 THEN 100
115 ON K2 GOSUB 200,250,300,400,500,600,650,700,800,75,10000
120 IF K2=12 GOTO 6000
125 GOTO 100
199 '**
     ** routine moves the cursor forward              <spacebar>
     **
200 IF PTR=LAST THEN RETURN
210 PTR=PTR+1 :V=V(PTR) :GOSUB 4000
220 IF V AND 64 THEN SET(X,Y)
230 RETURN
240 '**
     ** back up cursor                                       </>
     **
250 IF PTR<1 THEN RETURN
260 V=V(PTR) :IF V AND 64 THEN RESET(X,Y)
270 V=NOT V(PTR) AND 15    '** invert all bits to back up
280 GOSUB 4000 :PTR=PTR-1 :RETURN
290 '**
     ** Search for a vector                                  <S>
     **
300 PRINT@ 0,"search vector?";CL$;
310 GOSUB 1000 :GOSUB 2000 :IF K1=0 GOTO 310
320 IF K1=10 THEN RETURN
330 V1=V :PTR=PTR+1 :GOTO 350
340 PTR=PTR+1 :V=V(PTR) :IF V=V1 THEN PTR=PTR-1 :RETURN
350 GOSUB 4000 :IF V AND 64 THEN SET(X,Y)
360 IF PTR=LAST THEN RETURN
```

Listing 3 continued on page 414

Circle 327 on Inquiry card.

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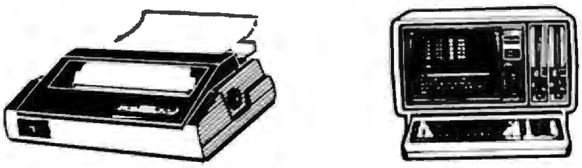

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Listing 3 continued:

```
370 GOTO 340
390 '**
     ** Change a single vector at cursor                    <C>
     **
400 IF PTR=LAST RETURN
410 PRINT@ 0,"vector to change?";CL$;
420 GOSUB 1000 :GOSUB 2000 :IF K1=0 GOTO 420
430 IF K1=10 THEN RETURN
440 V(PTR+1)=V :GOSUB 200
450 RETURN
490 '**
     ** Insert a single vector                              <I>
     **
500 PRINT@ 0,"vector to Insert?";CL$
510 GOSUB 1000 :GOSUB 2000 :IF K1=0 GOTO 510
520 IF K1=10 THEN RETURN
530 FOR J=LAST TO PTR+1 STEP-1
540    V(J+1)=V(J)
550 NEXT :LAST=LAST+1
560 V(PTR+1)=V
570 GOSUB 4000 :IF V AND 64 THEN SET(X,Y)
580 PTR=PTR+1 :RETURN
590 '**
     ** Delete a single vector                              <D>
     **
600 IF PTR=LAST THEN RETURN
610 PRINT@ 0,"Deleting a vector";CL$;
620 FOR J=1 TO 300 :NEXT
630 FOR J=PTR+1 TO LAST :V(J)=V(J+1)
640 NEXT :LAST=LAST-1 :RETURN
645 '**
     ** Hack off line & eXtend                              <H>
     **
650 PRINT@0,"Hacking from cursor on";CL$
660 FOR DELAY=1 TO 300 :NEXT
670 LAST=PTR :GOTO 800
690 '**
     ** List (draw) entire figure                           <L>
     **
700 CLS :X=X1 :Y=Y1
710 FOR J=1 TO LAST
720    V=V(J) :GOSUB 4000
730    IF V AND 64 THEN SET(X,Y)
740 NEXT
750 PTR=0 :X=X2 :Y=Y2
760 RETURN
790 '**
     ** Extend the shape                                    <X>
     **
800 IF PTR=LAST GOTO 840
810 FOR J=PTR TO LAST :V=V(J)
820    GOSUB 4000 :IF V AND 64 THEN SET(X,Y)
830 NEXT :PTR=LAST
840 PRINT@ 0,"EXTEND: (0 for COMMAND) X:";
850    PRINT X;" Y:";Y;" len:";LAST;CL$;
860    GOSUB 1000 :GOSUB 2000 :IF K1=0 THEN 860
870    IF K1=10 THEN RETURN
880    PTR=PTR+1 :LAST=PTR :V(PTR)=V
890    GOSUB 4000 :IF V AND 64 THEN SET(X,Y)
900 GOTO 840
990 '**
```

Listing 3 continued on page 416

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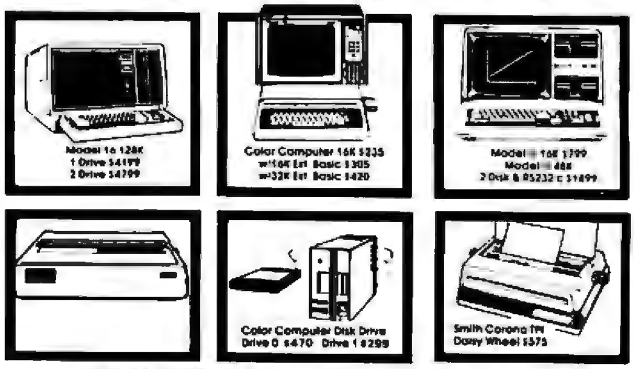

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IBM - HARMONICA ½". SERIES I. MOD 4973/II, 3200, 3289, MOD 2.	3/pk	9.42 ea	20.85/3 pk	(6.95 ea)	1/2" x 108'	Nylon Jet Blk	C-350
NEC SPINWRITER	4/pk	23.40/3 cart	23.60/4 pk rb. reload	(5.90 ea)	1/2" x 51'	Nylon/Ex Lng Life	R-400
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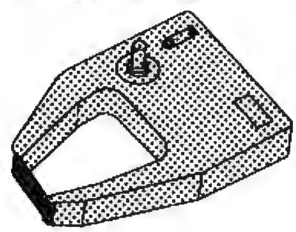
RADIO SHACK DAISY WHEEL II	1/pk	24.95/3pk	8.25	(8.25 ea)	.250"	Mylar Multistrike	C-789
RADIO SHACK LPIII, LPV	one/pk	13.95/cart	8.95/Reload rib.* only	(8.95 ea)	.500" x 45'	Nylon Incl Instr	R-T3
RADIO SHACK LPII, LPIV	3/pk	18.95/3 pk	11.95/3 pk	(3.98 ea)	.563" x 45'	Nylon Jet Blk	C-700
TELETYPE MOD 33, 28, 35, 37, 38, 88.	10/pk	2.40 ea	13.90/10 pk	(1.39 ea)	1/2" x 36'	Nylon Jet Blk	R-450
WANG M/S. 5541W, WC, 5581, WD, 6581W, 2281W	1/pk	6.85 ea	5.95 ea	(5.95 ea)	5/16" x 393'	Multistrike Film	C-550



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Circle 452 on inquiry card.

Listing 3 continued:

```
     ** get 1 key with blinking cursor
     **
1000 IF POINT(X,Y) THEN RESET(X,Y) :GOSUB 5000 :SET(X,Y)
     ELSE SET(X,Y) :GOSUB 5000 :RESET(X,Y)
1010 K$=INKEY$ :IF K$="" THEN GOSUB 5000 :GOTO 1000
1020 K=ASC(K$) :RETURN
1990 '**
      ** decode keypad as a vector byte
      **
2000 K1=INSTR(VK$,K$)
2010 MP=0 :IF K1>9 THEN MP=1 :K1=K1-9
2020 V=CH(K1)-16*MP
2030 RETURN
2040 '**
      ** non-disk: for above  use
      ** 2000 K1=0 :FOR J=1 TO LEN(VK$)
      ** 2002   IF MID$(VK$,J,1)=K$ THEN K1=J
      ** 2004 NEXT
      ** same for below, using CK$
      **
2990 '**
      ** Decode a command
      **
3000 K2=INSTR(CK$,K$) :RETURN
3990 '**
      ** adjust X and Y according to vector V
      **
4000 IF V AND 1 LET Y=Y-1
4010 IF V AND 2 LET Y=Y+1
4020 IF V AND 4 LET X=X+1
4030 IF V AND 8 LET X=X-1
4040 X=X+(X>127)*128 - (X<0)*128     '** screen wrap-around
4050 Y=Y+(Y>47)*48 -(Y<0)*47
4060 RETURN
4990 '**
      ** short delay routine
      **
5000 FOR DELAY=1 TO 30 :NEXT :RETURN
5990 '**
      ** exit editor, compile shape$                    <ENTER>
      ** and write to disk
      **
6000 SHAPE$=""
6010 FOR J=1 TO LAST
6040    SHAPE$=SHAPE$+CHR$(V(J))
6050 NEXT
6060 PRINT@ 0, CL$; :INPUT"disk save on line number";LN!
6070 PRINT CL$; :LINEINPUT"string variable name? ";SN$
6080 DW$=STR$(LN!)+" "+SN$+"="+CHR$(34)+SHAPE$+CHR$(34)
6083 PRINT DW$ :PRINT
6085 Q$="" :INPUT"format ok";Q$ :IF Q$="N" CLS :GOTO 6060
6090 IF F1=0 THEN F1=1 :PRINT CL$; :LINEINPUT "filespec? ";FS$
        :OPEN"O",1,FS$
6100 PRINT#1,DW$
6110 '
6120 CLS :Q$="" :INPUT "edit another string (Y/N)";Q$
6130 IF Q$="N" THEN CLOSE :END
6140 GOTO 65
8999 '**
```

Listing 3 continued:

```
      ** instructions
      **
9000 CLS :PRINT "     CREATE...a graphics editor for KWIKDRAW"
9010 PRINT"This program is an aid in creating and modifying a"
9020 PRINT"string of vector characters: `A'-`J' and `1'-`:'"
9030 PRINT"You may input or build this string with the editor."
9040 PRINT"   The NUMERIC KEYPAD is used to    <9>   <8>   <7>"
9050 PRINT"move a  cursor  in  the  desired       *    :    *"
9060 PRINT"pattern.  Use these keys whenever   <6> -   *   - <4>"
9070 PRINT"you are prompted for a VECTOR and      *    :    *"
9080 PRINT"while extending the shape.          <1>   <2>   <3>"
9090 PRINT"   The <0> key is used to cancel commands and to"
9100 PRINT"exit EXTEND mode."
9110 PRINT"   You may define the X and Y screen positions for"
9120 PRINT"your `model' and your `working copy'.  The top line"
9130 PRINT"shows: the current X and Y, offsets from the start,"
9140 PRINT"the PRINT@ position, position within the shape,"
9150 PRINT"and length of the shape string.";
9160 PRINTTAB(50);"Press <ENTER>"; :X=126 :Y=46 :GOSUB 1000
9999 '**
      **  Menu of commands                                    <M>
      **
10000 CLS :PRINT TAB(9);"Create - graphics editor for KWIKDRAW"
10010 PRINT"commands:";TAB(38);"....by Dan Rollins"
10040 PRINT"   <spacebar>...cursor forward"
10050 PRINT"   </>..........cursor backward"
10060 PRINT"   <A>..........Abort edit without change"
10070 PRINT"   <ENTER>......exit editor & save shape to disk"
10080 PRINT"   <D>..........Delete a single vector"
10090 PRINT"   <L>..........List (draw) shape, cursor to start"
10100 PRINT"   <S>..........Search for a vector"
10110 PRINT"   <C>..........Change a vector"
10120 PRINT"   <I>..........Insert a single vector"
10130 PRINT"   <X>..........eXtend shape (enter EXTEND mode)"
10135 PRINT"   <1> - <9>....vector keys for S,C,I,X commands"
10140 PRINT"   <0>..........escape from S,C,I,X commands"
10160 PRINT"   <SHIFT>.......move-only vector (with <1> - <9>)"
10170 PRINT"   <M>...........display this list";
10175 PRINT TAB(50);"press <ENTER>";
10180 X=126 :Y=46 :GOSUB 1000
10190 IF I=0 THEN I=1 :CLS :RETURN
10200 GOTO 700
```


Circle 266 on inquiry card.

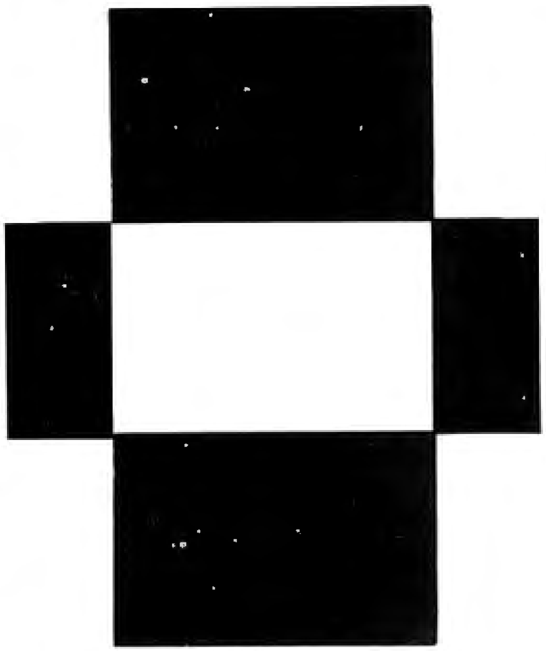

Figure 1: *A simple figure drawn using the CREATE program.*

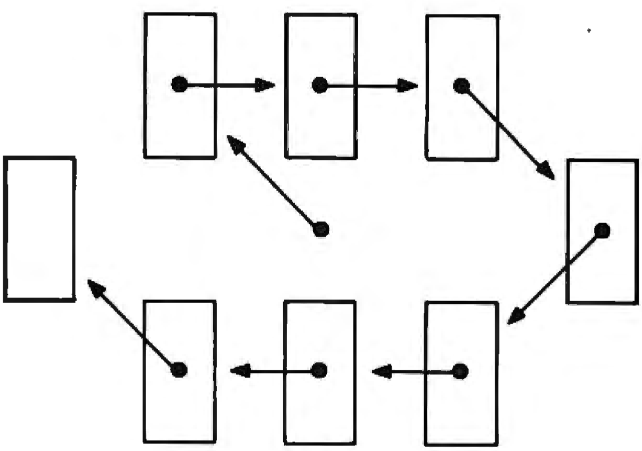

Figure 2: *Sequence of cursor moves showing how figure 1 was drawn. The figure has been expanded for clarity.*

Text continued from page 394:

walk through a sample session. For example, to create figure 1, we ordinarily write this BASIC subroutine:

```
1000 SET(X-1,Y-1) :SET(X,Y-1) :SET(X+1,Y-1)
     :SET(X+2,Y)
1010 SET(X+1,Y+1) :SET(X,Y+1) :SET(X-1,Y+1)
     :SET(X-2,Y)
1020 RETURN
```

A GOSUB to this routine would slowly draw the shape in a position relative to the key position defined by the X and Y coordinates.

Defining the same figure as a series of vectors can be as easy as running the CREATE program (see listing 3) and using the numeric keypad to move a dot in the necessary pattern. But to *understand* the process, look at figure 2. Beginning at a central position, the first cursor motion will be northwest with the resulting pixel turned on. The next two motions are east, etc. The result is a pattern of directions:

NW, E, E, SE, SW, W, W, NW

Referring to table 1, we see that these vectors are defined by the characters

I D D F J H H I

The shape would be defined within a BASIC program as

SHAPE$ = "IDDFJHHI"

Now that the shape is defined, it may be drawn at any screen position by storing a few parameters and invoking the KWIKDRAW USR routine.

The shape-interpreter will look at the bit positions of each of the vector bytes to determine the direction in which to move the cursor. The control codes (A through J and 1 through :) were chosen specifically for the bit positions of their binary values. Using these bit patterns as instructions, KWIKDRAW decodes these bytes as motions of a cursor. For example:

Direction	Vector ASCII hexadecimal	Bits 76543210 WESN	Vector ASCII hexadecimal	Bits 76543210 WESN
North	= A = 41 =	01000001	1 = 31 =	00110001
East	= D = 44 =	01000100	4 = 34 =	00110100
Northeast	= E = 45 =	01000101	5 = 35 =	00110101

Bit 0 (the rightmost bit) of a byte is the flag for moving north, and bit 3 indicates motion east. When both bits 0 and 3 are 1, motion is to the northeast. Also, notice that A and 1 have the same binary value with the exception that bit 4 is on in the latter. This bit is tested to determine whether to move without changing whatever is in the background. Bits 5, 6, and 7, untested by the program, are on only for the convenience of the BASIC programmer.

The first action taken by KWIKDRAW in vector interpretation is the adjustment of its X,Y pointer. Usually, the key position (the X,Y pair passed to the program) will not be plotted. Remember, the principal aspect of a vector is *motion in space*. If you want the very first character to indicate a screen change at the exact coordinate defined by the X,Y parameters, a move and plot command of C will first move the cursor north, then south and plot the position. Otherwise, the first position plotted will be offset by one step from the starting X,Y coordinate in the direction defined by the vector.

Passing Parameters

Four basic parameters are required by KWIKDRAW in its processing of a shape-definition string:

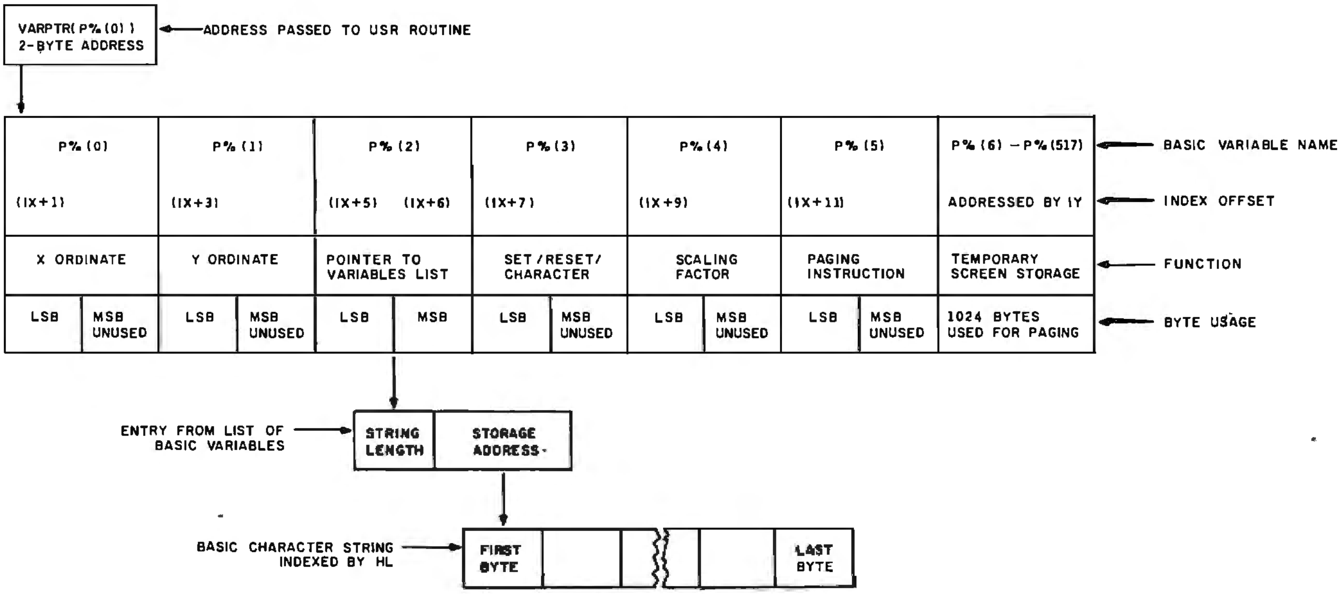

Figure 3: *Organization of string data accessed by the VARPTR function of the KWIKDRAW program.*

- where to draw the shape (an X,Y coordinate pair)
- whether to set/reset a pixel or use a character
- a pointer to the shape-definition string
- a scaling factor to define the size of the shape

Additionally, you may decide whether or not to page the screen workspace in or out of video memory—more on that later.

An inherent limitation of the USR hook is that only one integer argument at a time may be passed to the routine it calls. Because of the number of parameters needed by KWIKDRAW, a sophisticated protocol was developed. The arguments are placed in elements of an integer array, and the address of the first array element is passed to KWIKDRAW.

The VARPTR function returns an address that points either directly or indirectly to the storage address of the variable.

VARPTR(*integer array variable*) points directly to a contiguous block of main memory, addressing the LSB (least significant byte) of the variable named. The next higher address is the MSB (most significant byte), the following 2 bytes are the LSB and MSB of the array element next in line, etc. For example:

```
10 A%(0) = 2
20 PRINT.PEEK(VARPTR(A%(0))),
   PEEK(VARPTR(A%(0))+1)
```

This will print

```
 2    0
```

The variable is stored using the two's complement convention. Negative numbers have been increased by 1 and have had all bits flip-flopped. Thus, if A%(0) = −2, the result would be

```
 254    255
```

VARPTR(*string variable*) returns an address that is the location of a block of data associated with the string. The address itself will contain a 1-byte string length (0–255). The next 2 bytes are a pointer to the actual main-memory storage location for the characters. This address is read in normal Z80 format, that is, MSB followed by LSB. Figure 3 should help in visualizing just how the addresses are accessed by KWIKDRAW.

One word of caution when using these facts in conjunction with the USR command. It is usually desirable to include the VARPTR function explicitly as the USR argument, rather than setting a variable to the value for reuse. For example, always pass the pointer with

```
UU = USR(VARPTR(P%(0)))
```

Don't use

```
VP = VARPTR(P%(0)) :UU = USR(VP)
```

The reason for this is based upon Microsoft's variables table handling. Simple (nonarray) variables are inserted into the list on the fly. As a new simple variable is created, all array variables are pushed higher in memory. In the example above, VP will point correctly *until the storage for the* UU *variable is allocated.* The insertion of UU into the variables table alters the position of the P%( ) array, making the value of VP invalid. Also, the address returned by VARPTR(*string variable*) may be invalidated by BASIC's string reorganization.

P%(0) = key horizontal (X) ordinate:
display range: 0–127 (PIXEL mode)
0–63 (CHARACTER mode)

P%(1) = key vertical (Y) ordinate:
display range: 0–47 (PIXEL mode)
0–15 (CHARACTER mode)

P%(2) = pointer to string variable data block:
usually VARPTR(shape$)

P%(3) = display mode:
0 = RESET pixels
1 = SET pixels
2–255 = display character

P%(4) = scaling (magnification) factor:
possible range: 1–256 (0 = 256)
practical range: 1–15

P%(5) = paging code:
0 = copy screen to memory, draw shape, copy memory to screen
1 = copy screen to memory, draw shape
2 = draw shape, copy memory to screen
3 = draw shape (in memory only)

Table 2: *Control parameters used in the passing of parameters to the shape interpreter.*

These problems crop up only when they're least expected. They may always be avoided by taking this precaution: *Never define a new variable between the storing of parameters in the P%( ) array and the invoking of the USR command.* This is the first place to start looking when KWIKDRAW does something unexpected.

Table 2 indicates the array variables used in the passing of parameters and the limits associated with each. Discussion of this parameter array will always refer to the P%( ) array. Any INTEGER variable array would work, however, and the "%" character may be omitted if a DEFINT command has been specified for the variable.

Note that invalid data in these variables will *not* crash the program. A possible problem, however, is encountered when the scaling factor is set to 0. KWIKDRAW will appear to lock up because it cycles through the SET/RESET routine more than 65,000 times per shape-definition byte. The practical range for scaling a pixel shape is approximately 1 to 15.

Invalid X,Y coordinates are ignored by the program. A shape may be drawn so that part of it is off the screen. Specifying ordinates less than 0 or greater than the screen size is allowed. It is usually advisable to use a central point of the shape as the key vector during shape-definition. This gives the shape its maximum range of motion during animation. Another reason for this precaution is due to the nature of the scaling function.

When the scaling factor is greater than 1, each vector will be drawn as a filled rectangle SCALE wide by SCALE high. The rectangle will be placed with its northwest corner at the current cursor position, and cursor motion will be in increments with the step size equal to SCALE. As the shape is enlarged (its scaling factor is increased), the shape will appear to move southwest. Assuming that the key position remains the same, the vectors will force cursor motion in greater and greater steps and fill larger and larger blocks. By using a central location within the shape as the key vector, this sliding effect can be minimized.

Paging the Video

A flaw in the TRS-80 Model I hardware causes an effect known as *hashing* on the video screen. Unwanted streaks and flickering can be seen during rapid graphics operations. The *TRS-80 Technical Reference Handbook* explains that the video-divider chain loses control of the display for short periods of time while the central processing unit accesses video memory. Unfortunately, the only way to minimize this effect is to address video RAM (random-access read/write memory) as seldom as possible.

KWIKDRAW may make hundreds—even thousands—of accesses to video RAM during the drawing of a single shape. The resulting hashing could be an irritating source of eye fatigue. Additionally, the action of drawing a complex shape (or one scaled to many times its original size) takes a certain amount of time—even at machine-language speeds. It is desirable to eliminate this visible lag between the drawing of the first and the last vector.

For these reasons, a paging feature is included as part of the machine-language code. KWIKDRAW uses non-video RAM as working storage for the screen. All shapes are drawn in this work area—screen memory being addressed only at the start and/or end of the shape-drawing process. Of special significance are the options of (1) copying the current contents of the screen to storage, and (2) drawing multiple shapes within the working storage before moving it to the display area. Though screen hashing is not completely eliminated, the utility of KWIKDRAW is greatly enhanced by the inclusion of this paging function.

Video-paging requires that 1024 bytes of main memory be set aside for working storage. To avoid having to set MEMORY SIZE and to keep the program compatible with TRS-80 Models I and III of all memory configurations, the storage area for an integer array is used for manipulating the screen. Because the P%( ) array is being used to pass parameters to KWIKDRAW, it is the logical place for the screen work area. Therefore, this array must be dimensioned to at least 517. The first six elements (0–5) are for parameter passing. The rest (512 elements with 2 bytes per element = 1024 bytes) are used for screen operations.

The paging is performed using the Z80 op code LDIR, a block-move instruction. This is a memory-to-memory transfer that moves bytes from the source address defined by the HL register pair to the destination address held in DE. The BC register pair is automatically used as a byte counter for this operation and is set here to 1024—the total number of screen bytes. For paging out of video RAM, HL is pointed to the screen address (3C00 hexadec-

Description of the KWIKDRAW Assembly-Language Program

Much of the utility of KWIKDRAW is rooted in the fact that it is located on a BASIC program line and avoids the necessity of reserving high memory. Several trade-offs were needed to accomplish this end. Speed is traded for relocatability, program size is traded for compatibility with the BASIC program line format, and modularity is seemingly lost in the necessity of avoiding CALLs.

The program is, however, written in a modular style with each section being basically self-contained. First, the program initializes its variables. Then it takes the requested paging action. The next section interprets each of the bytes of the vector string. It adjusts the horizontal and vertical pointers, determines plot/no plot action, and plots a position according to the scaling parameter. Finally, the return paging action is taken and execution is passed back to BASIC.

The CALL to 0A7F hexadecimal in line 1050 returns HL with the address of the first byte of the P%( ) array. The IX index register is immediately set to this value by pushing it from HL onto the stack and popping it into IX. Because this address points directly to the X (horizontal) ordinate, the offset byte used in accessing the value would assemble to a 0. Because BASIC line format dictates that this must be avoided, IX is decremented. The X ordinate is now found in the address referred to by IX+1.

The address used for the start of screen storage is used several times during the program. It is convenient to have it accessible as a main register. This address is the same as the location of the seventh element of the parameter array P%(6), and is calculated by adding 12 to the USR argument, i.e., the start of the P%( ) array. Then it is saved in the IY register. Lines 1850, 2380, and 2840 access this address with a PUSH and a POP to another register.

When the storage address has been determined, the paging action takes place. Two of the four possible paging codes, held in P%(5), request that the current contents of the screen be copied to storage before any shape-drawing occurs. Testing the lowest bit of P%(5) sets a flag used in selecting the desired action. The BIT op code used here (testing a single bit of a byte at an indexed address) is very useful in this type of bit-logic application. As with all BIT testing, the Z flag is set when the bit is off. Think of it as complementing the test bit and placing it into the Z flag, or remember that the Z flag is set as if a CP (compare) operation was performed between the test bit and a 0.

When the paging argument is 0 or 1, the screen is moved into the storage area. Notice in lines 1250–1280 that absolute addresses of 3C00 and 0400 hexadecimal must be loaded into the HL and BC registers. Here again, the zero bytes must be avoided so that the registers are loaded, then decremented or incremented to the correct values. The LDIR (load, increment, and repeat) op code duplicates the screen bytes into the storage area where they may be altered with a minimum of screen hashing.

Lines 1310–1420 finish the initialization process. The number of characters in the vector string is saved in the B register, the starting X and Y coordinates are placed into the D and E registers respectively, and HL is pointed to just efore the start of the vector string. The program is now set up to begin the interpretation process.

The main loop decodes each vector byte as motions of an X,Y pointer. HL is adjusted to point to the byte to decode. The bits of this byte are tested individually. The DE pointer is adjusted in any of eight directions—according to which of the bits are on. Adjustments are made in increments of the scaling factor. When DE has been updated, the fifth bit is tested for a plot/no plot action. If the byte being examined is an ASCII character between 1 and : (31–3A hexadecimal), the main body of the program is skipped. Register B is decremented; if it's not 0, execution loops back to decode another vector.

A truly modular program would simply make a CALL to the plot routine when the characters A through H were encountered. KWIKDRAW must jump past the program exit code to line 1960 where the plotting action begins. A pair of nested loops is set up in lines 1960–2090. If programmed in BASIC, the rest of this program would look something like

```
10 FOR J=1 TO SCALE
20      FOR K=1 TO SCALE
30           SET(X+K,Y+J)
40      NEXT K
50 NEXT J
```

When SCALE = 0, the loops are each performed 256 times. This mistake will cause a delay of about 7 seconds per (plotting) vector byte.

The loops are ended at lines 3030–3170. The outer-scaling loop sends control back to the top of the main loop by way of a two-span bridge. Because the Z80 JR (jump relative) op code has a range of −126 to +129 bytes from the program counter, and the distance between the bottom and the top of the loop is outside this range, this indirect route must be taken. Two spans to the bridge avoid breaking up any of the logical program modules.

*The assembler code analogous to the SET(X+K,Y+J) example from above is actually two separate modules. Depending on the value of the SET/RESET/CHARACTER parameter passed in P%(3), a point is defined as either a single pixel or an entire byte of memory. When P%(3) is greater than 1, the code beginning at line 2230 (CHARACTER mode) is invoked. Here, a PRINT@ screen position (0–1023) is calculated from the X and Y coordinates. The formula used is position = (Y*256 + X*4) / 4. This is calculated very rapidly using the register shift and rotate directives. The position obtained is added to the start of the screen storage area, yielding an address to which the parameter byte is saved.*

*Calculations for determining which pixel to set or reset are somewhat more complicated. Both a PRINT@ position and a pixel value must be ascertained. The former is simply position = (INT(Y/3)*256 + INT(X/2)) / 4. The remainder of the Y/3 operation (0–2) is saved in the B register, and the carry flag holds the remainder left after the division by 4 (0 or 1).*

A pixel is lit by applying a logical OR to the graphics byte at the indicated position. Masking the same value from the

Text box continued on page 423

Text box continued:
byte will darken this pixel. Graphics bytes will always have a value greater than or equal to 128 (80 hexadecimal). Applying the logical OR to one of these values:

1	2
4	8
16	32

and to any graphics byte, will light the respective pixel.

The SET/RESET routine of KWIKDRAW determines which of these values to use by multiplying the B register by 2 and adding the carry flag value, then extracting 2 to the power of the resulting sum. The formula, where MOD is a remainder function, is

*bit = 2 ↑ (MOD(Y/3) * 2 + MOD((INT(Y/3) * 256 + INT(X/2)) / 4))*

Once these numbers have been obtained, the screen storage byte is modified for the indicated action. Any nongraphics byte at the position is first changed to a blank graphics byte. For a SET action, the pixel value is compared with the current byte using a logical OR operation. A RESET action is performed by complementing the pixel value and then performing a logical AND with the position byte. The resulting byte is saved at line 2980. Incidentally, this SET/RESET routine is modeled after the one found in the Level II ROM. Several modifications made it relocatable and speeded it up a bit.

Both the SET/RESET and the CHARACTER routines check for coordinates that would modify bytes outside the storage area. When an X,Y pair is out of range, the routine is simply skipped—allowing shapes to be drawn wholly or partially off the screen.

Finally, the last vector byte has been interpreted when the B register is decremented to 0 by the DJNZ on line 1750. Execution falls through to the paging and exit module. Here, the paging argument is again tested. A value of 0 or 2 causes the updated storage area to be copied onto the screen. Control is then handed back to the BASIC program.

imal), and DE is set to the address of the sixth element of the P%( ) array. The LDIR op code then copies the screen to the storage area. Paging back into video RAM is accomplished by reversing these registers so that the storage area is copied to the screen.

A detailed description of the KWIKDRAW shape-table interpreter (listing 1) is included with this article in a separate text box. This, plus the remarks within the listing, will explain the structure of the program and detail the techniques used in this example of hybrid programming.

The problem new users will most often experience with KWIKDRAW is incorrect handling of parameter passing. A BASIC programmer is used to having English-sounding words like PRINT and DRAW as commands. KWIKDRAW takes a giant step backward in this respect. There is no easy way to remember which parameter goes in which element of the P%( ) array.

I suggest that a copy of table 2 (the list of parameter codes) should be available for easy reference during programming with KWIKDRAW.

A Graphics Editor

CREATE is a handy utility program for defining the vector strings needed by KWIKDRAW (see listing 3). It is a graphics editor in much the same way that BASIC's EDIT mode is a text editor. Normally, you'll design a shape on a graphics worksheet and use CREATE for encoding it into a vector string.

Operation is simple; define two pairs of key X,Y coordinates at the prompts. The first is the position at which a reference model is drawn. The latter is for the working copy. Next, CREATE expects input of a series of vector characters that are to be edited. This is the only time you'll have to refer to table 1. You may use a null entry here to define your starting shape string as C—the plot-the-key-position vector described earlier. To edit a few changes to a predefined string, you may read it in from disk, set SHAPE$ to its value, and skip this input prompt.

Commands recognized by CREATE are

SPACEBAR	Advance the cursor
/	Back up the cursor
A	Abort edit without change to SHAPE$
ENTER	Exit editor and save the shape
D	Delete a single vector
L	List (draw) the shape, cursor to start
S	Search for a vector
C	Change a single vector
I	Insert a single vector
X	Enter EXTEND mode (add vectors)
0	Escape from S,C,I,X commands
1–9	Vector keys for S,C,I,X commands
SHIFT	Move-only vector—with <1> through <9>

The L, S, C, and I commands are followed by a vector from the numeric keypad. The X command expects a series of such vectors.

Visualize the keypad as being superimposed on the screen with 8 at the top, 4 on the left, 3 at the lower right, etc. Move the cursor and plot the resulting pixel by pressing the key corresponding to the desired direction. Press the Shift key with the direction key to include a move-only vector. The 0 key is used to escape from any of the above commands.

Some important data is displayed during the editing process: the current X,Y pixel coordinate, the current PRINT@ position, the length of the string, and the current offsets from the starting X and Y. Though positions are relative during KWIKDRAW's interpretation of the shape, knowing the size of the shape is handy in defining multiple shapes (alphabetic characters, frames of animation), and the X,Y offsets are needed for chaining a series of complex figures.

Pressing the Enter key from COMMAND mode saves the shape in the variable SHAPE$ for processing to disk. Don't have disks? Use LPRINT SHAPE$ and copy it into your applications program. Don't have a printer? Get a pencil.

Disk users will be prompted for a file name and a sequential file is opened. You'll then be prompted for a line number and a variable name. The string is written as a BASIC line in the format

```
line# variablename="....vector characters...."
```

For example:

```
10240 SHAPE$(2,4)="IDDFJHHI"
```

The resulting file may be merged with an applications program that contains the KWIKDRAW routine. It would be easy to change the format so that the shape may be read as a DATA line.

Multiple Pages and Other Trivia

Some of the utility of KWIKDRAW will not be completely apparent until it has been used a few times. For example, a working page may be filled with any byte (except 0 or 1) by

```
CL$="CDDD"
P%(0)=0 :P%(1)=0________ X and Y to top left
P%(2)=VARPTR(CL$)______ point to the four vectors
P%(3)=2 - 255___________ byte to fill (in
                         CHARACTER mode)
P%(4)=16 _______________ scaling factor
P%(5)=3_________________ don't page IN or OUT
UU=USR0(VARPTR(P%(0)))  fill the page
```

Use this as a subroutine for clearing a page before building a frame of animation.

Sometimes BASIC is too slow in processing changes to a page between displays. By defining the P%( ) array with two dimensions, more than one page of video storage is available. For example, DIM P%(517,2) provides three (0, 1, and 2) separate pages for manipulation. Doubly dimensioned array variables are stored with the first-dimensioned subscripts varying fastest. Thus, P%(0,1) of the above example will actually be stored in the addresses sequentially adjacent to P%(517,0).

KWIKDRAW doesn't care what variable address it receives as the USR parameter. It *does* expect this address to point to a series of parameters followed by 1024 bytes for paging. Therefore, any of the dimensioned pages may be accessed by placing the parameters in the elements 0 through 5 of that subscript level, then invoking the shape-interpreter. At the expense of memory, multiple paging can provide maximum speed.

Listing 4: *Subroutines for use with the KWIKDRAW program.*

```
998 '**
     ** subroutine compiles a vector string which will
     ** connect 2 points.  Most useful for coordinate pairs
     ** separated by 3 or less vectors  -OR-
     ** when the line between the points is straight.
999 '** On entry    : X1,Y1 = starting point
     **             : X2,Y2 = ending point
     **             : IN = 1 for plot vectors, 0 for move only
     ** On exit     : A$ holds vector string
     **             : X1,Y1 become X2,Y2
     **
1000 A$=""
1010 IF X1=X2 AND Y1=Y2 THEN RETURN
1020    V=0
1030    IF Y1>Y2 THEN V=V OR 1
1040    IF Y1<Y2 THEN V=V OR 2
1050    IF X1>X2 THEN V=V OR 8
1060    IF X1<X2 THEN V=V OR 4
1070    A$=A$+CHR$(64-IN*16+V)
1080 GOTO 1010
1999 '**
      ** subroutine rotates a vector string
      ** on entry  : A$ = string to rotate
      **           : R = number of 45 degree rotations (1-7)
      ** on exit   : B$ holds rotated vector string
      **
2000 B$=""
2010 FOR J=1 TO LEN(A$)
2020    V=ASC(MID$(A$,J,1)) :V1=V AND 15
2030    FOR K=1 TO R
2040       V2=0
2050       IF V1 AND 1 THEN V2=V2 OR 5
2060       IF V1 AND 2 THEN V2=V2 OR 10
2070       IF V1 AND 4 THEN V2=V2 OR 6
2080       IF V1 AND 8 THEN V2=V2 OR 9
2090       IF (V2 AND 3)=3 THEN V2=V2 AND 12
2100       IF (V2 AND 12)=12 THEN V2=V2 AND 3
2110       V1=V2
2120    NEXT K
2130    B$=B$+CHR$(V1 OR (V AND 240))
2140 NEXT J :RETURN
```

Listing 4 contains two subroutines that are useful in manipulating a predefined vector string. The routine at line 1000 demonstrates the flexibility of the bit logic of the shape-interpreter. Write a program that generates X,Y pairs—say a sine/cosine routine that draws a circle. For each new X,Y pair, call this routine and concatenate a string from the return value in A$. The result would be a vector string that will draw a circle in the blink of an eye.

I determined that rotating a shape has limited value—considering the asymmetric nature of the TRS-80 pixel. Therefore, this is not a function handled by KWIKDRAW. It is simulated in the subroutine at line 2000, which will rotate a shape in increments of 45 degrees.

Normally, the resulting string would be typed into a program rather than calling this routine during operation.

Conclusion

The descriptions in this article can't convey the dynamic nature of shape-table graphics. I urge you to enter and use KWIKDRAW to see for yourself just what is possible. The effect is orders of magnitude beyond anything possible with BASIC alone. You've got a graphics tool now that can really "shape up" your TRS-80 graphics. Its use is limited only by your own imagination. Dazzle your friends with your programming expertise . . . you might even dazzle yourself! ■

For $20, Mr. Rollins will provide a Model I disk. It contains the published listings plus some further examples of shape-table graphics, including a program that manipulates a jumbo ASCII character set.

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BYTELINES

News and Speculation about Personal Computing

Conducted by Sol Libes

Random Rumors: It's rumored that Commodore Business Machines and some of its alternate suppliers are working on CMOS (complementary metal-oxide semiconductor) versions of the 6502 microprocessor (used in the Apple II, Atari 400 and 800, and Commodore personal computers) that would allow low-power operation. . . . One reliable source tells me that this year IBM plans to offer a high-resolution color video monitor for the Personal Computer that emulates IBM's 3279 terminal. . . . Word has it that Radio Shack will soon start selling the Casio handheld computer and drop one of the Sharp models it currently handles. . . . It is rumored that Apple Computer Inc. will shortly cut the price for the Apple II and Apple III by 10%. . . . Sharp is reportedly working on a computer based on Motorola's 68000 microprocessor that will provide a single-user Unix operating system, similar to the Fortune Systems 32:16.

What's Going on at the Shack? It is now over half a year since Radio Shack introduced its 16-bit computer, the Model 16, with the promise of a three-user operating system running on the Motorola 68000 microprocessor housed within the unit. However, so far purchasers can run only the old TRS-80 Model II single-user 8-bit Z80 operating system and applications software. Rumors have been floating around that Microsoft was adapting its Xenix operating system for the Model 16. Now it turns out that the operating system was really being developed by Ryan-McFarland and that Tandy later changed its mind and went to Charles River Data Systems for the multiuser operating system. Finally, it is expected that Tandy will also offer a single-user 16-bit operating system designed by Ryan-McFarland, in which case I wonder if there will be upward migration from the single- to multiuser systems.

Tandy reported that computer sales rose 69% for the last fiscal year, up to $624 million from $369 million, and that these sales now account for 31% of the company's business—back in 1978, computers accounted for only 2.4%. Further, Tandy claims that the TRS-80 Model II accounted for 25% of its computer sales; the Model III, 27%; the Color Computer, 7.2%; pocket computers, 2.5%; software sales, 8.5%; printer sales, 16.7%; and computer-related products, 12.2%. (It is strange that these percentages do not total 100%.)

Tandy also reported that gross profits as a percentage of sales were 59.3%—far higher than the norm for the electronics industry. Net profits were reported to be 11%. Radio Shack now has 392 computer centers and plans to open 125 more. It also sells computers through 5127 company-owned stores and another 2999 franchised outlets. The number of stores will increase by 170 this year.

At IBM: Rumors concerning IBM's future plans suggest that the firm intends to enter the portable-computer market with a "baby" Personal Computer system made outside the U. S. by Matsushita, that it is at the preproduction stage of a new 4-inch floppy-disk drive, and that it will introduce soon a 3270 IBM terminal emulator and RJE (remote job entry) package for the Personal Computer with an anticipated selling price of $700. A high-resolution color monitor is also expected that will allow the Personal Computer to emulate an IBM 3279 terminal. Because the Personal Computer costs less than IBM's series 327x terminals, which are used with IBM's large mainframe computers, doubtless customers of such systems will be switching to the IBM Personal Computer for their terminal needs.

IBM has also started selling enhancements for its Displaywriter desktop word-processor system that allow it to act as a terminal. Further, IBM now sells the p-System (Pascal language) for the Displaywriter for users who want it to function as a complete computer system. The Displaywriter uses an Intel 8086 microprocessor, and therefore it's strange that IBM doesn't plan to offer the MS-DOS and CP/M-86 operating systems for the unit, considering that these are available for the Personal Computer. Of course, concurrent CP/M-86 for the Displaywriter can be purchased directly from Digital Research. I can only wonder now if Microsoft will offer MS-DOS for the unit.

IBM offers one other desktop unit, called the System 23 Datamaster. It is the most expensive of IBM's small computers but uses an 8-bit microprocessor (the Intel 8085, an enhanced version of the 8080). It's likely this processor was chosen because the Datamaster was introduced before the Displaywriter and the Personal Computer. The Datamaster offers much more disk storage capacity than either, however.

It seems likely that IBM will replace the Displaywriter and Datamaster with enhanced versions of the Personal Computer, probably using the new Intel 80286 processor (an enhancement of the 8086). Thus the next Displaywriter may be the Personal Computer with a display and keyboard better suited to word processing, and the next Datamaster may be a Personal Computer with larger disk storage. In this way, IBM could maintain upward compatibility through its entire line of desktop computers, terminal compatibility with its mainframes, and workstation compatibility with its new networking system. If this happens IBM will have the most comprehensive line of office-product computer systems in the industry.

In the meantime, IBM is due to introduce soon its hard-disk option (using the Seagate 5¼-inch drive) for the Personal Computer. Word is that the firm expects to sell about 300,000 this year alone. Also Tecmar, which develops peripherals and enhancements compatible with the Personal Computer, is reportedly planning to introduce a Winchester add-in using either one or two Syquest Technology 3.9-inch, 5-megabyte hard-disk drives with removable media. This would be an ideal combination, allowing the user to easily back up the IBM hard disk.

Recent advertisements from franchised IBM Personal Computer dealers have offered $500 worth of free software with the purchase of an IBM Personal Computer, some are offering discounts of up to 15%, and some dealers are offering financing. This may suggest that supply and demand have begun to catch up with one another.

IBM has discovered that some of its franchised dealers, unauthorized dealers, and private entrepreneurs buy the minimum-priced 16K-byte version of the Personal Computer and add their own (much less expensive) memory and disk drives, then sell the full system either at list price or at a discount. A private entrepreneur can buy the minimum-priced 16K-byte machine with no disk drive for $1250, add three additional banks of memory chips (for as little as $10 each bank) and a Tandon disk drive (for about $300), and resell the machine for about 10% below the $2200 list price, making a $400 profit. IBM is concerned because the purchaser is buying a machine where only half of the product's value is from IBM. The problem became apparent when purchasers took their machines in for repair to IBM service facilities. Perhaps IBM will take the tack Apple Computer Inc. considered when it was faced with the problem a few years ago: namely, sell only machines with full complements of memory and disk drives.

Commodore Doings: Atari has filed a federal suit charging Commodore Business Machines with infringement of Atari patents, designs, and trademarks for a joystick and paddle controller used in video games and computers. Commodore has launched a $22 million advertising campaign to drum up sales for its Commodore 64 and VIC-20 personal computers. In the meantime, VIC-20s are selling like hotcakes, and Commodore is turning out 9000 per day with the expectation that 1 million will be sold by the end of June. With a list price of under $200 and many merchandisers discounting to as low as $159, it is far and away the lowest-priced computer available with color-video capability. Surely many consumers are buying the VIC-20 instead of a video-game unit because they can buy a computer and a game player for the same price as a games-only machine.

Several companies are supposedly planning to introduce emulators for the Commodore 64 that will allow it to run Apple II, Atari 400 and 800, and TRS-80 software. However, I would look very skeptically at such emulators for several reasons: first, emulators virtually always run much slower than the real thing, which could take all the fun out of many games. Second, many software authors often write clever program routines that depend on hardware specific to the system for which the software was designed; programs including such routines will not run properly with an emulator. Therefore, before buying an emulator, check its operation carefully to make sure it can do what you want.

Some Apple Bytes: Laser Microsystems, Corona, California, has announced that it is designing a plug-in processor card for the Apple II using the powerful new National Semiconductor 16032 16-bit microprocessor. Laser expects to introduce a Unix-like operating system for the board (the company also expects to introduce IBM Personal Computer and TRS-80 versions later on).

On the marketing front, reports say that Apple is still having friction with its independent retail dealers. The most recent rub is Apple's new in-house national-accounts program to sell directly to the Fortune 1000 companies. Second, despite many attempts, Apple has been unable to control sales by unauthorized discount retailers that are underselling authorized dealers. These discounters are believed to be obtaining their Apple IIs from authorized dealers who overbuy to get a better discount and then secretly reship at just a few dollars above cost. Apple says it will take strong action to cut off the supply lines to unauthorized dealers. In the meantime, the six West Coast mail-order dealers cut off by Apple over a year ago, who then filed suit against Apple, have not been able to get the government to take up their case.

Of Clones and Look-Alikes: You can tell a really successful product by how many "clones" (imitations) exist for it. For example, I know of two TRS-80 Model I/Model III clones currently sold, and Apple Computer Inc. is trying to stop the importation and sale of a number of clones from the Far East. Already about six IBM Personal Computer clones are made in the U. S., and at a Japan electronics show held this past October, Hitachi, Mitsubishi, NEC (Nippon Electric Company), Matsushita, Sanyo, and Toshiba all showed IBM-compatible systems, many of which will appear in this country later in the year. The question is whether a product is as compatible as its manufacturer claims it is. Many clone suppliers contend that, compared to the original, their product is far superior, contains added features, and gives you more value for your dollar.

You have to look closely at these claims because, in all too many cases, such statements conceal hidden snags. It may be that a clone maker cannot copy the original product exactly without violating some hardware patent or software copyright and thus has to get around this by changing part of the design and calling the change an added feature. The net result is that the clone is not a clone but a look-alike—it may be able to run some of the software made for the original but not all of it; or, it may work with some of the plug-in peripherals but not all of them.

For example, one system that is advertised as IBM-compatible uses 3-inch floppy disks. Now how do you take a program supplied on an IBM Personal Computer 5¼-inch floppy disk and get it into this new machine? I suppose what the supplier probably means is that once you get a program onto the 3-inch disk, it will run on the company's computer.

Another system is advertised as disk-compatible with the IBM Personal Computer, the Osborne 1 and the Xerox 820. Interpret this to mean that you can copy a file (or the whole disk) from one system's disk format to the other's. But how does the Personal Computer's 8088 program execute on the supplier's Z80-based system? And how does a program that uses the special I/O (input/output) features work on a system with different I/O procedures? What the manufacturer really means by "disk compatibility" is that many (but not all) data or text files can be converted from the original format to run on the "compatible" machine.

New companies entering the personal computer market will find their entry easier if they make their machines compatible with the dominant machines on the market. However, purchasers should look very closely at such compatibility claims to see if something less than 100% compatibility is offered and, if so, whether this will create problems.

Zilog to Sample Z800: Word has it that Zilog will soon begin distributing samples of its new upgrade of the Z80, called the Z800, with production expected this fall. The Z800 will be upward compatible with the Z80 (in other words, it will execute a Z80 machine-code program) and will offer an expanded instruction set and enhanced performance features. Zilog is promising a three- to five-fold performance improvement. The processor will run at clock speeds as high as 25

MHz and will be capable of directly addressing up to 500K bytes of memory using an internal memory-management circuit with dynamic page relocation and memory protection. It will have modes for both system programs (this mode is meant to be used by programs performing operating-system functions that may access all registers) and user programs (this mode limits access to registers and prohibits execution of instructions that alter system status).

The expanded instruction set will include multiply and divide instructions (8 and 16 bits), will handle strings up to 64K-bytes long, will allow system calls at the machine-code level, and lots more. It also has more addressing modes and features suited to multiuser and multiprocessing environments. No doubt the Z800 will have a tremendous impact on the 8-bit market, significantly improving the operation of CP/M-80 single-user systems and multiuser systems such as MP/M and TurboDOS. When the Z800 is coupled with version 3 of CP/M-80 (which is now called CP/M+), we can expect to see greatly enhanced single-user systems.

CP/M+ Introduced: Digital Research Inc. announced CP/M+ (the newest version of CP/M-80) at the Comdex show in December and is expected to start shipping copies to customers this month. This is the third major upgrade of the CP/M-80 disk operating system since its original development nine years ago. In all cases, Digital Research has maintained upward compatibility for software running under CP/M.

The first CP/M upgrade (version 1.4, introduced in 1976) took what was a bare-bones DOS (disk operating system) and made it suitable as a general-purpose development system. Version 2 (1979) overcame many of the limitations of the earlier versions and improved CP/M's operation for more sophisticated application programs, larger memory, and larger mass-storage systems.

CP/M+ has been enhanced for the newer generation of 8-bit computers with banked memory systems having upwards of 1 megabyte of memory and very large hard-disk systems. Further enhancements speed up transfers between memory and disk storage, and error-handling has been improved. CP/M+ is also furnished with a greatly expanded set of utility files (such as a Help program). However, many of these utilities appear to have been available previously for the earlier versions via CP/M user-group libraries.

CP/M+ still retains what is without doubt CP/M's greatest asset: a modular structure that allows programmers to implement the system on virtually any hardware system that executes Intel 8080 machine code. The BIOS (basic input/output system) module, written by the system programmer, contains all the hardware drivers and software interfaces to the CCP (command control program) and BDOS (basic disk operating system) parts of CP/M. It should be noted that CP/M+ has a greatly increased number of BIOS and BDOS calls for the added features. The generating of the actual CP/M+ system program for a user's computer (what programmers call the system procedure) is much more complicated and hence more difficult to create than under previous versions. A program is supplied by Digital Research to help the system programmer generate CP/M+ properly. Also, CP/M+'s added features take up 4K bytes more of memory space; this should prove to be no problem because CP/M+ is intended to run on systems with memory expanded far beyond 64K bytes.

Battle of the DOSes: Digital Research Inc. assuredly has the 8-bit single-user DOS market sewn up with CP/M-80, and the new version will ensure that this position is maintained for a long time to come. However, the multiuser and 16-bit fields appear to be up for grabs. While Digital Research's MP/M is a multiuser version of CP/M that allows users to run CP/M applications programs in a multiuser environment, the system is based on a single-processor system architecture and allocates a maximum of 48K bytes of memory space to each user. Some time ago, Software 2000 of Arroyo Grande, California, released TurboDOS—a CP/M-compatible DOS that performs disk buffering for better performance and allows print spooling so the user can go on with other tasks while the system sends data to the printer. A software module is available that allows multiple processors to be connected via any number of network configurations so that each user can access the resources of any others. (Software protection can also lock resources to make them inaccessible.) This system is presenting a serious challenge to MP/M in the 8080/Z80 multiuser/multitasking marketplace. Further, it is likely that other software houses may introduce similar packages.

The 16-bit market as yet has no definite leader, although Microsoft with MS-DOS currently appears to be the chief contender. When the first 8086-based personal computer was introduced by Seattle Computer Products (SCP) back in 1979, there was no software for it. Digital Research was working on CP/M-86, but it was a low-priority project. Microsoft, however, created a version of BASIC in 8086 code, so SCP started furnishing BASIC with its system and wrote a DOS. A year later, Digital Research finally introduced CP/M-86 just as other vendors started to introduce 8086-based systems. CP/M-86 and SCP-DOS, although very similar in structure and operation, were not compatible.

When IBM went looking for a disk operating system for the Personal Computer, the company approached Digital Research but for some reason didn't hit it off. Because IBM was also negotiating for Microsoft's BASIC, Microsoft quickly obtained the rights to SCP-DOS and adapted it to the Personal Computer. Microsoft renamed it MS-DOS and licensed it to about two-dozen other hardware vendors.

Microsoft will soon introduce version 2 of MS-DOS to overcome some of the limitations of the first version, provide more features, and achieve upward compatibility with Microsoft's Xenix, a multiuser/multitasking DOS based on the Unix operating system and licensed from Bell Laboratories. Digital Research has introduced a multitasking version of CP/M-86; however, with IBM using MS-DOS (IBM calls it Personal Computer DOS) as its principal operating system (the company also offers CP/M and the p-System at significantly higher cost) it's very likely that, in the 16-bit market at least, MS-DOS will dominate. What makes a DOS successful is the software available to run under it. It appears to me that there are far more software houses developing software to run under MS-DOS than under CP/M-86. Most 8086 hardware suppliers appear to be hedging their bets by furnishing both operating systems.

Mail-Order Sales to Stop: Following in the footsteps of Apple Computer Inc. and Hewlett-Packard, two software suppliers are trying to stop mail-order sales of their products. Micropro International (creator of Wordstar, et al.) of Sausalito, California, and TCS Software, Houston, Texas, have notified dealers that they must cease mail-order sales and sell only to customers to whom they can provide post-sale support. Micropro is believed to have as many as 100 mail-order dealers. Considering the difficulty Apple has had trying to cut off mail-order sales, it will be interesting to see how successful software suppliers will be in this effort.

Intel Profile: Founded only 14 years ago, Intel Corporation has proved to be one of the most innovative companies in the microcomputer field. It has a long string of firsts: the first practical dynamic RAM, the first microprocessor, the first EPROM, the first 1K-bit static RAM, the first 8-bit microprocessor, the first 32-bit microprocessor, and the first single-chip microcomputer. It now employs nearly 17,000 people and does close to $1 billion of business. This year, Intel is expected to introduce a 256K-bit EPROM, a 64K-bit EEPROM, and a 4-megabit bubble-memory device (a 16-megabit device is expected next year). A 1-megabit dynamic RAM is also in development (imagine a full 64K bytes in one integrated circuit).

In the microprocessor field, Intel expects to introduce a new 32-bit microprocessor called the 80386 (or iAPX386) that is upward compatible with the 8086 family. Intel will also start shipping the 80286, an enhanced 8086 with virtual-memory ability. We can expect to see a version of this device with 8-bit I/O also. The current iAPX-432 32-bit microprocessor is also due for an upgrade in microcode and interconnection capabilities to improve its throughput. It is also expected that the new 432 will be able to handle gigabytes of memory. Intel is also known to be doing research in speech recognition; however, introduction of any devices in this area still appears to be several years off.

A Unix Status Report: My son (who is quite familiar with the Unix operating system) and I recently conducted a survey of Unix-like operating systems for microcomputers. We canvassed 35 companies selling such operating systems for microcomputers and discovered the following: four companies sell Unix-like operating systems for 8-bit systems; two are for 6809 systems and two for Z80 systems. All but one provide multitasking and multiuser facilities. Further, utilities are available that run on CP/M-based systems and provide many Unix-like facilities such as I/O redirection and hierarchical file system.

An incredible number of software houses are now supplying Unix-licensed and Unix-like operating systems for 16-bit microcomputers. The most popular version is for Motorola's 68000, second is for Zilog's Z8000; less popular are versions for the Intel 8086 and the National Semiconductor 16032, the latter probably because it is so new. Virtually all of these operating systems require large memories and hard-disk systems. Although almost all of these systems provide the basic features of Unix, most are lacking features such as virtual-memory management. Many lack process- and memory-management features common on standard minicomputer Unix systems.

Also, Unix systems typically have good program development and text processing support. However, you may have to pay extra for anything other than the minimum with these systems. Nearly every vendor charges extra for languages such as BASIC, Pascal, FORTRAN, and COBOL. Some even charge extra for a C compiler (Unix is written in C). Further, none offer a high-level debugger (sdb is the standard utility that Unix programmers use for debugging C programs). Lack of a debugger certainly makes program development more of a hassle and more time consuming. It's interesting that three suppliers provide CP/M emulators that run as a task under Unix.

New Machine Goes to Hollywood: Tracy Kidder's book *The Soul of a New Machine* (Little, Brown, 1981) won a Pulitzer prize for general nonfiction, and now Columbia Pictures has taken an option on it to possibly make it into a movie. The book describes in a very human way the struggle to develop the Data General MV-8000 32-bit super minicomputer.

The Software Stars: Which are the three top-selling microcomputer software packages to date? If you guessed Microsoft BASIC, CP/M, and Visicalc, give yourself a gold star. Microsoft BASIC, which is now running on more than 1 million microcomputers, is the top seller. Originally written in 1975 by Bill Gates and Paul Allen to run on the MITS (management information and text system) Altair 8800 computer, it is today available on virtually every major microcomputer system and is considered the standard for BASIC interpreters. It has been implemented on some large computers. Second in popularity is the CP/M disk operating system currently running on over a half-million microcomputers and more than 600 different systems. Written by Gary Kildall in 1974, its first appearance was on the IMSAI 8080 microcomputer system in 1976. Third is Visicalc, written for the Apple II computer in 1979 by Dan Bricklin, Bob Franston, and Steve Lawrence; it has already sold over 300,000 copies and is currently available for many other systems as well.

All three packages were developed on large computer systems by pioneering individuals working outside of commercial organizations. They did not perceive the broad-based acceptance that their efforts would receive, and at the time they didn't realize that within a few years they would be leaders of large companies employing a hundred or more people and grossing many millions of dollars each year.

Shakeout Predicted: Currently several hundred microcomputers are on the market, all based on a mere handful of microprocessors, operating systems, and application programs. Therefore, many of the systems are nearly identical inside and out. Yet there is a limited amount of dealer shelf space on which to show them, creating a bottleneck at the retail level. System suppliers have tried to become much more aggressive in their marketing, but only the better-financed and established companies are succeeding. Add to this the current recession, and it's no surprise that industry pundits are predicting a shakeout among personal computer manufacturers in the very near future as marketing becomes more important than the products themselves.

What's New in Video Games?: Mattel and General Instrument Corporation have announced a new venture called Playcable that will allow owners of Mattel Intellivision units to access games via cable-television systems. Control Video Corporation of Washington plans a similar service, to be accessed via the telephone lines, for Atari 5200 game owners. Meanwhile, Compuserve is offering games that can accommodate up to 10 players at a time. Compuserve claims that one game, called Megawars, is its second largest revenue producer, attracting 2000 players a week at a rate of $5 per hour. X-rated games are also becoming quite an attraction in bars and even at home.

Gross income from arcade games has skyrocketed in the last few years but appears to have leveled off at about $8 billion (yes, billion) and arcade-game suppliers are searching for new ways to increase game playing. Thus under development and due shortly on the arcade scene are games using videodiscs and three-dimensional games in which the enemy appears to be hurtling objects directly at the player. The videodisc creates more life-like pictures and sound, with explosions that are more like the real thing. Atari has already demonstrated a prototype game using holography to create ghost-like three-dimensional images. There is no word on whether the firm actually plans to produce it.

Random News Bits: Radio Shack has cut the price of its Color Computer from $399 to $299, no doubt to be more competitive with Commodore, Texas Instruments and Atari. . . . Comprocsys Ltd, 1 Branch RD, Park St., St Albans AL1 4RJ, England, is selling a ROM for the ZX81 that turns that $99 machine into a development system with full-screen editor, multifile operating system, assembler, debugger, and more. . . . Intel appears to be the first company to meet the Department of Defense specifications for its comprehensive subset of the Ada language. . . . Hewlett-Packard has established a new Personal Office Computer division in Sunnyvale, California, that will be separate from the Personal Computation group, which produces the company's current line of personal computers. . . . Users of Compuserve will soon be able to use the U. S. Postal Service E-COM (Electronic Computer Originated Mail). Unfortunately, it is only available to business users. . . . NEC claims to have developed a software technique for recognizing handwritten characters with 99.5% accuracy.■

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed, stamped envelope.

Sol Libes
c/o BYTE Publications
POB 372
Hancock, NH 03449 ■

BYTE's Bits

Articles on Computers and Writing Sought

The Writing Instructor is a quarterly journal on teaching composition. The theme of the Summer 1983 issue will relate computers to writing instruction. Authors are encouraged to submit articles about computer-aided instruction, the use of word-processing and interactive computer programs for composition, personal classroom experiences using computers in writing instruction, computer-aided assessment of student tests, and speculative or reflective essays on the implications of computers in the humanities.

Articles should be no longer than 15 double-spaced typewritten pages. You may use internal documentation whenever practical; otherwise, use the *MLA Handbook*. Submit two copies of your manuscript along with pertinent biographical information and a stamped, self-addressed envelope to The Writing Instructor, c/o The Freshman Writing Program, University of Southern California, Los Angeles, CA 90089, Attn: Randall Adams, Issue Editor, Summer 1983.■

Event Queue

February 1983

February
Continuing Engineering Education, George Washington University, Washington, DC. Among the courses being offered are "Selecting Small Computers for Business and Government," "Local Communication Networks and Digital PBXs," and "Computer Communications Systems and Networks." Course fees range from $685 to $855. Further details are available from Douglas Green, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8515.

February
Seminars of Interest to Women Professionals, various sites in the New York City and Boston metropolitan areas. This series of one- and two-day seminars is presented by Boston University Metropolitan College. Among the topics on the agenda are "Tactical Innovations in Marketing Management," "Sales Management for Today's Newly Promoted Sales Manager," and "Data Processing Fundamentals for Accounting and Financial Managers." The seminar fees are $325 and $495, depending on duration. For registration information, contact Ms. Joan Merrick, University Seminar Center, Suite 415, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.

February-March
Courses for Developers and Users of Computer Systems, various sites throughout the U.S. Among the courses being offered by the AMA (American Management Associations) are "Fundamentals of Data Processing for the Non-data Processing Executive," "BASIC: A Computer Language for Managers," and "Database Concepts and Design." For complete registration and course information, contact the AMA, 135 West 50th St., New York, NY 10020, (212) 586-8100.

February-June
Intensive Seminars of Interest to Data Processing Professionals, Boston metropolitan area. Among the two- to five-day seminars offered are "Project Management" and "Data Communications." Registration fees range from $495 to $975. For a seminar bulletin, contact Ms. Ginny Bazarian, Office of Continuing Education, Higgins House, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

February-June
Seminars in Simulation, Management, Statistics, and Computer Science, various sites throughout the U.S. "Simulation Modeling for Decision Making," "Database Design," and "Satellite Communications Technology" are some of the topics to be presented. For details, contact the Institute for Professional Education, POB 756, Arlington, VA 22216, (703) 527-8700.

February 14-18
Auditing in the Contemporary Computer Environment, New York, NY. This course is designed for internal auditors and financial and data-processing professionals. It provides a comprehensive audit approach for computer-based systems, including how to evaluate controls and how to design a program of tests using questionnaires, checklists, software tools, and flow charts. For details, contact Marge Umlor, EDP Auditors Foundation, 373 South Schmale Rd., Carol Stream, IL 60187.

February 15-18
Embedded Computer Systems, Boston, MA. Participants in this course will learn how to design reliable and fault-tolerant systems, how to implement real-time and interrupt-driven controls, and how to evaluate bus structures, protocols, and networking. The registration fee is $845. For details, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (213) 450-2060.

February 15-18
Peripheral Array Processors for Signal Processing and Simulation, University of California, Los Angeles. The fee for this course is $845. Contact Marc Rosenberg at the UCLA Extension, Continuing Education in Engineering and Mathematics, 6266 Boelter Hall, Los Angeles, CA 90024, (213) 825-1047.

February 15-18
Designing Real-Time Hardware for Digital Signal and Image Processing, Washington, DC. Participants in this short course will learn how to implement digital filters, fast Fourier transforms, correlation, modulation, and other real-time processes by designing with general-purpose 16-bit microprocessors. Case histories and lectures will be featured. The fee is $845. For further details, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (213) 450-2060.

February 16-18
The Third Annual TALMIS, Ambassador West, Chicago, IL. This conference brings together software publishers and users of microcomputer-based training systems. Issues on the agenda include the home market, local networking, new hardware, and successful distribution channels. Question-and-answer sessions will be held. Further information is available from Mary O'Keefe, TALMIS Inc., 115 North Oak Park Ave., Oak Park, IL 60301, (312) 848-4000.

February 16-19
Data and Telecommunications/Japan Exposition '83, Tokyo Ryutsu Centre, Tokyo, Japan. For information, contact Cahners Exposition Group, Cahners Plaza, 1350 East Touhy Ave., POB 5060, Des Plaines, IL 60018, (312) 299-9311. In Japan, contact Cahners Exposition Group S.A., Hino Building 3F, 3-4-11 Uchikanda, Chiyoda-ku, Tokyo 101, Japan; tel: 03-254-6041.

February 21-23
Office Automation Conference, Civic Center, Philadelphia, PA. More than 200 exhibitors are expected to participate in this conference. Fifty technical sessions will explore such topics as current and advanced office technology and human factors and social issues. Further details are available from the American Federation of Information Processing Societies Inc., 1815 North Lynn St., Arlington, VA 22209, (703) 558-3624.

February 22-26
The Eighteenth Annual Bias-Microelettronica '83, Milan, Italy. This international exhibition is expected to attract more than 80,000 visitors. Areas of interest include active and passive components, instrumentation and equipment for component manufacturing, laboratory instrumentation, microcomputers, peripherals, and telecommunications systems. For information, contact Ente Italiano Organizzazione Mostre, Bias-Microelettronica '83, Viale

Premuda 2, 20129 Milan, Italy; tel: 796.096; Telex: CONSEL 334022.

February 23-25
Microcomputers in Education, New York, NY. This hands-on workshop is designed for teachers and administrators. Topics on the agenda include Logo, Pascal, microcomputers as laboratory instruments, and microcomputers in mathematics and science. Fees range from $120 to $300, depending on length of participation. For full details, contact Technical Education Research Centers Inc., 8 Eliot St., Cambridge, MA 02138, (617) 547-3890.

February 24-25
Computers in Construction, San Diego, CA. This seminar is designed to assist construction contractors and construction management firms in acquiring computer systems. The registration fee is $395. For further information, contact CIP Information Services Inc., 1105-F Spring St., Silver Spring, MD 20910, (301) 589-7933.

February 25-27
The Second Annual Computer Expo '83, Tupperware Convention Center, Orlando, FL. This exposition focuses on hardware, software, word processing, graphics, peripherals, supplies, services, and computer furnishings for mini- and microcomputers. Seminars will be held. For details, contact Tom Blayney, POB 1185, Longwood, FL 32750, (305) 339-1731.

March 1983

March
Continuing Engineering Education Courses, George Washington University, Washington, DC. Among the courses being offered are "Managing Data Processing Systems in Multiproject Environments" and "Design of Digital Control Systems." Fees range from $685 to $855. Further details are available from Douglas Green, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8515.

March 1-4
Computer Network Design and Protocols, Washington, DC. This short course emphasizes the practical aspects of network design, interfacing, protocols, and packet switching. Topics include how to determine system requirements, how to use packet- and message-switching techniques, and how to interface local systems to value-added networks. The fee is $845. For more information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (213) 450-2060.

March 4-5
Conference on Computer Technology: The Challenge to Business and Industry, Brown University, Providence, RI. Plenary addresses and seminars will focus on such topics as future technology and applications, robotics, and training and education requirements. For additional information, contact the Conference on Computer Technology, Registration Office, AIESEC Box 1930, Brown University, Providence, RI 02912, (401) 861-4835.

March 7-11
Computer-Aided Engineering and Manufacturing: Seminars and Exhibition, McKimmon Center, North Carolina State University, Raleigh. This comprehensive program is de-

signed to update manufacturing managers, engineers, and professionals on the capabilities of computers, microprocessors, robotics, and CAD/CAM (computer-aided design/manufacturing) systems through discussions, hands-on experience, and demonstrations. For further information, write to Robert Edwards, Industrial Extension Service, North Carolina State University, POB 5506, Raleigh, NC 27650.

March 8-9
ACM SIGCOMM '83—Symposium on Communications Architectures and Protocols, University of Texas, Austin. This symposium is sponsored by the Association for Computing Machinery. Address inquiries to Rebecca Hutchings, Honeywell/FSD, 7900 Westpark Dr., McLean, VA 22102, (703) 827-3982.

March 8-10
Semicon/Europa '83, Zuespa Convention Center, Zurich, Switzerland. The Semiconductor Processing and Equipment Symposium will include technical papers and exhibits on such topics as process-related defects, pattern definition, and process chemistry. Full details are available from the Semiconductor Equipment and Materials Institute Inc., Suite 212, 625 Ellis St., Mountain View, CA 94043, (415) 964-5111.

March 8-11
Distributed Processing, Mini and Microcomputer Implementations, Washington, DC. This course is designed to provide a comprehensive introduction to distributed processing hardware and software. Topics of interest include unique design requirements of distributed systems and how to partition systems tasks and hardware. The fee is $845. Further details are available from Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (213) 450-2060.

March 8-11
Local Area Networks, Los Angeles, CA. This course focuses on the practical integration of available software and hardware elements, based on an understanding of network architectures and protocols. The fee is $845. For further details, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (213) 450-2060.

March 9-11
Secretary Speakout '83, Sheraton Hotel, Boston, MA. The theme for this symposium is "The Professional Secretary's New Identity in the Information Age." Speakers will address the impact of office technology through case history presentations, panels, open microphone sessions, and discussion groups. This event is sponsored by the Professional Secretaries International Research and Educational Foundation. Full details are available from Candace M. Louis, PSI, Crown Center G-10, 2440 Pershing Rd., Kansas City, MO 64108, (816) 474-5755.

March 12-17
The Twenty-fourth Annual Management Conference of the Electronic Representatives Association, Cancun, Mexico. Educational programs, special meetings, round-table discussions, and workshops will highlight this annual event.

Contact the Electronic Representatives Association, 20 East Huron St., Chicago, IL 60611, (312) 649-1333.

March 14-15
The Seventh Annual Conference of the Michigan Association for Computer Users in Learning—MACUL '83, Hyatt Regency, Dearborn, MI. Sessions and speakers will highlight this conference. For more information, contact Betty VandenBosch Shaw, Coordinator of Mathematics, Flint Community Schools, 923 East Kearsley, Flint, MI 48502, (313) 762-1007.

March 14-17
The Seventh Annual Federal Office Systems Expo—FOSE '83, Washington Convention Center, Washington, DC. Sixty high-level sessions will cover the development of integrated office systems in both government and industry. More than 200 companies will display the latest in office systems technology. For more information, contact Mary Beth Gouled, National Trade Productions Inc., 9418 Annapolis Rd., Lanham, MD 20706, (800) 638-8510; in Maryland, (301) 459-8383.

March 14-18
Computer Graphics Applications for Management and Productivity—CAMP '83, International Congress Center, Berlin, West Germany. This conference features tutorials, technical papers, and exhibits that reflect the practical applications and state of the art of computers and computer-graphics technology. Topics on the agenda include computer-aided design and manufacturing, sales-support graphics, and improving the use of engineering data. A hardware and software exhibition will be held. Full particulars are available from the World Computer Graphics Association, Suite 250, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

March 15-16
Selecting a Microcomputer for Scientific and Engineering Applications, Colorado School of Mines, Golden, CO. This short course reviews hardware and software technology for potential buyers of microcomputers in relation to specific scientific and engineering applications. The fee is $195. Contact the Space Office, Colorado School of Mines, Golden, CO 80401, (303) 273-3321.

March 15-18
Distributed Processing, Mini and Microcomputer Implementations, San Diego, CA. For details, see March 8-11.

March 15-18
Local Area Networks, Boston, MA. For details, see March 8-11.

March 16-17
Business-Expo, Houston, TX. This show features everything from computers, copiers, and telephone equipment to interior decorating, office design, and financial consulting. More than 20 seminars on business technologies will be offered. Complete details are available from Business-Expo, 702 East Northland Towers, 15565 Northland Dr., Southfield, MI 48075, (313) 569-8280.

March 17-19
The Third Annual Microcomputers in Education Conference, Arizona State Universi-

ty, Tempe. The theme for this conference is "Forward to the 3 C's: Communicating, Calculating, and Computing." Demonstrations, workshops, and presentations will emphasize the potential of computers to revolutionize the learning process. Topics to be explored include how computers are changing the nature of: content in subject areas, teaching, and what it means to be well educated. University credit will be available. Further information can be obtained from Marilyn Sue Ford, B-47 Payne Hall, College of Education, Arizona State University, Tempe, AZ 85287, (602) 965-7363.

March 18-20
The Eighth West Coast Computer Faire, Civic Auditorium and Brooks Hall, San Francisco, CA. Attendance this year is expected to reach 40,000. More than 600 exhibitors and a wide assortment of seminars make this one of the largest annual computer shows. For more information, contact The Computer Faire, 333 Swett Rd., Woodside, CA 94602, (415) 851-7075.

March 21-24
Interface '83, Miami Beach Convention Center, Miami, FL. This conference will cover all aspects of data communications and information processing in technology, management, policy, and strategy. It is cosponsored by McGraw-Hill's *Business Week* and *Data Communications* magazines. For further details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

March 21-24
Personal Microcomputer Interfacing and Scientific Instrumentation Automation, Virginia Polytechnic Institute and State University, Blacksburg, VA. This is a hands-on workshop where the participant designs and tests concepts with the actual hardware. The fee is $595. For more information, contact Dr. Linda Leffel, C.E.C., Virginia Tech, Blacksburg, VA 24061, (703) 961-4848.

March 22-24
Cincinnati Business Show, Exhibition-Convention Center, Cincinnati, OH. A wide range of products and services will be displayed, including computers, satellite equipment, electronic mail systems, and telecommunications equipment. For more information, contact Ray G. Nemo, Cincinnati Business Show, 10608 Millington Court, Cincinnati, OH 45242, (513) 791-6300.

March 22-25
Computer Network Design and Protocols, San Diego, CA. For details, see March 1-4.

March 22-25
Embedded Computer Systems, Washington, DC. For details, see February 15-18.

March 24-25
Computers in Construction, Orlando, FL. For details, see February 24-25.

March 24-25
The Western Educational Computing Workshops, Hayward, CA. These workshops, sponsored by the California Educational Computing Consortium, provide demonstrations and hands-on experience with new computer applications, software, and hardware. Contact Jerry Rose, Computer Center, California State University,

25800 Hillary St., Hayward, CA 94542.

March 24-25
Workshop on Performance and Evaluation of Local Area Networks, Worcester, MA. This workshop will seek to increase interaction and communications between active researchers and systems developers on the performance and evaluation of local-area networks. Contact T. C. Ting, Computer Science Department, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5670.

March 25
Communication Aids and Computers: A Voice for the Non-Vocal, Stokes Auditorium, Children's Hospital, Philadelphia, PA. This conference will present recent advances in technology, methodology, and research as they relate to computers and speech technology. Sessions will include lectures, videotapes, and equipment demonstrations. The registration fee is $75 (if postmarked prior to March 4, 1983, the fee is $65). This conference is sponsored by the Children's Seashore House and the Division of Child Development and Rehabilitation of the Children's Hospital of Philadelphia. For further information, contact Joan Bruno, Chief Speech Pathologist, Children's Seashore House, 4100 Atlantic Ave., Atlantic City, NJ 08404, (609) 345-5191, ext. 205.

March 25-27
Fantasylair '83, Tonkawa High School, Tonkawa, OK. This annual spring gaming convention is sponsored by the Northern Oklahoma Dungeoneers. It features fantasy and war games, tournaments, a costume contest, seminars, and prizes. The admission is $3 per day; group discounts are available. For information, contact the Northern Oklahoma Dungeoneers, POB 241, Ponca City, OK 74602, (405) 762-0349.

March 28-31
National Design Engineering Show and Conference, McCormick Place, Chicago, IL. The conference is sponsored by the American Society of Mechanical Engineers' design engineering division. It will run concurrently with the National Plant Engineering and Maintenance Show and Conference. Details are available from Clapp & Poliak Inc., 708 Third Ave., New York, NY 10017, (212) 661-8410.

April 1983

April 5-8
Computers/Graphics in the Building Process, Convention Center, Washington, DC. The focus will be on the needs of private sector and federal users for computer/graphics applications in architecture, engineering, design, planning, and management of the building process. America's top 400 construction contractors and 500 leading design firms are expected to attend the tutorials, exhibits, and technical and management sessions. This event is cosponsored by the National Academy of Sciences' Advisory Board on the Built Environment (ABBE) and the World Computer Graphics Association (WCGA). For details, contact the WCGA, Suite 399, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

April 5-8
Distributed Processing, Mini and Microcomputer Implementations, Boston, MA. For details, see March 8-11.

April 5-8
The Second Annual Convention and Exposition of the Electronic Funds Transfer Association—EFT Expo, Riviera Hotel, Las Vegas, NV. Gen-

Event Queue

eral and concurrent sessions will focus on electronic payment systems and services. Topics to be covered include automated teller machines, home information and financial services, legal issues, and technical standards. Further information is available from the EFT Association, Suite 800, 1029 Vermont Ave. NW, Washington, DC 20005, (202) 783-3555.

April 10-13
APL83, Sheraton Washington Hotel, Washington, DC. This conference and exhibition includes hands-on displays and presentations of technical papers. For particulars, contact D & S Whyte Associates, Conference and Exhibits Manager, Suite 200, 117 King St., Alexandria, VA 22314, (703) 548-2802.

April 11-15
Intergraphics '83, Takanawa Prince Convention Center, Tokyo, Japan. This conference and exhibition will cover a wide range of computer-graphics topics, including business and management graphics, virtual machine languages, and chemical and biochemical applications of computer graphics. Complementing formal programs will be speakers, discussions, and tutorials. For complete details, contact the World Computer Graphics Association, Suite 250, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

April 12-13
Selecting a Microcomputer for Scientific and Engineering Applications, Golden, CO. For details, see March 15-16.

April 12-15
Computer Network Design and Protocols, Boston, MA. For details, see March 1-4.

April 13-20
Hanover Fair '83—Cebit '83, Hanover, West Germany. The Hanover Fair is one of the world's largest industrial trade fairs. Attention will be paid to office equipment and data-processing technology. More than 1200 exhibitors from 30 countries will display their products to a crowd of more than 230,000. Full information is available from the Hanover Fairs Information Center, Salem Industrial Park, POB 338, Whitehouse, NJ 08888, (800) 526-5978; in New Jersey, (201) 534-9044.

April 15-17
The Use of Computers in Psychology, Hilton, Wilmington, NC. With a focus on microcomputers, the five planned symposia will explore such issues as statistical and therapeutic applications and the use and misuse of microcomputers in psychological assessment. For complete details, write to Steven R. Edelman, Association of Eastern North Carolina Psychologists, 105 Lou Dr., Goldsboro, NC 27530.

April 19-21
Electro/83—High-Technology Electronics Exhibition and Convention, Coliseum and Sheraton Centre, New York, NY. For information, contact Electronic Conventions Inc., 999 North Sepulveda Blvd., El Segundo, CA 90245, (800) 421-6816; in California, (213) 772-2965. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

Books Received

The Art of Programming the 1K ZX81, M. James and S. M. Gee. London, England: Bernard Babani Publishing Ltd. (The Grampians, Shepherds Bush Rd.), 1982; 86 pages, 11.1 by 17.6 cm, softcover, ISBN 0-85934-084-8, £1.95.

Assembly Language Programming for the Apple II, Robert Mottola. Berkeley, CA: Osborne/McGraw-Hill, 1982; 143 pages, 16.4 by 23.3 cm, softcover, ISBN 0-931988-51-9, $12.95.

BASIC Exercises for the Apple, J. P. Lamoitier. Berkeley, CA: Sybex, 1982; 258 pages, 17.7 by 22.8 cm, softcover, ISBN 0-89588-084-9, $12.95.

The Cosmic Mind-Boggling Book, Neil McAleer. New York: Warner Books, 1982; 207 pages, 13.3 by 20.2 cm, softcover, ISBN 0-446-97663-6, $7.95.

Discover FORTH, Learning and Programming the FORTH Language, Thom Hogan. Berkeley, CA: Osborne/McGraw-Hill, 1982; 142 pages, 16.5 by 23.4 cm, softcover, ISBN 0-931988-79-9, $14.95.

Fun with Microcomputers and BASIC, Donald D. Spencer. Reston, VA: Reston Publishing Co., 1981; 128 pages, 21.2 by 27.8 cm, softcover, ISBN 0-8359-2214-6, $9.95.

A Guide to Software in Applesoft, Bruce Presley. New York: Lawrenceville Press, 1982; 181 pages, 21.5 by 27.8 cm, softcover, ISBN 0-442-25890-9, $12.95.

Inside Atari DOS, Bill Wilkinson. Greensboro, NC: Compute! Books, 1982; 120 pages, 15.5 by 22.4 cm, spiral binder, ISBN 0-942386-02-7, $19.95.

Interface Projects for the Apple II, Richard C. Hallgren. Englewood Cliffs, NJ: Prentice-Hall, 1982; 170 pages, 17.4 by 23.4 cm, softcover, ISBN 0-13-469387-6, $12.95.

An Introduction to Programming and Problem Solving with Pascal, 2nd edition, G. Michael Schneider, Steven W. Weingart, and David M. Perlman. New York: John Wiley & Sons, 1982; 468 pages, 16.4 by 23.3 cm, hardcover, ISBN 0-471-08216-3, $21.95.

Introduction to UCSD p-System, Charles W. Grant and Jon Butah. Berkeley, CA: Sybex, 1982; 370 pages, 17.7 by 22.8 cm, softcover, ISBN 0-89588-061-X, $14.95.

Microcomputers in Amateur Radio, Joe Kasser. Blue Ridge Summit, PA: Tab Books, 1981; 307 pages, 12.7 by 20.8 cm, softcover, ISBN 0-8306-1305-6, $9.95.

Microcomputers, What They Are and How to Put Them to Productive Use! A. J. Dirksen. Blue Ridge Summit, PA: Tab Books, 1982; 231 pages, 19.5 by 23 cm, softcover, ISBN 0-8306-1406-0, $11.95.

Microprocessor Systems, Interfacing, and Applications, Robert J. Bibbero and David M. Stern. New York: John Wiley & Sons, 1982; 195 pages, 16.4 by 23.4 cm, hardcover, ISBN 0-471-05306-6, $20.

Pocket Guide to BASIC, Roger Hunt. Reading, MA: Addison-Wesley, 1982; 64 pages, 4 by 6.3 cm, softcover, ISBN 0-201-07744-2, $6.95.

Pocket Guide to COBOL, Ray Welland. Reading, MA: Addison-Wesley, 1982; 96 pages, 4 by 6.3 cm, softcover, ISBN 0-201-07750-7, $6.95.

Pocket Guide to FORTRAN, Philip Ridler. Reading, MA: Addison-Wesley, 1982; 64 pages, 4 by 6.3 cm, softcover, ISBN 0-201-07746-9, $6.95.

Pocket Guide to Pascal, David Watt. Reading, MA: Addison-Wesley, 1982; 64 pages, 4 by 6.3 cm, softcover, ISBN 0-201-07748-5, $6.95.

Pocket Guide to Programming, John Shelley. Reading, MA: Addison-Wesley, 1982; 64 pages, 4 by 6.3 cm, softcover, ISBN 0-201-07736-1, $6.95.

Practical Guide to Computers in Education, Peter Coburn, Peter Kelman, Nancy Roberts, Thomas F. F. Snyder, Daniel H. Watt, and Cheryl Weiner. Reading, MA: Addison-Wesley, 1982; 266 pages, 16.4 by 23.4 cm, softcover, ISBN 0-201-10563-2, $9.95.

Practical Pascal Programs, Greg Davidson. Berkeley, CA: Osborne/McGraw-Hill, 1982; 205 pages, 21.1 by 27.5 cm, softcover, ISBN 0-931988-74-8, $15.99.

Problem Solving and Computer Programming, Peter Grogono and Sharon H. Nelson. Reading, MA: Addison-Wesley, 1982; 284 pages, 16.4 by 23.4 cm, softcover, ISBN 0-201-02460-8, $14.95.

Programming Microcomputers with Pascal, M. D. Beer. New York: Van Nostrand Reinhold, 1982; 256 pages, 15.3 by 23.4 cm, softcover, ISBN 0-442-2136-9, $13.95.

Solid-State High-Frequency Power, Irving M. Gottlieb. Reston, VA: Reston Publishing Co., 1982; 246 pages, 16.4 by 23.3 cm, hardcover, ISBN 0-8359-7048-5, $21.95.

Structured Programming with COMAL, Roy Atherton. New York: Halsted Press, 1982; 266 pages, 16.4 by 23.4 cm, hardcover, ISBN 0-470-27318-6, $49.95.

The Z8000 Microprocessor, A Design Handbook, Bradly K. Fawcett. Englewood Cliffs, NJ: Prentice-Hall, 1982; 310 pages, 17.4 by 23.2 cm, softcover, ISBN 0-13-983734-5, $16.95. ■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

BYTE's Bits

CP/M Bulletin Board Up in Los Angeles

Softwaire Centre International has a remote CP/M and bulletin-board system up and running in Los Angeles. Callers can send, receive, and read messages, and the system accepts data rates of 110, 300, 450, 600, and 710 bits per second. The system features an extensive catalog of the latest Apple, Atari, CP/M, IBM Personal Computer, and TRS-80 software titles. It's open 24 hours a day, and you're invited to leave messages and new ideas for the community.

Soon, volumes of CP/M Users Group (CPMUG) public-domain software will be available for downloading. The firm also plans to offer an array of source programs targeted at Apple, Atari, and TRS-80 users.

Contact The Softwaire Centre, 11768 West Pico Blvd., West Los Angeles, CA 90064, (213) 473-1136, or leave a message for the system operator, "SYSOP," on the bulletin board, (213) 479-3189. ■

Ask BYTE

Conducted by Steve Ciarcia

CP/M for Homebrewed Systems

Dear Steve,

I have been bitten by the homebrew bug. I have a tentative design for a Z80-based computer with 64K bytes of memory and a memory-mapped video display that I plan to build with a Standard Microsystems Corporation CRT-5037. The system will use a Western Digital Corporation FD-1771 floppy-disk controller and whatever ROM (read-only memory) I may need. I'm fairly confident of my hardware and programming abilities, up to and including writing an operating-system monitor.

What would it take to run the CP/M disk operating system? Is it generalized enough to be flexible; is a source listing available so that I can change the software to suit my system? How does CP/M talk to its host system? Is it merely designed for serial video? Can system ROM exist anywhere in memory? Does Digital Research even release this sort of information to Joe-Average hobbyist?

I know that tackling this will not be a piece of cake, but I'm a technician and do this sort of stuff for a living. In fact, I enjoy it—save for occasional head-to-wall bangings.

Phil Rorex
Long Beach, CA

CP/M (control program for microcomputers) is made by Digital Research Corporation. In order to protect its product, no source code is available. The CP/M operating system is made up of the following main subsystems:

FDOS (functional disk operating system)—which is divided into (a) the BIOS (basic input/output system), which handles data transfers to and from peripherals, and (b) BDOS (basic disk operating system), which manages all disk files
CCP (console command processor)—which reads and processes your commands
TPA (transient program area)—a program storage and operating area
BOOT—a program that tells you where the CCP is located.

The BIOS is unique for each microcomputer. When you buy CP/M, you configure the BIOS so that it knows where your printer, terminal, and other devices are located. All other parts of CP/M are truly hardware-independent.

It takes a minimum of 16K bytes to run CP/M, and system ROM can be placed in the TPA. A bootstrap ROM is usually located at hexadecimal 0000 to read in the CP/M system. Digital Research has extensive documentation concerning the loading and implementation of CP/M. For further information, contact Digital Research Corp., POB 579, Pacific Grove, CA 93950, (408) 649-3896. . . . **Steve**

Remote IBM Keyboard Operation

Dear Steve,

I'd like to use my IBM Personal Computer's keyboard some 75 feet away from the main machine. Do you know a simple driver circuit using buffers and Schmitt triggers that will let me do this?

Buryl B. Noah
Hartsdale, NY

I addressed this problem several years ago in an article titled "Come Upstairs and Be Respectable" (May 1977 BYTE, page 50; also available in Ciarcia's Circuit Cellar, *volume 1, from BYTE/McGraw-Hill, Princeton Rd., Hightstown, NJ 08520, (609) 426-5254). The parallel output of the keyboard is converted to serial data by a UART (universal asynchronous receiver/transmitter), then transmitted over a long twisted pair. Because the output of the IBM's keyboard is serial, all you need to do is build the part of the circuit that buffers and detects the signals (figure 1).*

The preferred method for transmitting data over long distances is to use a balanced line. In my article, I used National Semiconductor's 5-volt differential line driver, DS8830, and a line receiver, DS8820. Texas Instruments makes equivalent devices called the SW75182 and the SW75183. . . . **Steve**

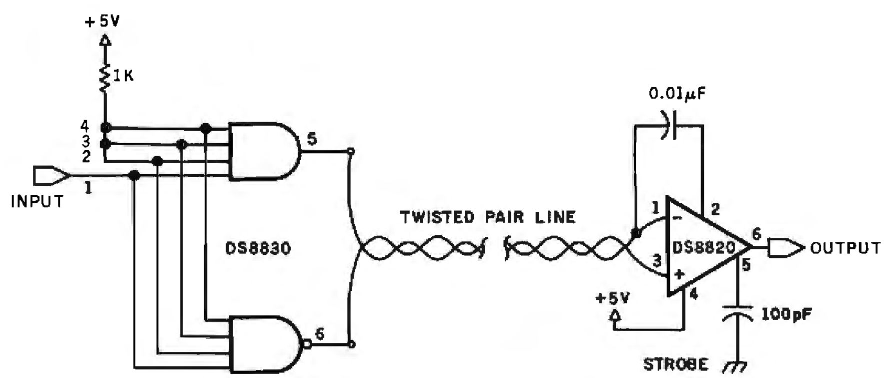

Figure 1

Doubling Expansion Interface Memory

Dear Steve,

The Expansion Interface for the Radio Shack TRS-80 Model I has only 16K bytes of memory. I would like to upgrade that to 32K bytes. How do I go about it? I see that there are eight unused sockets inside the interface. Can I plug in eight more 4116-200ns dynamic-memories, or is there more to it than that?

Michael Meyers
San Bernardino, CA

Expanding the Radio Shack Expansion Interface from 16K bytes to 32K is simply a matter of plugging eight additional memories (type 4116-200ns) into the eight empty sockets you mentioned. The only precautions are to be sure that the circuits are oriented properly and you must avoid any static damage *by touching a ground connection before handling the devices. Naturally, all power must be off before inserting or removing any ICs from a computer or expansion interface. . . .* Steve

Speaking of Speech Recognition

Dear Steve,

As a long-time subscriber to BYTE, I have enjoyed your many articles. In particular, I was quite impressed by your article entitled "Use of Voiceprints to Analyze Speech," which appeared in the March 1982 BYTE (page 50).

In that article, you made reference to speech-recognition systems, both for professional computing systems and personal computers. You also mentioned that budget-priced speech-recognition systems, costing in the neighborhood of $500, are available. Do you know where I could get more information about such systems? Could you give me the names and addresses of one or more companies that market speech-recognition systems for personal computers? Are any systems available for S-100 bus computers?

R. L. Froemke
Tallahassee, FL

The field of speech recognition is emerging from science fiction into reality. Many companies are making products for both the hobbyist and the industrial computer markets. Here's a list of several companies marketing speech-recognition systems. . . . Steve

Centigram Corp.
Suite 108
155A Moffett Dr. Park
Sunnyvale, CA 94086

Interstate Electronics
707 East Vermont St.
Anaheim, CA 92803

Perception Technology Inc.
95 Cross St.
Winchester, MA 01890

Scope Electronics Inc.
1860 Michael Faraday Dr.
Reston, VA 22090

Scott Instruments
Suite 5
815 North Elm Street
Denton, TX 76201

Threshold Technology
1829 Underwood Blvd.
Delran, NJ 08075

Verbex Corp.
2 Oak Park
Bedford, MA 01730

Voicetek
POB 388
Goleta, CA 93017

Interchanges Slow, If Possible

Dear Steve,

I have a Radio Shack TRS-80 Model III at home and an Apple II Plus at work. Both machines have two 5¼-inch disk drives. I would like to write ASCII files and BASIC programs to disk with either machine and be able to read them with both.

Currently, I must transfer files through RS-232C serial interfacing, modems, and over telephone lines. The disk drives for both computers run at 300 rpm (revolutions per minute), so is it possible, with software only, to read files with the TRS-80 from a disk written by the Apple and vice versa?

Finis E. Gentry
Prospect, KY

Your question about interchanging disks between Radio Shack and Apple computers points up a major problem in the personal computer industry: because the disk formats are not similar, it is impossible for one computer to read another computer's disk.

The fact that the disks run at the same speed is of no relevance because the number of sectors is not the same, the directories are stored on different tracks, and the data formats are not alike. Your method of using an RS-232C interface and a modem to transfer between computers works fine. But it's terribly slow if data is transferred at 300 bps (bits per second). If both computers are in the same room, the serial ports can be directly connected and data transferred at rates of up to 19,200 bps.

One of the strong points of the CP/M operating system (distributed by Digital Research) is that its disk formats are identical for different computers. Therefore, the disks are portable and can be saved on one computer and loaded on another. . . . Steve■

Clubs and Newsletters

By Word of Mouth

W.P. News: Writer's POV on Word Processing is a newsletter for wordsmiths who work with computers. It is published bimonthly by Word of Mouth Enterprises. The newsletter includes evaluations of hardware and software for writing needs, interviews with authors, and up-to-date developments for writers. The annual subscription fee is $20. For more information, write to Word of Mouth Enterprises, 1765 North Highland #306, Hollywood, CA 90028.

Attention: Dentists

Dentists in Detroit have formed a users group for those who have purchased the Dental Practice package from Moore Business Systems Inc. The group's members discuss various hardware and software products, assist members with specific computer problems, and plan to develop a library of self-help materials. For more information, forward a self-addressed envelope to W.A. Riggert, D.D.S., Parkwood Dental Group, 10831 West Ten Mile Rd., Oak Park, MI 48237.

Experimenters in Canada

Ipso Facto is a publication of the Association of the Computer-Chip Experimenters, a nonprofit, educational organization based in Ontario, Canada. Meetings are held on the second Tuesday of each month, September through June, at 7:30 p.m. in room B123, Sheridan College, 1430 Trafalgar Rd., Oakville, Ontario. Membership dues are $18 and entitle you to six issues of *Ipso Facto*. For further information, write to Mike Franklin, Association of Computer-Chip Experimenters, 650 Laurier Ave., Milton, Ontario L7T 4R5, Canada, or call (416) 878-0740.

Foghorn from FOG

The First Osborne Group (FOG) is for Osborne users and other computer owners. The group plans to present reviews of new software and hardware in its newsletter, *Foghorn*, and through local meetings. Vendors or interested individuals can contact Craig R. Chun, Apt. 225, 1607 Parkmoor Ave., San Jose, CA 95125, or call (408) 947-1650.

OSBUG in Canada

An Osborne 1 Users Group (OSBUG-Canada) meets on the third Monday of each month in the Vancouver area. OSBUG-Canada works with both FOG and the Northwest Osborne Users Club. Further information can be obtained by contacting Debra Danny, 15227 Russell Ave., White Rock, British Columbia, V4B 5C3 Canada, or by phoning (604) 536-0266.

TRS-80 Users in Chicago

The Chicago TRS-80 Users Group publishes a monthly newsletter. *Chicatrug News* prints "All the TRS-80 News You Need When You Need It." Single issues are $1.50; subscriptions cost $12 for one year in the U.S., $16 in Canada and Mexico, and $26 elsewhere. Press releases and articles are welcome. For further information, contact Emmanuel B. Garcia Jr. & Associates, Suite 2118, 203 North Wabash, Chicago, IL 60601, or call (312) 782-9750.

Audio-Visual News Updated

Navanews is the biweekly bulletin of the National Audio-Visual Association (NAVA), an international trade association of audio-visual/video dealers, manufacturers, and producers. Subscriptions are $50 per year. For information, write to NAVA, 3150 Spring St., Fairfax, VA 22031, or call (703) 273-7200.

Southern Hobbyists

The CSRA Computer Club is an active group of computer hobbyists and professionals that has been producing a monthly newsletter for six years. Dues are $12 a year; students are half price. Anyone interested may attend meetings which are held on the third Thursday of each month at 7:30 p.m. For more information, write to the CSRA Computer Club, POB 284, Augusta, GA 30903.

Tips for the Salesman

Master Salesmanship is a newsletter that focuses on effective techniques for selling data-processing products and services. For a free copy of *Master Salesmanship*, call Michael Lodato at (213) 889-2607, or write to M.W.L. Inc., 32038 Watergate Court, Westlake Village, CA 91361.

Attention: Homebrewers

The *Homebrew Computer Club Newsletter* will keep you posted on this San Francisco Bay area club's monthly meeting dates and locations. To subscribe, write to the *Homebrew Computer Club Newsletter*, POB 626, Mountain View, CA 94042.

Newsletter Offer

The Small Business Systems Group publishes a newsletter that is available free for six months from the date of your return of the Product License Agreement proving purchase of at least $150 of hardware or software sold through SBSG. For details, write to the Small Business Systems Group, Newsletter Subscription, 6 Carlisle Rd., Westford, MA 01886, or call (617) 692-3800.

Phoenix Valley Idea Exchange

The Phoenix Valley of the Sun IBM PC Idea Exchange is held once a month for anyone interested in using and programming the IBM Personal Computer. It is sponsored by the United Systems Corporations of Phoenix, Arizona. For meeting information, write to the IBM PC Idea Exchange, c/o United Systems Corporations, 1074 East Sandpiper Dr., Tempe, AZ 85283, or call (602) 831-9363.

SVC³ Presents: A New Club

The Silicon Valley Color Computer Club is for TRS-80 Color Computer owners. It meets on the fourth Tuesday of each month at 7:30 p.m. in the GTE-Sylvania Cafeteria, Building #3, 100 Ferguson Dr., Mountain View, California. For more information, call

(408) 749-1947, or write to the Silicon Valley Color Computer Club, POB 61593, Sunnyvale, CA 94088.

Support for Home Computer Users

The International Home Computer Users Association is an independent, nonprofit organization formed as a support group for home computer owners. It provides members with an information and referral service, a biweekly bulletin, consumer aid, and a monthly newsletter. The group has published information on how to start a users group in your area. For more information, write to ICA, POB 371, Rancho Santa Fe, CA 92067.

Apfelsaft Comes from West Germany

The *Apfelsaft* newsletter is available to Apple and Basis Computer users anywhere in the world. It is produced for English-speaking people living overseas. *Apfelsaft* (apple-juice) is supported by the Ramstein Computer Club, which meets monthly. For further information, write to *Apfelsaft*, Wade Arnold, Benzinoring 37, D-6750 Kaiserslautern, West Germany, or call (0631) 93396.

SUN in Illinois

The Sinclair Users Network (SUN) is a nationwide users group for owners of Sinclair ZX80/81 and Timex/Sinclair 1000 computers. It produces monthly bulletins and quarterly newsletters containing the latest information from Sinclair, Timex, and other manufacturers. For further information, write to Diana Wright, 2170 Oak Brook Circle, Palatine, IL 60067, or call (312) 934-9375.

Information from Waterloo

Infowat is the newsletter produced by Watsoft Products Inc., a company established by the University of Waterloo in Ontario. The newsletter has reviews of educational software developed by the university. A subscription (10 issues) costs $10 (Canadian funds in Canada, U.S. dollars elsewhere). To receive information, write to *Infowat*, POB 943, Waterloo, Ontario N2J 4C3, Canada. ■

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

Software Received

Apple

The Apple's Core, a tutorial program. The disks and manual comprising this package serve as a beginner's guide to Applesoft BASIC. Each lesson in the manual corresponds to a program on the disk. For the Apple II Plus; floppy disk, $49.95. The Little Professor, POB 301, Swanton, VT 05488.

The Arithmetic Classroom, part of a set of tutorial programs. The programs in this package cover the basic principles of mathematics. Each program covers a different aspect of math. For the Apple II Plus; floppy disk, $49.95. Sterling Swift Publishing Co., 1600 Fortview Rd., Austin, TX 78704.

Artesians, an arcade-type game. You must steal several containers of water from a four-story building while sneaking through the floors and avoiding the guards, dogs, and the artesians. For the Apple II; floppy disk, $34.95. Rennaisance Technology Corp., 1070 Shary Circle, Concord, CA 94518.

Beneath Apple Manor, an adventure-type game. This remake of the original game includes high-resolution graphics and sound. Your mission is to explore an underground maze and find treasures. For the Apple II; floppy disk, $29.95. Quality Software, Suite 105, 6660 Reseda Blvd., Reseda, CA 91335.

The Blade of Blackpoole, an adventure-type game with graphics. Your quest is for the magical sword Myraglym. You must fight off beasts and flesh-eating plants as you search the caverns near the blackpoole. For the Apple II; floppy disk, $39.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

Bug Battle, an arcade-type game. Bugs have invaded your garden and your laser is the only defense you have against them. Game features include graphics and sound. For the Apple II Plus and Apple III; floppy disk, $22.50. United Software of America, 750 Third Ave., New York, NY 10017.

Bug Byter, a screen-oriented 6502 machine-language debugger. This debugger features a display of all registers, literal and transparent breakpoints, and a resident assembler and disassembler. For the Apple II; floppy disk, $47.50. Computer Advanced Ideas Inc., Suite 341, 1442A Walnut St., Berkeley, CA 94709.

Bulk Mailer, a mailing-list program. This system is configured for either a floppy-disk or a hard-disk system. It can store 1200 names on a floppy disk or 32,000 names on a hard disk. Names can be coded and retrieved. For the Apple II; floppy-disk version, $125; Corvus hard-disk version, $250. Satori Software, 5507 Woodlawn Ave. N, Seattle, WA 98103.

Career Directions, a program to help high school students identify career interests. By completing a series of exercises, students can determine the type of career they prefer. For the Apple II; floppy disk, $59.95. Systems Design Associates Inc., 723 Kanawha Blvd. E, Charleston, WV 25031.

Caves of Olympus, an adventure-type game. You are far beneath the Palace of Anson Argyris. You must try to escape the attack of the Laren invaders by traversing the caves of Olympus. For the Apple II Plus; floppy disk, $39.95. Howard W. Sams & Co. Inc., 4300 62nd St., POB 558, Indianapolis, IN 46268.

Counting Plus, an educational program designed to introduce very young children to the principles of numbers. It covers simple counting, addition, and subtraction. For the Apple II; floppy disk, $34.95. The Little Professor (see address above).

Desktop/Plan II, a financial planning, budgeting, and analysis package with graphics. This program lets you build modifiable financial models. It can make use of Visicalc data files. For the Apple II; floppy disk, $250. Visicorp, 2895 Zanker Rd., San Jose, CA 95134.

Diamond IX, a baseball statistics package. A coach can keep individual and team statistics to see his team's strong and weak points. Reports can be displayed or sent to a printer. For the Apple II; floppy disk, $41.95. Competitive Computing Inc., 15 Sequoia Dr., Watchung, NJ 07060.

Disk O' Utilities, a package containing 13 utility programs, including automatic line numbering for Applesoft programs, a program to recover files, a catalog sorter, and a routine to indicate the number of free sectors on a disk. For the Apple II Plus; floppy disk, $13.95. Broadway Software, Suite 136, 642 Amsterdam Ave., New York, NY 10012.

Diversi-DOS, a utility program that's compatible with Apple DOS 3.3. This program loads and saves BASIC, binary, and text files two to five times faster than DOS 3.3. A keyboard and print buffer are provided. For the Apple II; floppy disk, $30. Diversified Software Research Inc., 5848 Crampton Court, Rockford, IL 61111.

The DOS Enhancer, a set of utility programs to speed up Apple DOS 3.3. These programs increase the speed of disk-file saves and reads. Additionally, the programs have expanded menus and are said to run BASIC programs five times faster than DOS 3.3. For the Apple II; floppy disk, $69.95. S & H Software, 58 Van Orden Rd., Harrington Park, NJ 07640.

DOS Helper, a utility program that lets you change DOS commands, modify error messages, alphabetize catalogs, expand catalog displays, restore deleted files, lock or unlock files, and more. For the Apple II; floppy disk, $29.95. The Little Professor (see address above).

Ernie's Quiz, a set of four educational games for children aged 4 to 7. This package includes guessing and counting games, a make-a-face puzzle, and a puzzle using Sesame Street Muppet characters. For the Apple II; floppy disk, $50. Apple Computer Inc., 20525 Mariani Ave., Cupertino, CA 95014.

Family Pak 1, a trio of games for the entire family: Hi-Lo, Hangman, and Go Fish. For the Apple II; floppy disk, $29.95. Cortland Data Systems, POB 14414, Chicago, IL 60614.

Fore, a golf simulation game featuring high-resolution graphics. This game offers a choice of two courses, eight types of terrain, and 15 clubs. For one to four players. For the Apple II; floppy disk, $29.95. Epyx/Automated Simulations Inc., 1043 Keil Court, Sunnyvale, CA 94086.

Games for the Apple Computer, a program disk of modules that lets you create games. This package complements Franklin, Knoltnow, and Finkel's book *Techniques for Creating Golden Delicious Games for the Apple Computer*. For the Apple II; floppy disk, $47.90, including the book. John Wiley & Sons Inc., 605 Third Ave., New York, NY 10158.

Instant Mathematical Programming, a program package that solves a variety of mathematical problems. Designed for professionals or students, this program can, for example, handle simultaneous equations in algebraic form. For the Apple II; floppy disk, $250. PCD Systems Inc., 163 Main St., POB 143, Penn Yan, NY 14527.

Instant Zoo, a set of five programs for children aged 7 to 10. This package has fast-moving games to help develop pattern-recognition and word skills. For the Apple II; floppy disk, $50. Apple Computer Inc. (see address above).

League Registration, a filing system for sports league information. This system lets you organize, manage, and retrieve league and player information. A program disk can hold information on up to 500 players. For the Apple II Plus; floppy disk, $150. Market Computing, 201 15th Ave. SW, Puyallup, WA 98371.

League Scheduling, a program that creates a round-robin schedule for one or more athletic leagues. It prepares a game schedule taking into account teams, times, days of the week, and holidays or rainouts. For the Apple II Plus; floppy disk, $100. Market Computing (see address above).

League Standings, a program that registers game results and computes league and team standings for one or more leagues. This program records win/loss statistics, displays statistics on screen, and lets you edit statistics. For the Apple II Plus; floppy disk, $100. Market Computing (see address above).

Long-Term Reservations, a time-scheduling program that handles reservations for sports facilities where long lead-times and variable-length time periods are desired. Completed schedules can be sent to a printer. For the Apple II Plus; floppy disk, $100. Market Computing (see address above).

Mix and Match, a set of four educational games for children. This package includes a muppet match game, an animal word game, a puzzle, and a word game. An editor is provided for the word game. For the Apple II; floppy disk, $50. Apple Computer Inc. (see address above).

Monster Mash, an arcade-type game. Your job is to prevent the monsters from leaving the graveyard and attacking the people in the city. All you have are your reflexes and the Monster Mash. For the Apple II and Apple III; floppy disk, $29.95. The Software Farm, 3901 South Elkhart, Aurora, CO 80014.

PDQ 1.0, a database-management program featuring user-friendly prompts, simple commands, and fast retrieval. Its files can hold up to 28,000 characters. You can have as many as eight files on two drives. For the Apple II; floppy disk, $59.95. Howard W. Sams & Co. Inc. (see address above).

The Programmable Cube, a program for solving the Rubik's Cube puzzle. Serving as an exercise in programming instruction, this package allows you to develop a cube-solving program. Video displays generated by this program are suitable for black-and-white or color monitors. For the Apple II; floppy disk, $34.95. Metacomet Software, POB 31337, Hartford, CT 06103.

Quick-Search Librarian, a database-management program that cross-references literature citations. Technical references or journal articles can be cross-referenced with up to 12 keywords. One thousand articles or references can be stored on a single disk. For the Apple II Plus; floppy disk, $75. Interactive Microware Inc., POB 771, State College, PA 16801.

Rapid Reader, an educational program. This program helps to increase reading speed by progressively training you to rapidly recognize words and whole sentences. For the Apple II; floppy disk, $39.95. Silicon Valley Systems, Suite 4, 1625 El Camino Real, Belmont, CA 94002.

Short-Term Reservations, a time-scheduling program that can make weekly lists of reservations for sports facilities and print out the schedule showing reserved times, facilities, and contact persons. For the Apple II Plus; floppy disk, $100. Market Computing (see address above).

Spotlight, a set of four games for children aged 9 to 13. The games cover such advanced ideas as how light is reflected and elementary logic. For the Apple II; floppy disk, $50. Apple Computer Inc. (see address above).

Swim Meet, a management program for scheduling swimming meets. This program registers contestants, records times, assigns lanes, and prints a list of final standings. For the Apple II Plus; floppy disk, $125. Market Computing (see address above).

Tennis Draw, a tennis tournament-management program. This program registers and seeds players and teams for matches. It follows the U. S. Tennis Association rules. For the Apple II Plus; floppy disk, $60. Market Computing (see address above).

Transylvania, an adventure-type game. The object of this game is to rescue a princess from the evil vampire. You must search a forest and a castle deep within Transylvania—avoid the werewolf. For the Apple II; floppy disk, $34.95. Penguin Software, 830 4th Ave., Geneva, IL 60134.

Visicalc Advanced Version, an electronic spreadsheet program. This version allows you to protect memory cell contents and hide sensitive information. It includes on-screen help displays. For the Apple III; floppy disk, $400. Visicorp (see address above).

Atari

Alien Garden, an arcade-type game. You're an alien critter in a garden of crystal flowers. You must eat, bump, or sting as many flowers as you can before they destroy you. For the Atari 400/800; cartridge, $39.95. Epyx/Automated Simulations Inc., 1043 Kiel Court, Sunnyvale, CA 94086.

Armor Assault, a simulation game. You're the commander of NATO's armored forces. You must try to stop the enemy's armored columns from rolling across the North German plain. For one or two players. For the Atari 400/800; floppy disk, $39.95. Epyx/Automated Simulations Inc. (see address above).

Bandits, an arcade-type game. You must guard the supplies on a lunar supply depot from the thieving aliens. You are armed with a mobile laser gun and protected by a limited shield. For the Atari 800; floppy disk, $34.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

BASIC Routines, a set of program routines and instructions to help you learn how to program an Atari computer. This package features common subroutines for player graphics and disk utilities. For the Atari 400/800; floppy disk, $24.95. Adventure International, POB 3435, Longwood, FL 32750.

Disk Workshop, a set of disk-utility programs that allows you to edit disks, copy disks rapidly, send a disk directory to a printer, and use machine-language strings in BASIC programs. For the Atari 400/800; floppy disk, $39.95. Synergistic Software, Suite 201, 830 North Riverside Dr., Renton, WA 98055.

Diskey, a disk-utility program. With this program, you can examine and modify any sector on a disk, list unreadable sectors, send data in a sector to a printer, and copy a disk. Only one disk drive is required. For the Atari 400/800; floppy disk, $49.95. Adventure International (see address above).

Gorf, a set of four arcade-type games: Astro Battles, Laser Attack, Space Warp, and Flag Ship. In all the games, you must destroy the attacking aliens to increase your score. For the Atari 400/800; floppy disk, $39.95. Roklan Software, 10600 West Higgin Rd., Rosemont, IL 60018.

Labyrinths, a role-playing game. From a list of characters, you choose an identity to explore the labyrinth, find treasures, and fight monsters. For the Atari 400/800; floppy disk or cassette, $28.95 and $24.95, respectively. Progressive Computer Applications, POB 46, Burtonsville, MD 20866.

Paint, an educational program for children. This program lets your child draw color pictures on the screen, enlarge the picture, save it, and use different "brush" strokes and textures. For the Atari 400/800; floppy disk, $39.95. Reston Publishing Co. Inc., 11480 Sunset Hills Rd., Reston, VA 22090.

Programmer's Workshop, a set of six utility programs. This package includes a disk-to-cassette transfer program, a compare utility for BASIC programs, and a cassette data-rate increase utility. For the Atari 400/800; floppy disk, $39.95. Synergistic Software (see address above).

Sneakers, an arcade-type game. Shoot the aliens before they destroy your ships. This game features five levels of skill and up to nine attacks per level. Points are scored for each alien shot. For the Atari 800; floppy disk, $34.95. Sirius Software Inc. (see address above).

Wizard of Wor, an arcade-type game. As you progress through a series of mazes, you must destroy the wizard and the various creatures that aid him to score points and win the game. For the Atari 400/800; floppy disk, $39.95. Roklan Software (see address above).

CP/M

Accounts Receivable, an accounts-receivable package. This menu-driven package features on-demand reports for customer lists and master, aged analysis, and control reports. For CP/M-based systems; floppy disk, $1095. Cougar Mountain Software, 10 South Latah, POB 6886, Boise, ID 83707.

Data Champ, a database-management program. Designed for the first-time user, this package allows you to create a customized database. The manual includes a complete training program. For CP/M-based systems; floppy disk, $395. Innovative Micro Systems, 12506 East 21st St., Tulsa, OK 74219.

Disk Fix, a disk editor and file-recovery utility program. You can examine, copy, and edit any disk sector. It lets you recover disk files, reconstruct damaged sectors, and use both hexadecimal and ASCII numbers. For CP/M-based systems; floppy disk, $150. The Software Store, 706 Chippewa Square, Marquette, MI 49855.

The Disk Inspector, a disk-utility program that lets you examine any sector on any disk. Sectors from two different drives can be simultaneously displayed, copied, or modified. For CP/M-based systems; floppy disk, $29.95. Realworld Software Inc., Suite 103, 913 South Fourth St., DeKalb, IL 60115.

Fancy Font System, a text-processing and print-formatting package designed for use with the Epson MX-80 printer. You can use a wide variety of letter fonts or create your own special font. For CP/M-based systems; floppy disk, $180. Softcraft, Suite 1641, 8726 South Sepulveda Blvd., Los Angeles, CA 90045.

Menumaster, a system that allows you to develop custom menus for applications programs. The menus can provide user prompts, help and error messages, and error trapping. For CP/M-based systems; floppy disk, $195. Borland International, 69 Upper Georges St., Dun Laoghaire, Dublin, Republic of Ireland.

S-BASIC, a structured BASIC translator and compiler. This version of BASIC features the ability to reference subroutines by name, indenting to display program structure, and other such functions. Program line numbers are not required. For HDOS- and CP/M-based systems; 5¼-inch floppy disk, $49.95. Sunflower Software, 13915 Midland Dr., Shawnee, KS 66216.

IBM Personal Computer

Aqua Run, an arcade-type game. You are a diver seeking treasure in an undersea maze. You must protect yourself from the undersea creatures by avoiding or spearing them. For the IBM Personal Computer; floppy disk, $39.95. Soft Spot Micro Systems Inc., POB 415, North Canton, CT 06059.

Data Champ, a database-management program (see description under CP/M). For the IBM Personal Computer; floppy disk, $395. Innovative Micro Systems, 12506 East 21st St., Tulsa, OK 74219.

Executive Suite, a simulation game. In this game, you're an executive moving up the corporate ladder. You move through job interviews, middle management, and on into the executive suite. For the IBM Personal Computer; floppy disk, $39.95. Armonk Corp., Suite 955, 610 Newport Center Dr., Newport Beach, CA 92660.

FORTH/level 2, an implementation of the FORTH language. This package features a multitasking real-time operating system with online documentation and support for the 8087 mathematics processor chip. For the IBM Personal Computer; floppy disk, $300. FORTH Inc., 2309 Pacific Coast Highway, Hermosa Beach, CA 90254.

The Graphics Generator, a graphics generation program to create bar graphs, pie charts, and line or function graphs from mathematical data. You can superimpose graphs, send graphs to a printer, or save them on disk. For the IBM Personal Computer; floppy disk, $195. Robert J. Brady Co., Bowie, MD 20715.

Graphmagic, a graphics generation program. You can draw visual representations of mathematical data in the form of bar and line graphs, pie charts, and scattergrams. For the IBM Personal Computer; floppy disk, $89.95. International Software Marketing Ltd., Suite 421, 120 East Washington St., Syracuse, NY 13202.

Helpware, an interface program to IBM PC-DOS. This program simplifies using PC-DOS by providing a menu of file-manipulation commands. Files can be displayed, edited, and renamed with a single command. For the IBM Personal Computer; floppy disk, $195. Soft-

wrights Inc., Suite 100, 12606 Greenville Ave., Dallas, TX 75243.

Mathemagic, a mathematics-processing program. You can enter mathematical formulas into this program using names for variables, build libraries of formulas, and use arrays of formulas and variables. For the IBM Personal Computer; floppy disk, $99.95. International Software Marketing Ltd. (see address above).

Millionaire, a stock market simulation game. You can simulate buying and selling stocks, using put and call options, buying on margin, and borrowing against your net worth. The game gives you 15 stocks to manipulate. For the IBM Personal Computer; floppy disk, $99.95. Blue Chip Software, Suite 125, 19824 Ventura Blvd., Woodland Hills, CA 91364.

muMath/muSimp-80, a mathematics processing package. You can enter mathematical formulas using algebraic notation. This program will simplify the formula and provide the answer. For the IBM Personal Computer; floppy disk, $300. Microsoft Inc., 10700 Northrup Way, Bellevue, WA 98004.

The Pascal Toolkit, A Pascal utility program for use with MS-DOS. This program features an implementation of turtle graphics, console control commands, printer controls, and serial communications capabilities. For the IBM Personal Computer; floppy disk, $150. Hi Tech Computer Services, 17 Mein Dr., New City, NY 10956.

Pool 1.5, a high-resolution graphics simulation game. This program allows you to play eight-ball, rotation, nine-ball, or straight pool. It features shot replay and friction control. For the IBM Personal Computer; floppy disk, $34.95. Innovative Design Software Inc., POB 1658, Las Cruces, NM 88004.

Softspool, a software print-spooler program that creates a user-defined print-spooler buffer in memory. It permits output to be sent to a printer while another program is running. For the IBM Personal Computer; floppy disk, $49.95. Rickerdata, POB 288, Burlington, MA 01803.

Suite 16 Manager, an interface program to IBM PC-DOS. This program simplifies entering commands by providing a menu of command options. You can create your own menus for applications programs. For the IBM Personal Computer; floppy disk, $60. Softwhere, 2162 Deerfield St., Thousand Oaks, CA 91362.

Visibridge, a Visicalc utility program that enhances report-printing capabilities by providing variable-width columns, column suppression, decimal point alignment, and disk storage. For the IBM Personal Computer; floppy disk, $81. Solutions Inc., POB 989, Montpelier, VT 05602.

TRS-80

The BASIC Answer, a processing utility program for creating structured BASIC programs. Designed for use with the LDOS operating system, this utility lets you use labels instead of absolute line numbers. For the TRS-80 Models I and III; floppy disk, $69. Logical Systems Inc., 11520 North Port Washington Rd., Mequon, WI 53902.

League Registration, a filing system for sports league information (see description under Apple). For the TRS-80 Models I and III; floppy disk, $150. Market Computing, 201 15th Ave. SW, Puyallup, WA 98371.

Games for the II, a set of five arcade-type games: Skydiver, Star Battle, The Wall, Space Swarm, and Mayhem. Each game features graphics and automatic scorekeeping. For the TRS-80 Model II; 8-inch floppy disk, $29.95. Maryland Model II Games, 3304 Carlton Ave., Temple Hills, MD 20748.

Pandemonium, a word game. The object of this game is to place 25 random letters onto a playing board matrix to construct three-, four-, or five-letter words. A 6000-word dictionary is built into the program. For the TRS-80 Models I and III; floppy disk, $39.95. Soft Images, 200 Route 17, Mahwah, NJ 07430.

Other Computers

ACCR, a simple database-management program. You can store, retrieve, search, and edit information about your personal finances or property. This program requires 16K RAM. For the ZX81/Timex-Sinclair 1000; cassette, $19.95. R. S. Panwar, 2035 Kentland Dr., Houston, TX 77067.

ADDR, a simple database-management program. You can store, retrieve, search, and edit information. You can also create an address list or home inventory. This program requires 16K RAM. For the ZX81/Timex-Sinclair 1000; cassette, $19.95. R. S. Panwar (see address above).

The Birthday Program, a program that will display the name of the birthday person, play the "Happy Birthday" song, and display a birthday cake. Enter a secret word to blow out the candles. For the VIC-20; cassette, $3.95. Soft 4 You, POB 3254, Reston, VA 22090.

The Math Teacher, a tutorial program using color and graphics. This program provides drill instruction in the basics of addition, subtraction, multiplication, and division. It features three levels of difficulty and displays a student's score after 25 problems are answered. For the NEC PC8001A; floppy disk, $29.95. Computech, Department NEC-MT-BY, POB 7000-309, Redondo Beach, CA 90277.

Text Editor, Assembler, and **Disassembler**, a set of three programs for assembly-language programming. The text editor is a line-oriented editor; the assembler and disassembler are for 8080/Z80 files created by the editor. For the North Star Horizon; floppy disk, $75. Polaris Software, POB 22825, San Diego, CA 92122.

Utopia, a simulation game in which you become the ruler of a country. You control the economy, food supply, and defense. But beware of the pirates, hurricanes, and rebels. For one or two players. For the Intellevision Master Component; cartridge, $34.97. Mattel Electronics, 5150 Rosecrans Ave., Hawthorne, CA 90250.■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format, the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Passing Untyped Parameters in UCSD Pascal

An assembler-language function and a "trick" are combined in a parameter-passing method.

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Pascal's best feature is that it is strongly typed. The programmer must declare all variable types beforehand as integers within a certain range, real numbers, characters, user-defined, and so on.

But strong typing, while desirable in most situations, can be a hindrance in others. In particular, for certain systems programming applications programmers often have to pass a variable of unspecified type as a parameter to a subroutine. A close look at the parameter-passing schemes available in Pascal shows that the language was not designed for applications requiring untyped parameters.

Because Pascal is a block-structured language, individual tasks within a program are coded as separate functions and procedures. Each module may have protected data that is not accessible from other modules. Data is passed from one module to another by means of one of two parameter-passing schemes. The most common method uses value parameters, which allows the subroutine to have its own copy of the passed parameter. This preserves the integrity of the calling routine's data.

If, on the other hand, the programmer wants the subroutine to return a different value in the parameter instead of the original one, "variable parameters" may be used. In this instance, the subroutine is given the address of the parameter and performs its manipulations on the original memory locations in the calling routine where the parameter is located.

A method exists that allows the programmer to pass a value of an unspecified type as a parameter to a subroutine.

In keeping with Pascal's strong type-checking features, most compilers and their run-time systems assure that the type of parameter declared in the subroutine matches the type of variable passed from the calling routine. This applies to both parameter-passing schemes I've described, and it would seem to eliminate Pascal as an implementation language for certain systems applications.

Fortunately, however, a method exists that allows the programmer to pass a value of unspecified type as a parameter to a subroutine. Although my example is written for UCSD Pascal Version IV by Softech Microsystems, the method could be adapted easily to other versions of Pascal and other languages. I'll begin with an example of a situation in which a programmer would need to use this technique.

Describing a Problem

In a well-designed piece of software, the end user is presented with a completely formatted screen that resembles a blank form, with entry headings and space for the entries. As you make entries, your data is checked for validity. Detailed error messages immediately notify you of your mistakes, and you're given time to correct them.

Constructing this sort of end-user interface takes a significant amount

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of programming time, and the resulting code constitutes a major portion of the program. A general-purpose utility that enables the application programmer to set up screens and specify valid entries with ease is a valuable tool.

Such a utility has two sections. The first is a stand-alone program that lets the application programmer format each screen. The second section consists of a set of subroutines to be linked to the application program. As soon as the screen is formatted, it is stored as a data file to be used by the subroutines. The subroutines access the data file to set up the screen and guide you through the process of entering the data, performing validity checks, and so on.

To perform validity checks the routines must know which values are acceptable for each entry on the screen. Typically, the utility provides a number of predefined types—a dollars-and-cents type or a date type, for example. The application programmer specifies the type for each entry when the screen is originally set up. Because this information becomes part of the data file for that screen, it is accessible to the utility subroutines.

After the utility subroutines perform their tasks, the validated data is returned to the application program for the necessary processing. The application programmer must specify which variables are to be passed the entered data when the utility subroutines are invoked. Normally this is easily accomplished by writing something like GETSCREEN (VARIABLE1, VARIABLE2, . . .). Here GETSCREEN is a utility subroutine and the VARIABLE*n* (variables) in the application program are passed the data. In our present discussion, however, GETSCREEN is a subroutine in a general-purpose utility.

In one application the data passed back in VARIABLE1 might be an integer, so VARIABLE1 would be declared an integer. But in another application using the utility, VARIABLE1 might accept data of the character type, and it would be declared as such.

Although the utility subroutines know from the data file what kinds of

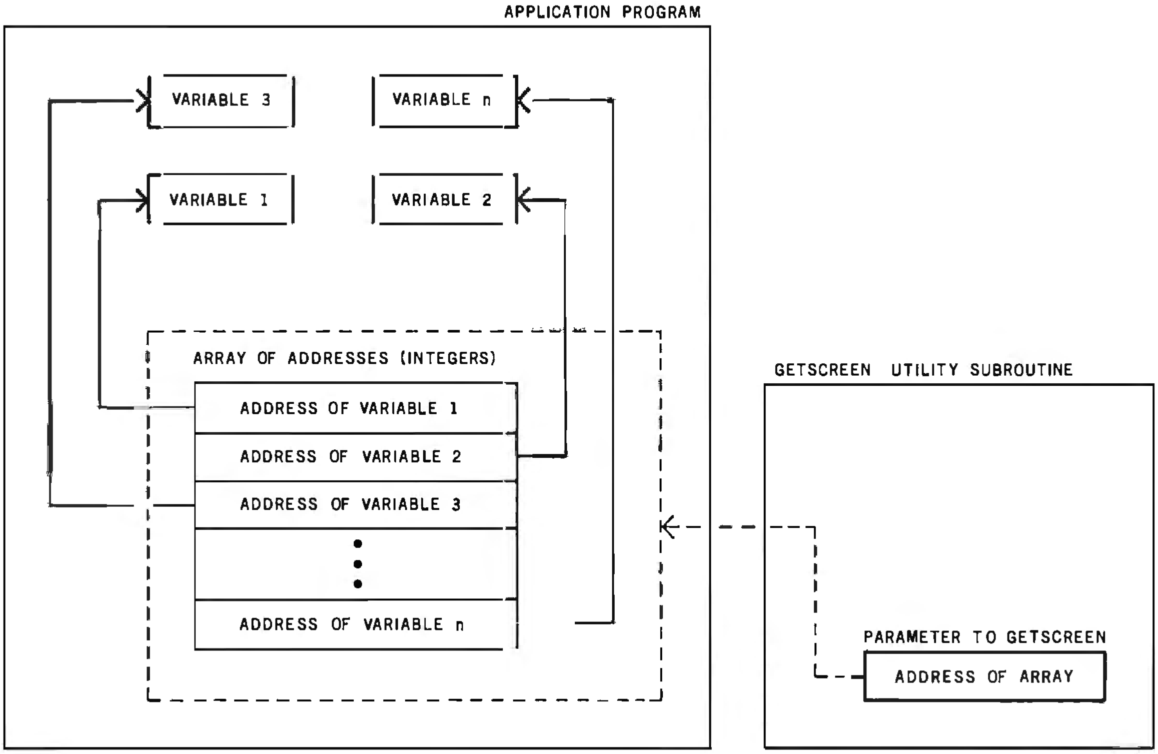

Figure 1: *Construction of an array in the application program containing the addresses-as-integers of each variable that will receive a value entered onto a screen. The array is passed as a variable parameter to GETSCREEN. GETSCREEN will input and validate the screen entries and then return the values to the variables of the application program using the addresses specified in the array.*

values each application needs for the VARIABLE*n*, the parameters corresponding to the VARIABLE*n* must be declared. As stated earlier, in Pascal the type of parameter declared in the subroutine must match the type of the corresponding variable in the calling routine. But in this case the author of the utility does not know the type of any of the variables passed from the application. In other words, the programmer needs to pass a value of unspecified type to a subroutine.

Identifying a Solution

To solve this problem, we will use a method adapted from a technique commonly found in assembler-language programs. This technique is similar to Pascal's variable parameter scheme in that the subroutine does not receive its own copy of a piece of data but instead is given its actual address.

The programmer writes the GETSCREEN routine so that it has only one parameter, an array of integers. Each integer in the array represents the address in memory of one VARIABLE*n* that will receive a value input to the screen. The array will have as many integers as the screen has data items. (See figure 1.)

GETSCREEN uses these integer/addresses as though they were variable parameters: it stores each data item entered and verified into the address specified by the appropriate integer in the array. Note that both the application program and the utility subroutine must explicitly manipulate addresses, while when variable parameters are employed the manipulation and passing of addresses is transparent to the programmer.

It is not difficult to write an ADDR function and make it part of the language.

Two important questions remain: How does the application program discover the addresses of the VARIABLE*n* to be placed in the array? and How does the utility subroutine use these addresses—which are really just integers—to pass values back to the VARIABLE*n*?

Adding a Function

In many languages, discovering the address of a variable is a relatively straightforward procedure. In PL/I, for example, the function ADDR (VARIABLE1) returns the address of VARIABLE1. Pascal does not contain an ADDR function, but writing one is easy, and making it a part of the language is simply a matter of including it in the system library.

The application programmer must write the function in the assembler language of the local processor to find the address of *any* variable, regardless of type. A Pascal subroutine will not permit this, but UCSD Pascal does allow assembler-language subroutines to be written with untyped parameters. The ADDR function shown in listing 1 is written in PDP-11 assembler language but can be adapted easily to any assembler

An ADDR Function for Pascal

The following directions will guide you through creating the ADDR function, including it in the system library, and using it in a program.

1. *Using the system editor, create a text file containing your version of ADDR.*
2. *Make sure that the .OPCODES and .ERRORS files for your assembler are on the system disk. Invoke the assembler by typing "a" at the outer-operating-system level. Respond appropriately to the prompts for text, code, and listing file names.*
3. *Invoke the library utility by typing "x" at the outer-operating-system level and responding to the prompt with "library" (library.code must be on your system disk). You will be asked to supply an output file name. Type any name ending in ".code" that doesn't already exist on your disk, such as "new.code." When you are prompted for an input file name, type "system. library." Then type "e" to copy all of the segments of your old library to what will become your new library. Type "n," then type the name of the code file containing your assembled ADDR function. Type "e" and then "q" to exit the library. Respond to the "notice" prompt by pressing Return.*
4. *Invoke the filer and "c" (change) the name of the system.library to old.library, and of new.code (or whatever you called it) to system.library. If the new system.library works as it should, you can remove the old.library.*
5. *Write the program that will use the ADDR function. Declare it as follows among the function declarations before you declare any function or procedure that uses it:*

   FUNCTION ADDR (VAR ANYTHING) : INTEGER; EXTERNAL;

6. *Use the "r" (Run) command at the outer-operating-system level to compile, link, and execute your program. The next time you want to execute your program, type "x" and then the name of the ".code" file created by the linker.*

Listing 1: *The PDP-11 version of the assembler-language ADDR function. The reader should become familiar with the UCSD Adaptable Assembler (see the UCSD Pascal Users Manual) before attempting to adapt ADDR to other processors.*

```
          .func    addr,1
          ;
          ;this function returns as its value
          ;the address of its single parameter
          ;
          mov      (sp)+,return     ;pop the return address and save it.
          mov      (sp)+,address    ;address of parameter. pop and save.
          tst      (sp)+            ;pop the junk.
          mov      address,-(sp)    ;return addr of param to top of stack.
          jmp      @return          ;depart to calling routine.
return    .word
address   .word
          .end
```

language supported by the UCSD system. (Complete instructions to assemble ADDR and include it in the system library are given in the text box.)

The routine itself is quite simple. When a function with variable parameters is invoked in the UCSD system, the interpreter pushes one word of what is for our purposes "junk" onto the system stack, pushes the addresses of the variable parameter(s), and pushes the return address. After the function returns, the interpreter expects to find these elements removed from the stack and the value of the function on top of the stack.

Because our ADDR function returns the address of its parameter as its value, it simply pops the return address and saves it, pops the address of the parameter and holds it momentarily, and pops the "junk" and discards it. Then it replaces the address of the parameter on top of the stack as the returned value and branches back to the calling routine.

The ADDR function must be declared an external routine in the application program. To use the function, the application programmer declares an array of integers whose size is the maximum number of entries permitted for a screen. The number of entries for a particular screen may be stored in that screen's data file or passed as an additional parameter to GETSCREEN. Before GETSCREEN is invoked, the ADDR function is applied to each variable that will hold a validated screen value (the VARIABLE*n*), and the resulting integer-form addresses are assigned to successive elements of the array (see listing 2).

Using a Trick

As soon as the utility subroutine receives the array of addresses, it must be able to use them to store the entered and validated data items in the appropriate places. The problem is that in Pascal and most other languages, the closest you can come to touching addresses is via pointers. And although pointers are really just addresses and addresses are really just integers, Pascal does not allow the pointers and addresses to mix. To sidestep this restriction you must employ one of Pascal's more infamous tricks—using a variant record to define the same storage location as both an integer and a pointer (see listing 3).

A variant record is required for each possible data type that the VARIABLE*n* of the application program may assume. Listing 3 contains variant records for the integer and character types called INT_POINTER and CHAR_POINTER. These variant records contain no tag field; the "CASE INTEGER OF 1: . . ; 2: . . ." is a device to enable the utility subroutines to refer to each variant record under two aliases.

When, for example, the alias

Listing 2: *Skeleton application program illustrating how the table of addresses is declared, filled, and sent to the utility subroutine.*

```
PROGRAM APPLICATION_SKELETON;

   CONST
      MAX_ENTRIES_PER_SCREEN = 100;           {OR WHATEVER}

   TYPE
      TABLE_TYPE = ARRAY [1 . . MAX_ENTRIES_PER_SCREEN] OF INTEGER;

   VAR
      TABLE_OF_ADDRESSES  : TABLE_TYPE;
      VARIABLE1           : CHAR;             {FOR EXAMPLE}
      VARIABLE2           : {WHATEVER THEY MAY BE}
      .
      .
      .

FUNCTION ADDR (VAR ANYTHING) : INTEGER; EXTERNAL;

BEGIN
      .
      .
      .
      TABLE_OF_ADDRESSES[1]: = ADDR (VARIABLE1);
      TABLE_OF_ADDRESSES[2]: = ADDR (VARIABLE2);
      .
      .
      .
      GETSCREEN (TABLE_OF_ADDRESSES);
      .
      .
      .
END.
```

Listing 3: *Skeleton utility subroutine illustrating how the table of addresses is used to send validated values back to the application program.*

```
PROCEDURE GETSCREEN_SKELETON;

   TYPE
     INT_POINTER = RECORD
        CASE INTEGER OF
           1 : (POINTER_AS_INTEGER : INTEGER);
           2 : (POINTER            : ↑INTEGER)
     END;

     CHAR_POINTER = RECORD
        CASE INTEGER OF
           1 : (POINTER_AS_INTEGER : INTEGER);
           2 : (POINTER            : ↑CHAR)
     END;

   VAR
     INT          : INT_POINTER;
     CHARACTER    : CHAR_POINTER;
     CH           : CHAR;

   BEGIN
```

Listing 3 continued:

```
  {FOR THE PURPOSE OF THIS EXAMPLE ASSUME THAT GETSCREEN HAS
  ALREADY DETERMINED THAT THE FIRST SCREEN ITEM IS OF TYPE CHAR AND
  HAS BEEN INPUT TO THE LOCAL VARIABLE CH.}
  .
  .
  .
  CHARACTER.POINTER_AS_INTEGER := TABLE_OF_ADDRESSES[1].

  {THE POINTER TO CHARACTER IN ITS INTEGER GUISE IS SET EQUAL TO THE
  ADDRESS OF VARIABLE1 IN ITS INTEGER GUISE.}

  CHARACTER.POINTER↑ := CH;

  {VOILA! VARIABLE1 IN THE APPLICATION NOW CONTAINS THE FIRST
  SCREEN VALUE.}
  .
  .
  .
END.
```

CHARACTER.POINTER_AS_INTEGER is used, CHAR_POINTER may be manipulated as any integer. The utility, knowing that a particular address in the array of integer/addresses passed to it by the application program belongs to a variable of type character, may take that integer/address and assign it to CHARACTER.POINTER_AS_INTEGER.

Once that happens, any reference to CHARACTER.POINTER↑ is a reference to a character variable in the application program. Thus, as soon as the utility subroutine GETSCREEN has accepted and validated an input of type character, it only has to assign it to CHARACTER.POINTER↑ and the data will be transported back to the application.

Because the utility knows from the data file what type variable each screen entry must be assigned to, it can take the corresponding address from the array and move it into the appropriate variant record. When the value itself is assigned to the pointed-to location, it lands exactly where the application expects to find it.

A parameter or parameters of unspecified type may be passed to a subroutine in Pascal. Purists may object to such tricks and pragmatists may point to other languages where machinations like these are unnecessary. But in defense of Pascal, few languages provide such a rich and balanced variety of features. To the credit of its designer and its implementers at UCSD, Pascal is flexible enough to accommodate situations for which it was not originally intended.■

A Terminal Program for the TRS-80 Model III

A world of information is just a phone call away.

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Imagine having these resources available to your TRS-80 Model III: general-use databases such as The Source and Compuserve, research-oriented databases such as Dialog, specialized databases covering practically any subject, and electronic bulletin boards for any interest. If the prospect appeals to you, all you need to do is transform your Model III into a "smart" terminal. Your telephone will do the rest.

Before attempting the conversion, you'll need two things. First, you must have a serial port (e.g., an RS-232C board) so that your Model III can communicate via a modem over the telephone lines. Of course, you'll also need a program that enables the computer to perform as a terminal. I wrote such a program for my TRS-80 Model III and have used it successfully over the past few months.

Several features of the TRS-80 Model III make it attractive for use as a terminal. First, its Control key (shift down-arrow) lets you enter control characters from the keyboard. On most larger computers, these characters control the operating system. For example, you might use Control-C to terminate program execution. A second important feature of the Model III is an (optional) RS-232C serial-interface board. I particularly like a couple of other features, such as the lowercase characters and the single-unit design of the Model III that incorporates the video display, keyboard, and disk drives. The only disadvantage of the Model III is that its screen has 64 columns instead of the usual 80. But for my work, at least, that hasn't been a serious drawback.

I wrote the terminal program in Z80 assembly language, which operates at 300 bits per second (bps), the most frequently used speed for remote terminals that communicate over the telephone line (chances are it would work satisfactorily at higher transmission rates, but that hasn't been tested). Note that the program is written only for the TRS-80 Model III and will not run on a Model I.

The program requires one or two disk drives and a minimum of 32K bytes of RAM (random-access read/write memory). The terminal program supports disk operations. For example, you can store a program on one of your disks and then either send it to the remote computer or store the output from the remote computer on a disk. If you have no disk drives and only 16K bytes of RAM, you can still use the program by simply eliminating the disk-related section (I will explain this in detail later).

If you want listings or hard copy of output from the remote computer, you can use a parallel printer. Again, the program will work even if you don't have a printer. You can either eliminate the printer-related sections of the program or disregard the printer-related commands.

I designed the terminal program (see listing 1) to access a PDP-11/45 minicomputer with version 7.0 of the RSTS/E operating system. A different operating system or computer may call for some changes to the program. I tried to make it as flexible and universal as possible so that no major changes should be necessary.

You may want to custom design the program to suit your particular needs. That way, you can incorporate the features you need and eliminate those you don't. (Hereafter, I will use "computer" to refer to the remote computer and "Model III" to refer to the TRS-80 Model III to avoid confusion between the two.)

Initializing the RS-232C Interface

The main section of the program, which allows the Model III to communicate with the computer (without printer or disk capability), is very simple. (See figure 1 for an illustration of its operation.) First, the RS-232C interface is initialized. A "don't wait" condition is necessary, so in line 480 of the program a 0 is loaded into location 16890. In line 500, all the bits in location 16889 are set to 1 by calling RSINIT (I needed an 8-bit word length with 1 stop bit and no parity; the eighth bit is ignored. Call your computer center or system

Text continued on page 464

Listing 1: *Model III terminal program. This listing contains all options for use with a printer and disk drives.*

```
SOURCE LISTING FOR TERMINAL PROGRAM

        ORG     5400H
;**********     MAIN PROGRAM CONSTANTS  **********
DUPLEX  EQU     5200H           ;DUPLEX FLAG
KBCHAR  EQU     002BH           ;KEYBOARD SCAN
VDCLS   EQU     01C9H           ;CLS
VDCHAR  EQU     0033H           ;VIDEO DISPLAY
RSINIT  EQU     005AH           ;INITALIZE RS232
RSRCV   EQU     0050H           ;RS232 RECEIVE
RSTX    EQU     0055H           ;RS232 XMT
CHAR    EQU     5202H           ;CHAR STORAGE
RCVBYT  EQU     16872           ;RCV LOCATION RS232
CURSOR  EQU     143             ;CURSOR CHARACTER
CURLOC  EQU     4020H           ;CURSOR ADDRESS
;**********     BUFFER CONSTANTS  **********
PRCHAR  EQU     003BH           ;LINE PRINTER ROUTINE
BUFLAG  EQU     5201H           ;BUFFER FLAG
BUFPTR  EQU     5203H           ;BUFFER POINTER
BUFNUM  EQU     5205H           ;BUFFER COUNT
BUFBEG  EQU     5800H           ;FIRST BUFFER LOC
;**********     DISK CONSTANTS  **********
XMTBYT  EQU     41F0H           ;RSTX BUFFER
DOS     EQU     402DH           ;TRSDOS
DCB     EQU     5207H           ;DCB FOR A DISK FILE
ERNL    EQU     5213H           ;LSB OF ERN
ERNM    EQU     5214H           ;MSB OF ERN
EOF     EQU     520FH           ;# BYTES IN LAST RECORD
CTRD    EQU     5239H           ;RECORD COUNTER
BUFFER  EQU     523BH           ;1ST ADDR OF DISK BUFFER
READ    EQU     4436H           ;READ RECORD FROM DISK
CLOSE   EQU     4428H           ;CLOSE FILE
OPEN    EQU     4424H           ;OPEN FILE
INIT    EQU     4420H           ;OPENS NEW FILE
WRITE   EQU     4439H           ;WRITE RECORD TO DISK
TEMPST  EQU     533BH           ;TEMP STORAGE FOR SCREEN
LINE    DEFM    'Enter Filename'        ;PROMPT
;****************************************
        CALL    VDCLS           ;CLS
        XOR     A               ;ZERO A REGISTER
        LD      (16890),A       ;NO WAIT CONDITION
        LD      A,255           ;SET UP RS232
        LD      (16889),A       ;INITALIZE RS232
        CALL    RSINIT          ;INITALIZE RS232
        XOR     A               ;ZERO A
        LD      (BUFLAG),A      ;BUFFER CLOSED
        LD      (DUPLEX),A      ;HALF DUPLEX
        CALL    BUFSET          ;INITALIZE BUFFER
RCV     CALL    RSRCV           ;CHECK RS232 RECEIVE
        LD      A,(RCVBYT)      ;PUT CHAR IN A
        JR      Z,KEYBD         ;IF NO CHAR, GO
        CP      10              ;LINE FEED?
        JR      Z,RCV           ;IF SO IGNORE IT
        LD      (CHAR),A        ;SAVE CHAR
        CALL    VIDEO           ;PRINT CHARACTER
        LD      A,(BUFLAG)      ;BUFFER STATUS
        CP      0               ;BUFFER CLOSED?
        JR      Z,KEYBD         ;IF SO GO
        CALL    BUFPUT          ;PUT CHAR IN BUFFER
KEYBD   CALL    KBCHAR          ;CHECK KEYBOARD
        JR      Z,RCV           ;GO CHECK RS232 IF NO CHAR
        LD      (CHAR),A        ;SAVE CHAR
        CP      2               ;TURN BUFFER ON?
        JP      Z,BUFON         ;IF SO, GO DO IT
        CP      15              ;TURN BUFFER OFF?
        JP      Z,BUFOFF        ;IF SO, GO DO IT
        CP      5               ;ERASE BUFFER?
        JP      Z,BUFER         ;IF SO, GO DO IT
        CP      16              ;PRINT BUFFER?
        JP      Z,BUFPR         ;IF SO, GO DO IT
        CP      1               ;BREAK KEY?
        JP      Z,DOS           ;IF SO, RETURN TO DOS
        CP      18              ;CTRL/R
        JR      NZ,SET1         ;IF NOT, GO
        PUSH    AF              ;SAVE A
```

Listing 1 continued on page 460

Listing 1 continued:

```
        JP      DISKRD          ;GO READ FILE
SET1    CP      6               ;CTRL/F ?
        JR      NZ,SET2         ;IF NOT, GO
        PUSH    AF              ;SAVE A
        JP      DISKRD          ;GO READ FILE AND SEND
SET2    CP      7               ;CTRL/G ?
        JP      Z,BUFXMT        ;GO XMT BUFFER TO COMPUTER
        CP      10              ;CTRL/J ?
        JP      Z,PAU2          ;IF SO, CONTINUE SENDING
        CP      23              ;CTRL/W ?
        JP      Z,DISKSV        ;WRITE BUFFER TO DISK
        CP      4               ;CTRL/D ?
        JR      NZ,SET          ;IF NOT, GO
        LD      A,(DUPLEX)      ;GET DUPLEX FLAG
        XOR     1               ;TOGGLE FLAG
        LD      (DUPLEX),A      ;SAVE FLAG
        JP      RCV             ;GO BACK
SET     CP      13              ;CARRIAGE RETURN ?
        JR      Z,XMT           ;IF SO, SEND IT
        LD      A,(DUPLEX)      ;DUPLEX FLAG
        CP      0               ;HALF DUPLEX?
        JR      NZ,XMT          ;IF FULL DUPLES, DON'T PRINT
        CALL    VIDEO
XMT     LD      A,(CHAR)        ;RESTORE CHAR TO A
        CALL    RSTX            ;XMT CHARACTER
        JP      RCV             ;START OVER
;**********  VIDEO - PRINTS CHAR ON VIDEO **********
VIDEO   LD      A,(CHAR)        ;GET CHAR
        PUSH    HL              ;SAVE HL
        CP      13              ;CARRIAGE RETURN
        JR      Z,CURS2         ;IF SO, GO
        CP      8               ;BACKSPACE ?
        JR      NZ,CURS         ;IF NOT, GO
CURS2   LD      HL,(CURLOC)     ;CURSOR LOCATION
        LD      A,32            ;BLANK
        LD      (HL),32         ;BLANKS PREVIOUS CURSOR
        LD      A,(CHAR)        ;RESTORE CHAR TO A
CURS    CALL    VDCHAR          ;PRINT CHAR
        LD      HL,(CURLOC)     ;GET CURSOR LOCATION
        LD      A,CURSOR        ;CURSOR  HAR
        LD      (HL),A          ;PRINT CURSOR
        LD      A,(CHAR)        ;RESTORE CHAR TO A
        POP     HL              ;RESTORE HL
        RET
;**********  BUFON - TURNS BUFFER ON  **********
BUFON   LD      A,1
        LD      (BUFLAG),A      ;BUFFER OPEN
        JP      RCV             ;GO BACK
;**********  BUFOFF - TURNS BUFFER OFF  **********
BUFOFF  XOR     A
        LD      (BUFLAG),A      ;BUFFER CLOSED
        JP      RCV             ;GO BACK
;**********  BUFPR - DUMPS FROM BUFFER TO PRINTER  **********
BUFPR   LD      HL,(BUFNUM)     ;NUMBER OF CHARS IN BUFF
        LD      A,H             ;GET MS COUNT
        OR      L               ;MERGE LS
        JR      NZ,LOP1         ;BUFFER EMPTY, GO BACK
        JP      RCV
LOP1    LD      DE,BUFBEG       ;FIRST BUFFER CHAR
PTLOOP  LD      A,(DE)          ;CHAR TO PRINT
        PUSH    DE
        CALL    PRCHAR          ;PRINT IT
        CALL    KBCHAR          ;CHECK KEYBOARD
        POP     DE
        CP      3               ;CNTRL C?
        JR      NZ,LOP
        JP      RCV             ;STOP PRINT, GO BACK
LOP     INC     DE              ;PT TO NEXT CHAR
        DEC     HL              ;NUMBER OF  HARS REMAINING
        LD      A,H             ;GET MS COUNT
        OR      L               ;MERGE LS COUNT
        JR      NZ,PTLOOP       ;GO IF COUNT NOT ZERO
        JP      RCV             ;DONE
;**********  BUFER - ERASES BUFFER  **********
BUFER   CALL    BUFSET          ;ERASES BUFFER
        JP      RCV             ;DONE
BUFSET  LD      HL,0
        LD      (BUFNUM),HL     ;NUMBER OF CHARS SET TO 0
        LD      HL,BUFBEG
        LD      (BUFPTR),HL     ;INITIALIZE BUFF POINTER
        RET
;**********  BUFPUT - PUTS CHAR INTO BUFFER  **********
BUFPUT  LD      HL,(BUFPTR)     ;NEXT POSITION
        LD      A,(CHAR)        ;GET CHAR
        LD      (HL),A          ;PUT CHAR IN BUFFER
        INC     HL              ;INC BUFPTR
        LD      (BUFPTR),HL     ;STORE IT
        LD      HL,(BUFNUM)     ;OLD NUMBER OF CHARS
```

Listing 1 continued:

```
                INC     HL              ;ADD 1
                LD      (BUFNUM),HL     ;STORE IT
                RET
;**********  DISKRD --READ A FILE FROM DISK  **********
DISKRD          CALL    FILNAM          ;SETS UP DCB
                LD      B,0             ;LRL SET TO 256
                LD      DE,DCB          ;1ST ADDR OF DCB
                LD      HL,BUFFER       ;1ST ADDR OF DISK BUFFER
                CALL    OPEN            ;OPENS SPECIFIED FILE
                CALL    RESTOR          ;RESTORE SCREEN
                LD      A,(ERNM)        ;MSB OF ERN
                LD      H,A             ;MSB OF ERN IN H
                LD      A,(ERNL)        ;LSB OF ERN
                LD      L,A             ;LSB OF ERN IN L
                LD      (CTRD),HL       ;# OF RECORDS TO READ
                DEC     A               ;LSB-1 OF ERN
                OR      H               ;ERN = 1 ?
                JR      Z,RDRC3         ;IF SO, GO
RDRC            LD      DE,DCB          ;GETTING READY TO READ
                CALL    READ            ;MOVE RECORD TO DBUFF
                LD      HL,BUFFER       ;1ST DBUFFER ADDR
                LD      DE,(BUFPTR)     ;DESTINATION
                LD      BC,100H         ;256 BYTES TO MOVE
                POP     AF              ;RESTORE A
                CP      6               ;CTRL/ F?
                PUSH    AF              ;SAVE A
                JR      NZ,LDBUF        ;MOVE BYTES TO BUFFER
                CALL    FAST            ;SEND TO COMPUTER
                JR      GETMR           ;CONTINUE
LDBUF           LDIR                    ;MOVE BYTES TO BUFFER
                LD      (BUFPTR),DE     ;SAVE NEW BUFFER POINTER
                LD      HL,(BUFNUM)     ;NEED TO UPDATE BUFNUM
                INC     H               ;ADD 256 TO HL
                LD      (BUFNUM),HL     ;SAVE # CHAR
GETMR           LD      HL,(CTRD)       ;PREVIOUS # RECORDS
                DEC     HL              ;CURRENT # RECORDS
                LD      (CTRD),HL       ;SAVE IT
                DEC     HL              ;CHECK IF (CTRD) IS 1
                LD      A,L             ;LSB
                OR      H               ;MERGE MSB
                JR      NZ,RDRC         ;IF (CTRD)>1, READ NEXT RECORD
RDRC3           LD      DE,DCB          ;1 RECORD LEFT
                CALL    READ            ;PUT IT IN DBUFFER
                LD      A,(EOF)         ;EOF OF LAST RECORD
                CP      0               ;FULL 256 BYTES ?
                JR      NZ,RDRC1        ;IF NOT, GO
                LD      DE,(BUFPTR)     ;DISTINATION
                LD      HL,BUFFER       ;SOURCE
                LD      BC,100H         ;# OF BYTES TO MOVE
                POP     AF              ;RESTORE A
                CP      6               ;CTRL/F ?
                PUSH    AF              ;SAVE A
                JR      NZ,LDBUF1       ;PUT INTO BUFF
                CALL    FAST            ;SEND TO COMPUTER
                JR      RDRC2           ;DONE
LDBUF1          LDIR                    ;MOVE 'EM
                LD      (BUFPTR),DE     ;SAVE BUFFER POINTER
                LD      HL,(BUFNUM)     ;UP DATE BUFNUM
                INC     H               ;ADD 256 TO HL
                LD      (BUFNUM),HL     ;SAVE # OF CHAR IN BUFFER
                JR      RDRC2           ;FINISHED READING FILE
RDRC1           LD      A,(EOF)         ;# BYTES TO MOVE
                LD      C,A
                LD      B,0             ;# BYTES TO MOVE IN BC
                POP     AF              ;GET A
                CP      6               ;CTRL/F?
                PUSH    AF              ;SAVE A
                JR      Z,RD            ;IF CTRL/F GO
                LD      HL,(BUFNUM)     ;PREVIOUS # IN BUFF
                ADD     HL,BC           ;UPDATE IT
                LD      (BUFNUM),HL     ;SAVE BUFNUM
                LD      DE,(BUFPTR)     ;DESTINATION
RD              LD      HL,BUFFER       ;SOURCE
                POP     AF              ;RESTORE A
                CP      6               ;CTRL/F ?
                PUSH    AF              ;SAVE A
                JR      NZ,LDBUF2       ;PUT INTO BUFF
                CALL    FAST            ;SEND TO COMPUTER
                JR      RDRC2           ;DONE
LDBUF2          LDIR                    ;MOVE BYTES INTO BUFF
                LD      (BUFPTR),DE     ;SAVE NEW BUFF POINTER
RDRC2           LD      DE,DCB          ;READY TO CLOSE FILE
                CALL    CLOSE           ;CLOSE IT
                JP      RCV             ;FINISHED, GO BACK
;**********  BUFXMT - DUMPS FROM BUFFER TO COMPUTER  **********
BUFXMT          LD      BC,(BUFNUM)     ;# CHAR IN BUFFER
                LD      A,B             ;MSB
                OR      C               ;MERGE LSB
```

Listing 1 continued on page 462

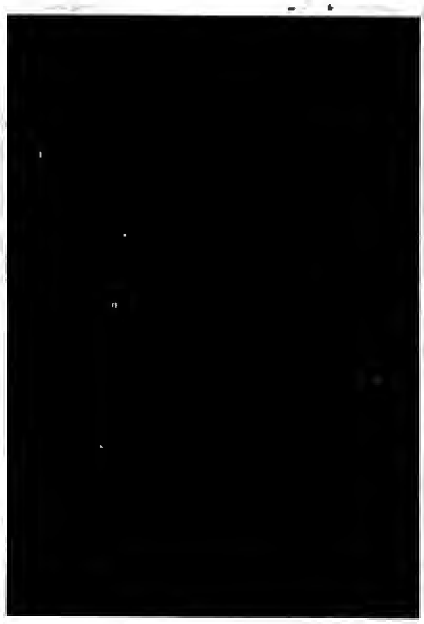
Listing 1 continued:

```
02590          JP      Z,RCV           ;BUFFER EMPTY, GO BACK
02600          LD      HL,BUFBEG       ;1ST BUFFER ADDR
02610 XMTLP    LD      A,(HL)          ;CHAR TO BE SENT
02620          LD      (CHAR),A        ;SAVE THE CHAR
02630          CP      0               ;ASCII 0 ?
02640          JR      Z,TEMP3         ;IF SO, SKIP IT
02650          CP      141             ;GRAPHIC CR
02660          JR      NZ,OK1          ;IF NOT IGNORE
02670          LD      A,13            ;CHANGE TO C[redacted]
02680 OK1      LD      (CHAR),A        ;SAVE CHAR
02690          LD      (XMTBYT),A      ;PUT CHAR IN XMT BUF
02700 SENDIT   CALL    RSTX            ;SEND IT
02710          JR      Z,SENDIT        ;WAIT UNTIL SENT
02720          CP      13              ;CARRIAGE RETURN?
02730          JR      Z,TEMP3         ;IF SO, GO
02740          LD      A,(DUPLEX)      ;DUPLEX FLAG
02750          CP      0               ;HALF DUPLEX ?
02760          JR      NZ,TEMP         ;IF FULL DUP, GO RCV
02770          CALL    VIDEO
02780          JR      TEMP3           ;SKIP RCV
02790 TEMP     CALL    RSRCV           ;CHECK RS 232 RCV
02800          LD      A,(RCVBYT)
02810          CP      0               ;ANYTHING THERE?
02820          JR      Z,TEMP          ;IF NOT, LOOK AGAIN
02830          LD      (CHAR),A        ;SAVE CHAR
02840          CALL    VIDEO           ;PRINT CHAR
02850 TEMP3    DEC     BC              ;DECREASE BUFF COUNT
02860          LD      A,B             ;TEST FOR 0 COUNT
02870          OR      C
02880          JP      Z,RCV           ;ALL DONE, GO BACK
02890          INC     HL              ;INCREASE CHAR LOCATION
02900          LD      A,(CHAR)        ;GET CHAR
02910          CP      13              ;CARRIAGE RETURN ?
02920          JR      NZ,XMTLP        ;IF NOT, GO GET NEXT CHAR
02930          LD      A,(HL)          ;NEXT CHAR IN BUFF
02940          CP      0               ;IS IT A 0 ?
02950          JR      NZ,PAUSE        ;IF NOT, GO PAUSE
02960          LD      A,C             ;TEST IF LAST CHAR
02970          DEC     A
02980          OR      B
02990          JP      Z,RCV           ;LAST CHAR 0, SO DONE
03000 PAUSE    CALL    RSRCV           ;CHECK FOR INCOMING CHARS
03010          LD      A,(RCVBYT)      ;GET CHAR
03020          CP      0               ;ANYTHING THERE ?
03030          JR      Z,PAU1          ;IF NOT, GO CHECK KEYBOARD
03040          CP      10              ;LINE FEED ?
03050          JR      Z,PAUSE         ;IF SO, IGNORE IT
03060          LD      (CHAR),A        ;SAVE CHAR
03070          CALL    VIDEO           ;PRINT RECEIVED CHAR
03080          JR      PAUSE           ;GO CHECK RS232 RCV
03090 PAU1     CALL    KBCHAR          ;CHECK KEYBOARD
03100          CP      0               ;ANYTHING THERE ?
03110          JR      Z,PAUSE         ;IF NOT, GO CHECK RS RCV
03120          CP      3               ;CTRL/C ?
03130          JP      NZ,XMTLP        ;GO SEND MORE CHARS
03140 TEMP2    PUSH    HL              ;SAVE CURRENT BUFF LOC
03150          PUSH    BC              ;SAVE BUFF COUNT
03160          JP      RCV             ;GO TO RCV
03170 PAU2     POP     BC              ;BACK FROM RCV
03180          POP     HL
03190 BACK     JR      XMTLP           ;GO SEND MORE CHARS
03200 ;**********  DISKSV - DUMP BUFFER TO DISK  **********
03210 DISKSV   LD      BC,(BUFNUM)     ;# CHARS IN BUFFER
03220          LD      A,C             ;LSB
03230          OR      B               ;MERGE MSB
03240          JP      Z,RCV           ;BUFFER EMPTY
03250          CALL    FILNAM          ;SETS UP DCB
03260          LD      HL,BUFFER       ;DBUFF ADDRESS
03270          LD      DE,DCB          ;DCB ADDRESS
03280          LD      B,0             ;LRL SET TO 256
03290          CALL    INIT            ;OPENS FILE
03300          LD      HL,(BUFNUM)     ;# CHARS TO WRITE
03310          LD      A,L             ;EOF
03320          LD      (EOF),A         ;SAVE IT
03330          CP      0               ;EOF = 0?
03340          JR      Z,OK            ;(CTRD) IS OK
03350          LD      A,H             ;MUST INCREMENT (CTRD)
03360          INC     A               ;A CONTAINS # RECORDS
03370 OK       LD      (CTRD),A        ;# RECORDS TO WRITE
03380          LD      (ERNL),A        ;LSB ERN
03390          XOR     A               ;ZERO A
03400          LD      (ERNM),A        ;MSB ERN
03410          LD      HL,BUFBEG       ;SOURCE
03420 WDISK    LD      BC,256          ;# BYTES TO MOVE
03430          LD      DE,BUFFER       ;DESTINATION
03440          LDIR                    ;MOVE 256 BYTES TO DBUFF
03450          LD      DE,DCB          ;DCB ADDRESS
```

Listing 1 continued:

```
                CALL    WRITE               ;WRITE TO DISK
                LD      BC,(CTRD)           ;RECORD COUNT
                DEC     BC                  ;RECORDS LEFT
                LD      A,B                 ;MSB
                OR      C                   ;MERGE LSB
                JR      Z,FINWRT            ;IF DONE,
                LD      (CTRD),BC           ;SAV
                JR      WDISK
        FINWRT  LD      DE,DCB              ;DCB ADDRESS
                CALL    CLOSE               ;CLOSE FILE
                CALL    RESTOR              ;RESTORE SCREEN
                JP      RCV                 ;DONE
        ;**********  FILNAM - SETS UP FILENAME  *
        FILNAM  LD      HL,16256            ;SOURCE
                LD      BC,128              ;# SCRE
                LD      DE,TEMPST           ;DESTIN
                LDIR                        ;SAVE LAST 2 LINES
                LD      A,64
                LD      IX,16256            ;1ST ADDR OF 15TH LINE
        LINE1   LD      (IX+0),CURSOR       ;DRAW LINE
                LD      (IX+64),32          ;CLEARS LAST LIN
                INC     IX                  ;INC PRINT POSITIONS
                DEC     A                   ;DONE ?
                JR      NZ,LINE1            ;FINISH LINE
                LD      HL,LINE             ;PRINT 'ENTER FILENAME'
                LD      B,14                ;NUMBER OF CHARS TO PRINT
                LD      DE,16320            ;1ST PRINT LOCATION
        MESS    LD      A,(HL)              ;PUT CHAR IN A
                LD      (DE),A              ;PRINT IT
                INC     HL                  ;INC MESSAGE POINTER
                INC     DE                  ;INC PRINT LOCATION
                DEC     B                   ;DEC COUNTER
                JR      NZ,MESS             ;IF NOT DONE, GO BACK
        START   LD      C,0                 ;INITIAL CHAR COUNT
                LD      HL,16336            ;1ST CURSOR LOCATION
                LD      (HL),CURSOR         ;PRINT CURSOR
        START1  CALL    KBCHAR              ;CHECK KEYBOARD
                CP      0                   ;ANYTHING THERE ?
                JR      Z,START1            ;IF NOT, CHECK AGAIN
                LD      (CHAR),A            ;SAVE CHAR
                CP      3                   ;CTRL/C ?
                JR      NZ,CONT1            ;IF NOT, GO
                CALL    RESTOR              ;RESTORE SCREEN
                JP      RCV                 ;ESCAPE BACK
                CP      3                   ;CNTRL/C ?
                JR      NZ,CONT1            ;IF NOT, GO
                CALL    RESTOR              ;RESTORE SCREEN
                JP      RCV                 ;BACK TO MAIN ROUTINE
        CONT1   CP      8                   ;BACK SPACE ?
                JR      NZ,CONT             ;IF NOT, GO
                LD      A,C                 ;GET CHAR COUNT
                CP      0                   ;FIRST CHAR ?
                JR      Z,START             ;IF SO, START OVER
                DEC     C                   ;DECREASE COUNT
                LD      A,32                ;BLANK
                LD      (HL),A              ;BLANKS PREV CURSOR
                DEC     HL                  ;DEC CURSOR LOC
                LD      (HL),CURSOR         ;PRINT CURSOR
                JR      START1              ;GO BACK TO KEYBOARD
        CONT    CP      13                  ;CARRIAGE RETURN ?
                JR      Z,MOVE              ;IF SO, GO
                LD      A,C                 ;GET COUNT
                CP      23                  ;MAX FILENAME LEN
                JR      Z,START1            ;MUST HAVE CR, GO BACK
                LD      A,(CHAR)            ;GET CHAR
                LD      (HL),A              ;PRINT IT
                INC     HL                  ;INCREASE CURSOR LOC
                LD      (HL),CURSOR         ;PRINT CURSOR
                INC     C                   ;INC COUNT
                JR      START1              ;GO CHECK KEYBOARD
        MOVE    LD      A,32                ;BLANK
                LD      (HL),32             ;ERASE CURSOR
                LD      B,0                 ;CHAR COUNT IN BC
                LD      HL,16336            ;SOURCE
                LD      DE,DCB              ;DESTINATION
                LDIR                        ;MOVE FILENAME TO DCB
                LD      A,13                ;CARRIAGE RETURN
                LD      (DE),A              ;CARRIAGE RETURN IN DCB
                RET                         ;DONE
        ;**********  RESTOR - RESTORES LAST 2 LINES TO SCREEN  **********
        RESTOR  LD      BC,128              ;# OF CHARS
                LD      HL,TEMPST           ;SOURCE
                LD      DE,16256            ;DESTINATION
                LDIR                        ;RESTORES LAST 2 ROWS TO SCREEN
                RET
        ;**********  FAST - SENDS CHARS TO THE COMPUTER  **********
        FAST    LD      A,(HL)              ;CHAR TO SEND
                CP      0                   ;ASCII ZERO ?
```

Listing 1 continued on page 464



Listing 1 continued:

```
04340            JR      Z,GO3          ;IF SO, SKIP IT
04350            CP      141            ;GRAPHICS CHAR ?
04360            JR      NZ,GO2         ;IF NOT, SKIP
04370            LD      A,13           ;CARRIAGE RETURN
04380 GO2        LD      (CHAR),A       ;SAVE CHAR
04390            LD      (XMTBYT),A     ;PUT IN XMT BUF
04400 GO1        CALL    RSTX           ;TRY SENDING IT
04410            JR      Z,GO1          ;TRY AGAIN
044[illegible]   CALL    VIDEO          ;PRINT CHAR
044[illegible] GO3  INC  HL             ;POINT TO NEXT CHAR
[illegible]      DEC     BC             ;DEC COUNTER
[illegible]      LD      A,C            ;LSB
[illegible]      CP      0              ;DONE?
[illegible]      JR      NZ,FAST        ;IF NOT, GO
[illegible]      RET                    ;DONE
0[illegible]     END     5400H
```

Text continued from page 458:

operator to determine the characteristics you need.) Refer to your Model III reference manual for an explanation of the RSINIT ROM (read-only memory) subroutine.

After initialization is completed, the main program continues with line 560, which checks the RS-232C port. If nothing has been received, the keyboard is checked. If, however, a character was received, it is displayed on the screen and then the keyboard is checked. If no character is received from the keyboard, the RS-232C port is checked again. If a character is entered from the keyboard, it is transmitted to the computer out the RS-232C port and the port is checked for received data.

The VIDEO subroutine (line 1100) displays the character on the screen. Notice that there is no call to VIDEO following the keyboard check. This indicates the "full-duplex" mode—every character sent to the computer is echoed back so that a character entered from the keyboard is displayed on the screen after it is received from the computer. If the computer operates in the "half-duplex" mode there is no echo, and characters entered from the keyboard must be displayed on the screen before they are sent to the computer. The terminal program has both full- and half-duplex capability and is initially in the half-duplex mode. To switch to full-duplex, simply press Control-D. To return to half-duplex, press Control-D again (this key toggles the duplex mode). If, at first, you find that characters entered from the keyboard are displayed twice on the screen, then the computer is in the full-duplex mode; toggle the terminal program to full-duplex. Incidentally, lines are not restricted to the screen width of 64 characters. Lines are terminated by the ENTER key and may be longer than 64 characters (though they will wrap around on the screen).

I decided to add a cursor, because it's hard to use the editor on the PDP-11/45 without one. The VIDEO subroutine to accomplish this is necessarily complex. If you don't want a cursor you can define the cursor character to be an ASCII 32 instead of a 143 in line 210, or you can simply eliminate all lines in VIDEO that are associated with the cursor (there won't be much left).

When the PDP-11/45 receives a carriage return, it echoes back a carriage return as well as a linefeed character (ASCII 10). But the "linefeed-inhibit" feature keeps the video display from skipping a line. (If this feature causes problems with your printer, you can take it out.) The PDP-11/45 returns a linefeed even in the half-duplex mode, so a carriage return is not displayed following the keyboard scan in this mode. If you find that the computer you are using does not echo a carriage return, then you will want to delete the feature.

Customized Versions

There are three different versions of the terminal program. The first is for a Model III that has 16K or more bytes of RAM but no printer or disk drives. In this case you can modify the terminal program by deleting lines 230-440, 530, 550, 630-660, 700-950, and 1270-4480 and then assembling what is left. This is the simplified terminal program that permits your Model III to communicate with the remote computer.

Printer Option

If you have a parallel printer, you'll want to use it to obtain program listings and hard copy of data output

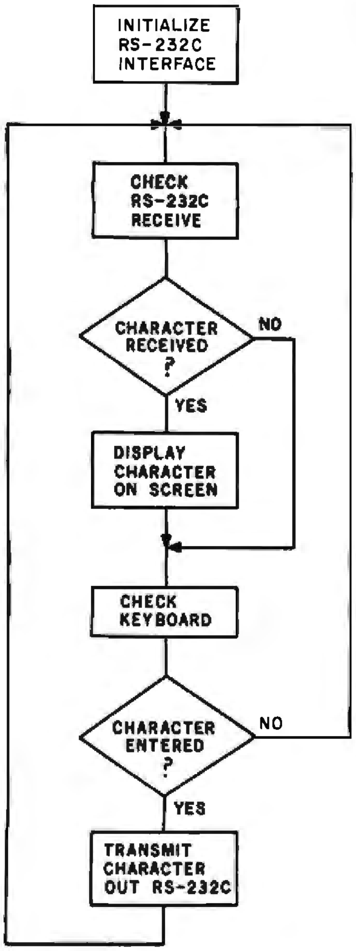


Figure 1: *Operation of the main section of the terminal program. The RS-232C board is controlled from the program.*

Key	Function
Break	returns you to TRSDOS
Control-D	toggles duplex mode
Control-B	opens buffer
Control-O	turns buffer off
Control-E	erases buffer
Control-P	dumps buffer to line printer
Control-G	dumps buffer to computer a line at a time
Control-R	reads from disk and dumps into buffer
Control-W	writes to disk
Control-J	jumps back and continues sending to computer
Control-F	fast transfer from disk to computer

Table 1: *Control commands for the terminal program.*

from the computer. In the interest of simplicity, I decided to avoid any kind of handshaking or sending "stall" or pause characters when using a printer. But rather than output characters to the line printer as they are printed on the screen, I used the scheme that follows.

If you press Control-B, every character that appears on the screen thereafter is put into a buffer in the Model III. (See table 1 for a list of all program commands.) When the output ceases from the computer, press Control-P and everything that is in the buffer will be sent to the printer. If you want to stop printing before the entire contents of the buffer are printed, you can press Control-C to return to the terminal program. Control-C is used as an "escape" throughout the program.

Two other keys control the buffer. Control-O turns it off (i.e., closes off the buffer to character insertion). In addition, Control-E erases the buffer. (A listing of all control keys appears in table 1.)

The only disadvantage to using a buffer this way is that it has a limited amount of space, so you may run out of RAM. I haven't found this to be a problem, though, even when the buffer is used for some disk operations as well. The assembled version of the terminal program occupies less than 1K bytes of RAM, which leaves at least 15K bytes of RAM for the buffer on a 16K-byte Model III.

The second version of the terminal program is for a Model III that has 16K or more bytes of RAM, a parallel printer, and no disk drives, as described above. Only the following lines should be deleted from the program in listing 1: 290-440, 780-940, and 1740-4480. In addition, the program should be moved down in memory as much as possible to maximize the size of the buffer. Make the changes in these addresses as listed in table 2. This version of the terminal program might be called the simplified program with printer capability.

Line Number		
100	ORG	42F2H
120 DUPLEX	EQU	42E9H
190 CHAR	EQU	42EBH
250 BUFLAG	EQU	42EAH
260 BUFPTR	EQU	42ECH
270 BUFNUM	EQU	42EEH
280 BUFBEG	EQU	45AEH
4490	END	42F2H

Table 2: *Memory address changes required for the printer option. Make these changes to the program in listing 1 to maximize the amount of memory in the buffer.*

Disk Drive Option

The third version of the program uses a Model III that has one or more disk drives, 32K or more bytes of RAM, and a parallel printer. This version is identical to the program in listing 1 and has two disk operations: (1) sending data from disk to the computer and (2) saving data received from the computer on disk.

The first operation employs two different methods to transfer data from a disk to the computer. The first method is a line-by-line transfer and the second is a continuous transfer. A line-by-line transfer is desirable because I access a PDP-11/45, which, in the immediate mode, has an immediate diagnostic for BASIC. In other words, if a BASIC program line with a syntax error is entered, for example, the computer will respond immediately and return an error message. It's useful to be able to correct a line immediately after the error message is displayed.

The line-by-line transfer makes use of the buffer. When you enter Control-R from the keyboard, a window opens up on the screen. You are then asked to enter the name of the disk file you want loaded into the buffer. The file is then dumped into the buffer and the screen is restored to its previous configuration. If the buffer already has data in it, the disk file is added to it. You can erase the buffer first with a Control-E. You can also close the buffer with a Control-O so that other characters are not put into it. If you enter Control-C as one of the filename characters, the screen is restored and execution jumps back to the main program.

Pressing a Control-G sends the data in the buffer to the computer. It is sent one line at a time; the operation pauses after a carriage return is encountered. This gives the computer a chance to respond. To send the next line, just press any key (except Control-C).

To escape from this "send" mode, enter Control-C, which returns you to the main section of the program. If the computer sends an error message after you have sent a line, you can correct the line before continuing on to the next one. Enter the corrected line and then press Control-J, and the Model III will continue sending where it left off. This way, you can send and edit a relatively large program in just a few minutes. The bother of having to send a character after each line is offset by the convenience of being able to edit a line immediately after it has been sent to the computer.

In the unlikely event that you have a program whose size exceeds the buffer, simply save it on disk in segments. Then successively load each part, send it to the computer, erase the buffer, load the next part, send it to the computer, and so on. This way you can save a program of any size.

The second transfer operation, continuous send, is similar but even easier. When you press Control-F, you will be asked to enter a filename just as before. The contents of that file will be sent without pauses to the computer. The characters will be displayed on the screen as they are sent. These characters are not put into the buffer, so there is no limit to the size of the program you send. The computer must be able to accept these characters as they are sent. If for some reason it is not ready, perhaps because of heavy use, some characters may be lost. Continuous send eliminates the need for handshaking or the use of stall or pause characters. There is no escape from the transfer operation; you must wait until the entire file has been sent.

The other disk operation, saving data sent from the computer, is easy as well. First put the incoming data into the buffer just as though you were going to output it to the printer. When the output has ceased, close the buffer with a Control-O so that no extraneous data is put into the buffer. Then enter a Control-W. You will be asked to enter a filename, after which the data will be written from the buffer to disk and the screen will be restored.

A Few Final Notes

Some of the more popular word processors store data with zero as a final character. This will not present a problem, because the program disregards zeros. In addition, a carriage return is often stored as an ASCII 141 character. The program will translate that to an ASCII 13 so that it will not be displayed on the screen.

The program has no disk-error recovery routines, so if a disk error occurs (if the computer tries to read a nonexistent file, for example) the program will probably bomb. Don't panic; simply press the Reset button to reboot, reload the program, and you'll be back in business. Whatever you do, don't hang up the telephone, because you will probably still be logged in, and the next person who accesses the computer may get into your account. I didn't put in any disk-error recovery capability so that I could limit the length of the listing.

One final note of caution: if you press Control-J (jump back) without having jumped out in the first place, the program will almost certainly crash. ■

Full-Stroke Keyboard for Atari

The B Key 400, a full-stroke keyboard, provides an alternative to the Atari 400's membrane keyboard. Manufactured by Inhome Software, the B Key 400 is easy to install and has all the features of a full-stroke keyboard. It's available for $119.95 from Inhome Software Inc., 2485 Dunwin Dr., Mississauga, Ontario L5L 1T1, Canada, (416) 828-0775.

Circle 550 on inquiry card.

Large Keyboards for Disabled

Cacti Computer Services has designed an 11- by 21-inch pressure-sensitive keyboard system for individuals with limited hand or finger control. This system consists of a keyboard with widely spaced contacts, a driver routine, an interface to plug into the computer, connecting cables, and a plastic mask. Once the driver routine has been loaded, the computer's keyboard combines with the large keyboard to run commercially available software without modifications.

Several keyboard layouts are offered, and custom arrangements can be made at no additional charge. The system is presently marketed for use with Apple and Commodore PET/CBM computers. It costs $525. For full details, contact Cacti Computer Services, 130 9th St. SW, Portage la Prairie, Manitoba, R1N 2N4, Canada.

Circle 551 on inquiry card.

Expansion Slots for Color Computer

Up to four separate peripherals can be simultaneously connected to Radio Shack's TRS-80 Color Computer with Maple Leaf Systems' Multiport, a multiple-slot expansion unit. Each peripheral is on line and accessible to a program by means of a POKE command. With Multiport, the Color Computer is able to switch between peripherals under software control, which allows a single program access to any or all peripherals at any time. Multiport is described as a powerful hardware circuit that connects directly to all models of the Color Computer.

Multiport comes assembled and tested for $99.50, and full instructions are included. It's available from Maple Leaf Systems, POB 2190, Station C, Downsview, Ontario M2N 2S9, Canada.

Circle 552 on inquiry card.

Interfaces in Computing

Interfaces in Computing is an international journal for system designers, electronic engineers, technicians, and production managers concerned with computing technology. Topics addressed in this quarterly range from low-speed communications between microprocessors to high-performance buses linking mainframes. Hardware and software interfacing are given equal priority.

Annual subscriptions to Interfaces in Computing cost 160 Swiss francs (approximately $89), including postage. Further details are available from Elsevier Sequoia S. A., POB 851, CH-1001 Lausanne 1, Switzerland; tel: (021) 20 73 81; Telex: 26 620 ELSACH.

Circle 553 on inquiry card.

Microdoctor Diagnoses Computers

Dataman Designs' Microdoctor is an intelligent device to help engineers diagnose faults in computers and computer-controlled products. Microdoctor's built-in printer produces hardcopy printouts of preprogrammed tests on chips in addressing space. This device is capable of testing ROMs (read-only memories), RAMs (random-access read/write memories), and I/O and data lines. It can also be used for memory-mapping unknown systems and writing to or reading from any device in address or I/O space. Memory contents are printed out in hexadecimal or ASCII codes.

Microdoctor, a Z80-based product, comes with a Z80 disassembler that can be used to print out disassembled listings of the ROM in any Z80 system. Disassemblers for other microprocessors are available. The Microdoctor

costs £295. Contact Dataman Designs, Lombard House, Cornwall Rd., Dorchester, Dorset, DT1 1RX, England; tel: (0305) 68066; Telex: 418442.
Circle 554 on inquiry card.

MISCELLANEOUS

Computer Cases for Commodore 64

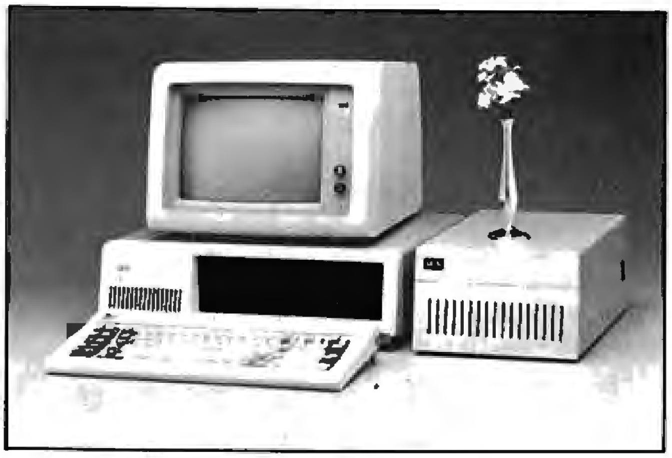
The Computer Case Company has added two carrying cases designed for the Commodore 64 to its product line. Made of luggage material with hard sides, brass hardware, and key locks, each case has room enough for additional equipment, papers, and manuals. Built-in rubber pads protect furniture, and steel lugs on the bottom protect the case when it's transported.

The CM703 case holds the Commodore, one or two disk drives, and the power supply. The CM704 case holds the computer, the data set program recorder, and the power supply. Both models can accommodate the Commodore VIC-20 and related equipment. These carrying cases are available at many computer stores or factory-direct from the Computer Case Co., 5650 Indian Mound Court, Columbus, OH 43213, (800) 848-7548; in Ohio, (614) 868-9464.
Circle 555 on inquiry card.

ASUs Ease Selection of Peripherals

Giltronix's series of automatic switching units (ASUs) is designed to facilitate automatic selection of peripherals by means of a computer or control device. ASUs give you remote peripheral options and the ability to select a printer, modem, etc. without leaving the keyboard. Giltronix ASUs have built-in software for unmanned computer-programmed control over peripherals. Networking capabilities are said to be enhanced through a specialized line-driving function. By connecting an ASU to a modem, remote-site port selection and operation can be achieved. Giltronix ASUs can switch RS-232C lines (TD, RD, RTS, CTS, DTR, DSR, DCD, and TC) and come configured for switching RS-232C ASCII/asynchronous data I/O devices.

Three models are currently available: the ASU3, ASU5, and ASU7 (three, five, or seven ports, respectively). Optional features include manual override and front-panel LED (light-emitting diode) monitoring. Prices range from $449 to $658. Full technical specifications can be obtained from Giltronix Inc., 970 San Antonio Ave., Palo Alto, CA 94303, (415) 493-1300.
Circle 556 on inquiry card.



Expansion Frame for the IBM PC

The PCX-6 expansion frame from RCS gives the IBM Personal Computer six additional system slots. Its fully socketed motherboard permits simple expansion by insertion of appropriate chips. Optional support equipment for the PCX-6 includes two asynchronous serial ports, three parallel ports, a real-time clock, and an extra heavy-duty power supply for running a 5¼-inch Winchester hard-disk drive inside the Personal Computer. RCS also offers 64K-byte memory increments (192K-byte maximum) featuring DPECC (dynamic parity error-correction circuitry). DPECC memory detects single- and double-bit parity errors and corrects single-bit errors without system processor overhead and without interrupts.

The PCX-6 can be purchased with or without the optional equipment installed. Prices begin at $595. Full information is available from RCS Inc., 2116A Walsh Ave., Santa Clara, CA 95050, (408) 727-7548.
Circle 557 on inquiry card.

Extra Slot for Apple Motherboard

Legend Industries' Soft 8 card plugs directly into the Apple II's slot 7 and provides slots 7 and 8. Switching between slots is software-driven, and you can shift back and forth between cards with simple software commands. With Soft 8, you can place nine software-accessible cards in your Apple.

Soft 8 is supplied with software that lets you modify standard Apple DOS so that it will recognize the added slot. The suggested retail price is $84.95. Soft 8 is manufactured by Legend Industries Ltd., 2220 Scott Lake Rd., Pontiac, MI 48054, (313) 674-0953.
Circle 558 on inquiry card.

What's New?

Atari/CP/M Interface

USS Enterprises' Critical Connection provides the means to connect an Atari 400 or 800 to a CP/M system so that the Atari can use the CP/M system's printer, disk drives, and keyboard. This system is made up of hardware to connect an RS-232C port on a CP/M system to an Atari disk/printer port, 50 feet of cable, and an 8-inch single-density disk with software that makes the CP/M system's drives, printer, and keyboard replace the Atari's.

The Critical Connection costs $175. The company requests that you provide the name of the CP/M system to be connected to the Atari. For a brochure describing the Critical Connection and further purchasing information, contact USS Enterprises, 6708 Landerwood, San Jose, CA 95120, (408) 997-0264.

Circle 559 on inquiry card.

Floor-Stand for Joysticks

The Grand Stand Company's joystick floor stand is designed for optimum positioning, comfort, and control. The company claims that it is an aid in eliminating wrist and elbow fatigue and improves finger dexterity. The stand is made from solid wood with a walnut finish and streamlined appearance. It costs $34.95. Order from the Grand Stand Co., 4231 Bluebell Ave., Studio City, CA 91604.

Circle 560 on inquiry card.

Interactive Training Programs for Professionals

American Training International (ATI) produces interactive training programs for popular software packages. These programs are targeted for professional users and are designed for CP/M systems and the IBM Personal Computer. ATI's menu-driven software provides hands-on practice, and a course can be completed in an average time of less than 45 minutes. Each course contains a general introduction and periodic refreshers.

ATI complements the training disks with a user's handbook that serves as a referenced hard-copy version of the information covered. Current titles available include Plan-Power for Visicalc, D. B. Power for dBASE II, ATI-Power for IBM PC-DOS, and ATI-Power for CP/M. Each course costs $75. For full details, contact ATI Inc., Suite 300, 3800 Highland Ave., Manhattan Beach, CA 90266, (213) 546-4725.

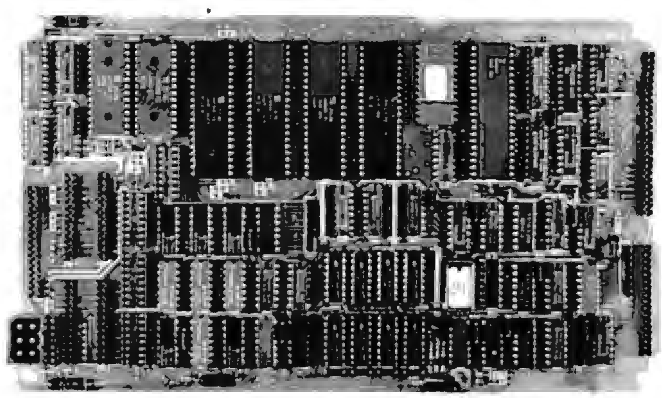
Circle 561 on inquiry card.

Diagnostic Service for Immediate Updates, Solutions

Tele-Maintenance, a communications and diagnostic service from Rotating Logic Systems, provides immediate hard-disk analyses and software updates. According to the company, electronic analyses over toll-free telephone lines will ensure that correct service solutions are conveyed to the user's display screen or printer. Routing software updates and service inquiries to factory technicians will give customers on-the-spot service and corrections. Full particulars on the Tele-Maintenance service will be supplied by Rotating Logic Systems, Highland and White St., Greensburg, PA 15601, (412) 832-0140.

Circle 562 on inquiry card.

SYSTEMS



Compact Z80 Board

Davidge Corporation's DSB-4/6 single-board computer measures 10 by 5¾ by ¾ inches—small enough to fit inside a 5¼-inch floppy-disk enclosure. The DSB-4/6 comes with a disk controller that automatically interfaces with both single- or double-density 5¼- and 8-inch floppy-disk drives simultaneously, a Centronics-type parallel port, a parallel hard-disk port that provides 8-bit bidirectional I/O and A0 and A1 address lines, a 2K-byte boot EPROM (erasable programmable read-only memory), and 64K bytes of RAM (random-access read/write memory). The DSB-4/6 can be configured for two or four RS-232C serial ports of which three can be used for standard peripherals; the fourth port is available for a modem. The company offers a choice of the 4-MHz Z80A or the 6-MHz Z80B processor.

In single units, the price for the DSB-4/6 ranges between $695 and $995, depending on processor and number of I/O ports desired. Quantity discounts are available. For complete details, contact Davidge Corp., Suite X, 1951 Colony St., Mountain View, CA 94043.

Circle 563 on inquiry card.

What's New?

User-Friendly Multiuser System

Z-Disk is a fully integrated desktop multiuser system designed for office or small business use from Product Associates Inc. This system features a simple menu-choice sequence and a mouse for easy menu selection. For each user, Z-Disk dedicates a processor module that contains a Z80 microprocessor, 64K bytes of RAM (random-access read/write memory), and complete I/O capabilities. A master processor module supervises all user requests for shared storage and peripheral devices. Communication between the master processor and user modules is handled by a high-speed parallel bidirectional synchronous interprocessor data channel.

Standard features include a user-to-system interface that makes Z-Disk user-friendly for nontechnical users, two serial ports, one parallel port, and field-expansion capabilities for up to five users. System software is made up of MP/M, CP/NOS, and Comstar software, which provides this system with an extensive base of CP/M-compatible applications functions. The Comstar software gives Z-Disk integrated word-processing, planning, and communications capabilities. It uses an interactive prompting menu approach to guide users through application procedures.

Mass storage for Z-Disk includes up to 40 megabytes of Winchester disk drives and a floppy-disk drive. Single Z-Disks have a base price of $2995; quantity and OEM (original equipment manufacturer) discounts are available. For full information, contact Product Associates, 465 Convention Way, Redwood City, CA 94063, (415) 364-3121.

Circle 564 on inquiry card.

Workstations Run Two Concurrent Jobs

Wordplex Corporation's 80-4 workstation can serve as the host computer in a three-terminal cluster. In an 80-4 network, the control station and its two satellites have individual displays and keyboards, 128K bytes of memory, and independent Z80 microprocessors. The control station has a double-sided double-density 5¼-inch floppy-disk drive (600K bytes of storage) and a 10-megabyte Winchester disk drive that's shared by all three workstations.

Wordplex's Gemini operating system highlights the 80-4 workstation. Gemini is said to give the 80-4 the processing power of two terminals in each satellite workstation through a Dualground processing technique. This process permits each satellite to load and run two concurrent tasks in main memory, with each job having a distinct screen image and keyboard buffer. Each workspace (ground) in the Dualground system comprises 32K bytes of dedicated memory. Also, a block of up to 24K bytes of memory is divided between the two workspaces and dynamically assigned as required.

The 80-4 offers users the option of running CP/M and CP/M-compatible applications on a stand-alone basis, and the cluster can have two ports for external communications. Optional equipment for the 80-4 workstation includes 5¼-inch double-sided double-density floppy-disk drives for the satellite terminals. A fully configured system costs less than $8000 per workstation. For complete details, contact Wordplex Corp., 141 Triunfo Canyon Rd., Westlake Village, CA 91361, (213) 889-4455.

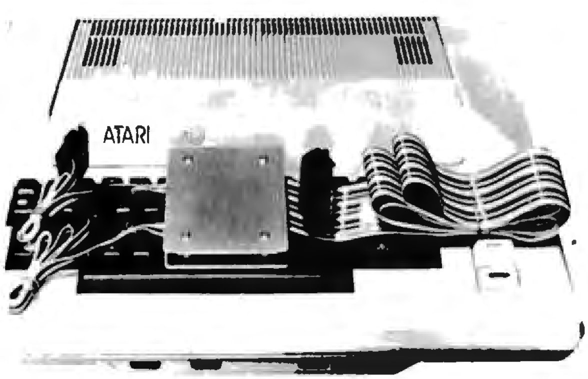
Circle 565 on inquiry card.

Mastermax Based on Z80/S-100

Mastermax, a four-slot S-100 Z80-based computer, is marketed by John D. Owens Associates. This single-card computer has dual 8-inch floppy-disk drives, 64K bytes of bank-selectable RAM (random-access read/write memory), and a four-channel direct memory access controller. The floppy-disk controller can handle both single- and double-density data transfers and control up to four 5¼- or 8-inch disk drives in either DMA (direct memory access), interrupt, or programmed I/O modes. Mastermax also incorporates 4-MHz operation, IEEE 696.1/D compliance, the CP/M operating system, two parallel I/O ports, and two RS-232C serial channels, one of which is programmable in either DMA, interrupt, or programmable I/O modes. When equipped with the TurboDOS multiuser operating system, Mastermax can accommodate four users accessing the same bus and database.

Options for Mastermax include 10-, 20-, and 40-megabyte Winchester hard-disk drives. With documentation, the basic system costs $2540. Further information is available from John D. Owens Associates, 12 Schubert St., Staten Island, NY 10305, (212) 448-6283.

Circle 566 on inquiry card.



Atari Printer Interface

Looking Glass Microproducts' Interface No.1 allows any printer with a Centronics-compatible parallel interface to be connected to an Atari 400/800 via controller jacks J3 and J4. The interface comes with a printer-handler that replaces the one resident in the Atari and occupies less than 128 bytes of user program area. The printer-handler is compatible with Atari cartridges and programs and comes on either cassette or disk.

Complete documentation, installation instructions, and program listings are supplied with Interface No.1. It costs $85, which includes a 15-day money-back guarantee. Dealer inquiries are invited. Full details are available from Looking Glass Microproducts, POB 5084, Loveland, CO 80537.

Circle 567 on inquiry card.

Random-Access Printing

Interactive Structures, manufacturer of the Pkaso ID12 Color Printer Interface, has introduced the IS Pipeline print buffer. Featuring random-access printing, Pipeline lets you select sentences, paragraphs, graphs, or pictures from different programs or computers so that you can compose and print a finished document. Pipeline is useful for inserting graphs into reports, placing addresses on form letters, and compiling letters out of component paragraphs. Standard operating functions include conventional FIFO (first-in, first-out) operation, data compression for space saving, the ability to bypass buffer operations for straight-through printing, a simple erase feature to clear the buffer, and automatic duplication. The Pipeline's memory can be expanded from 8K bytes to 128K bytes, and the system is compatible with any Centronics-type parallel computer-printer connection.

Pipeline comes with a plug-in power supply, cabling, and manual. It's guaranteed for one year and ranges in price from $195 to $405, depending upon buffer size. For further details, contact **Interactive** Structures Inc., 146 Montgomery Ave., Bala Cynwyd, PA 19004, (215) 667-1713.

Circle 568 on inquiry card.

Pac RAT Stores Up to 8 Megabytes

Damco's Pac RAT (random-access tape) gives you from 5 to 8 megabytes of on-line random-access storage (unformatted) in a package the same size and shape of a standard 5¼-inch floppy-disk drive. Each of Pac Rat's two magnetic tape cartridges has 88 tracks of 60 or 95 sectors (256-byte sectors) per track. A single read or write accesses each cartridge. Pac Rat's power requirements and controller interface are floppy-disk standard so that it can plug into existing systems. In small quantities, it costs less than $480. Contact Damco, 2210 18th Ave., Rock Island, IL 61201, (309) 793-0655.

Circle 569 on inquiry card.

8086 Upgrade for Heath/Zeniths

Technical Micro Systems' H-1000 is an 8086 upgrade that replaces the 2-MHz Z80 board in Heath/Zenith H-89/Z89 computers. This board retains all the Z80 board's features while providing a 16-bit 8086 processor, two additional I/O slots, 128K bytes of RAM **(random-access** read/write memory) that can be expanded to 1 megabyte, a dual-speed software-controlled clock for the Z80, and the ability to run the MS-DOS or CP/M-86 operating systems. It's completely compatible with existing Heath hardware and software. When in its 8086 mode, the H-1000 is software-compatible with Z-100 systems and the IBM Personal Computer under MS-DOS or CP/M-86.

In single units, the H-1000 costs $1495. Full details are available from Technical Micro Systems Inc., Department H, 366 **Cloverdale,** Ann Arbor, MI 48105, (313) 994-0784.

Circle 570 on inquiry card.

Modem Operates Independently of Host

Visionary 100 is a 300-bps (bit-per-second) programmable 8085 microprocessor-controlled modem that operates independently of the host computer. When your computer is switched off or working on a task, this modem can automatically answer a telephone, receive and store a transmission in its memory, and activate a front-panel message-waiting indicator. Additionally, the Visionary 100 can print a message, complete with date and time, to your terminal.

Standard features include an 8K-byte control program; a 2K-byte buffer that can be expanded to 24K bytes; a real-time clock and calendar; programmable auto-answer, auto-dial, auto-send, and reception; and storage and retrieval of telephone numbers, custom commands, and text files. Data formats provided are serial, binary, asynchronous 7 or 8 data bits, 1 or 2 stop bits, and no parity. Data rates of 300 or 1200 bps to the host machine and 300 bps to telephone lines are standard.

The Visionary 100 uses an RS-232C interface and is Bell System 100 series compatible (answer or originate). It costs $595 from Visionary Electronics Inc., 141 Parker Ave., San Francisco, CA 94118, (415) 751-8811.

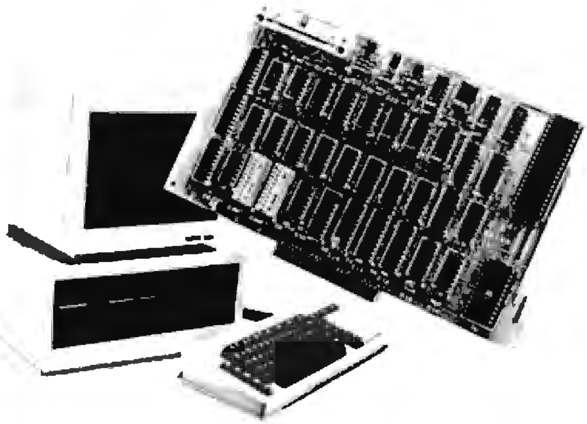
Circle 571 on inquiry card.

Printmate 99

MPI's Printmate 99 is an 80-column dot-matrix printer. It features a 1K-byte memory buffer, tractor and friction feeds, and built-in Centronics-type and RS-232C interfaces. It can print at 100 characters per second.

Options for the Printmate 99 include a 2K-byte memory buffer and a single-sheet feeder. The suggested price is $695. Full specifications can be obtained from MPI, 4426 South Century Dr., Salt Lake City, UT 84107, (800) 821-8848; in Utah, (801) 263-3081.

Circle 572 on inquiry card.



CP/M-86 and CP/M-80 Compatibility for Victor 9000

Small Systems Engineering Corporation's Victor-80 plug-in card lets the Victor 9000 run either 16-bit CP/M-86 or 8-bit CP/M-80 software. Victor-80 is based on Zilog's Z80 microprocessor and features up to 64K bytes of RAM (random-access read/write memory) running at speeds of up to 6 MHz with no wait states. It plugs directly into any of the Victor's four internal expansion slots and permits all standard CP/M 2.2 software to run without modification.

The Victor-80 comes with a floppy disk containing two files for software toggling between CP/M-86 and CP/M-80. Files generated under either CP/M are structurally identical, and any file created under one operating system can be used by the other without restrictions. Other standard features of this card include a built-in Corvus hard-disk interface and the ability to accommodate as many as four Corvus 20-megabyte disks simultaneously. Optional high-speed backup capabilities include the Corvus Mirror and a video-cassette recorder.

In single units, the 4-MHz Victor-80-A card costs $595, and the Victor-80-B, which operates at 6 MHz, lists for $650. Complete information is available from Small Systems Engineering Corp., 1056 Elwell Court, Palo Alto, CA 94303, (415) 964-8201.

Circle 573 on inquiry card.

PUBLICATIONS

CP/M Software Index

The third edition of the CP/M Software Index lists more than 1600 programs offered by 507 vendors. Produced by the Small Systems Group, the index is organized into five major areas: systems programs, general applications, accounting applications, utility applications, and industry-specific software. Each entry gives a brief description, price, operating system versions, and the vendor's name, address, and telephone number. Many of the programs will run under CP/M-86, MP/M-80, MP/M-86, and Concurrent CP/M-86 and all are said to be available for the CP/M-80 operating system.

Single copies of the index cost $10; outside North America, $14. Order from the Small Systems Group, POB 5429, Santa Monica, CA 90405.

Circle 574 on inquiry card.

Business Packages Catalog

A free catalog featuring more than 40 business applications packages and publications for Apple II and III computer users is available from Monument Computer Service. It includes accounting, word processing, payroll, and medical billing programs. Contact Monument Computer Service, Village Data Center, POB 603, Joshua Tree, CA 92252, (619) 365-6668.

Circle 575 on inquiry card.

New Release Explores Database Software

David Kruglinski's Data Base Management Systems is purported to be the definitive source for thorough and objective information on microcomputer database-management packages. It is intended to supply the information you need to intelligently decide how to buy and use database-management software for your business. In this book, the capabilities of file, relational, and network/hierarchical systems are defined and standards for evaluating database-management software are provided. Several software packages are examined, including Condor Series 20, dBASE II, FMS-80, Datastar, and many others that run under CP/M.

Data Base Management Systems, a 256-page paperback book, costs $16.95 and is available from Osborne/McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710, (415) 548-2805.
Circle 576 on inquiry card.

Inside the Personal Computer

The revised edition of Tenley Design's Inside the IBM Personal Computer can be ordered from Starware. This book provides a detailed explanation of the system's operation and serves as a supplement to the IBM Personal Computer Technical Reference Manual. The theory behind the system board electronics is described, and a design for a multifunction I/O board that's compatible with the IBM's expansion slots is provided. Information on interfacing user-supplied hardware and software to the system is presented.

Inside the IBM Personal Computer costs $12.95. It's published and distributed by Starware, 1701 K St. NW, Washington, DC 20006.
Circle 577 on inquiry card.

Directory Helps Consumers Compare Software

Information Sources' Small Systems Software and Services Sourcebook is designed to help you avoid purchasing programs that don't fill your needs. In nontechnical terms, this work describes the applications and limitations of 1300 minicomputer and microcomputer programs for machines manufactured by Apple, Commodore, Data General, Digital Equipment Corporation, Hewlett-Packard, Honeywell, NEC, and Zenith. This book, which is more than 500 pages, also gives you data on related services, hardware and operating system compatibility, purchasing terms, and vendors.

The Small Systems Software and Services Sourcebook is a limited edition available at a one-year subscription rate of $125. A 600-page comprehensive supplement with up-to-the-minute listings is included with each subscription. For further details, contact Information Sources Inc., 1807 Glenview Rd., Glenview, IL 60025, (312) 724-9285.
Circle 578 on inquiry card.

Comprehensive Software Catalogs

Queue has produced three free catalogs describing discount and educational software. Queue Catalog #10 lists more than 100 programs for the Atari, and Catalog #11 focuses on programs for the VIC-20. Listing several thousand programs from more than 140 publishers, Catalog #12 is devoted to the Apple computer.

Queue's educational software catalogs cover all grade levels from kindergarten (Catalog #8) to college (Catalog #9) and Apple, PET, and TRS-80 computers. To order, specify computer and catalog number. Queue Inc., 5 Chapel Hill Dr., Fairfield, CT 06432, (203) 335-0908.
Circle 579 on inquiry card.

SOFTWARE

Orbquest

Orbquest is a role-playing CP/M game from Digital Marketing Corporation. The game, set in a fantasy universe, challenges you with ever-changing situations where monsters and pitfalls confound your search for an orb buried in a multilevel dungeon. With each journey into the dungeon, you gain experience and magical powers that make you stronger and help you get closer to the glittering orb.

Orbquest requires a 56K-byte CP/M system and a cursor-addressable terminal. It costs $39.95, including a manual. It's available from Digital Marketing Corp., 2670 Cherry Lane, Walnut Creek, CA 94596, (415) 938-2880.
Circle 580 on inquiry card.

Free IBM PC Programs

B & L Computer Consultants is offering two free programs for the IBM Personal Computer. Electronic Disk causes system RAM (random-access read/write memory) to emulate a 160K-byte disk drive. It's said to be 50 times faster than a drive. This program requires 256K bytes of memory and is referenced as drive C. Electronic Disk can be employed in any application where a regular disk drive is being used.

New Reset provides two types of resets to DOS. The resets use the Control 1, Control 2, and Control 3 keys for single-handed control operation. Control 1 functions exactly like the IBM's Control ALT DEL sequence, and Control 2 functions similarly except

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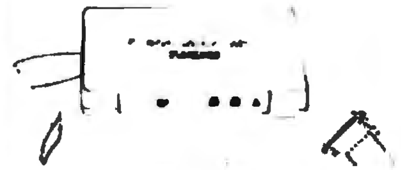

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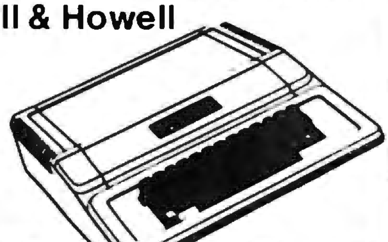

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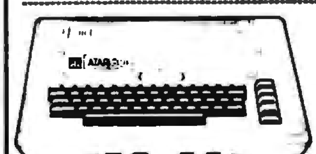

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that the memory is not erased. Control 3 does not involve rebooting from floppy disk; it merely returns you to the DOS prompt.

To receive these programs, send $6 to cover disk and handling costs to B & L Computer Consultants, Free Programs Numbers 1 and 3, 226 South Cole, Boise, ID 83709. A contribution of $15 and $10, respectively, is requested if you find these programs useful.

Circle 581 on inquiry card.

Workshop Helps Atari Programmers

The Disk Workshop from Synergistic Software, a set of seven utility programs for Atari 400/800 computers, is designed to help you with programming functions. Disk Workshop includes disk-editing capabilities, fast copying of disks, a formatted disk directory that can be sent to a printer, the ability to use machine-language character strings in BASIC, a screen dump for the Epson MX-80 printer outfitted with Graftrax or Graftrax Plus, and the ability to transfer large files to disk or cassette. One program in the set, Micro-DOS, gives you a RAM-resident program similar to Atari's DUP.SYS. Micro-DOS is online and available at any time.

The Disk Workshop requires 32K bytes of memory and a single disk drive. It costs $34.95 and is available from Synergistic Software, Suite 201, 830 North Riverside Dr., Renton, WA 98055, (800) 426-6505; in Washington, (206) 226-3216.

Circle 582 on inquiry card.

8087 Coprocessor Products

Microware has introduced a line of products for the 8087 coprocessor implementation on the IBM Personal Computer. The Fastpak includes Intel's 8087 numeric data processor, installation instructions, and your choice of four programming languages. The 87/88 Guide, a handbook on using the 8087 processor, accompanies this package. This guide introduces 8087 programming using 87Macro and the IBM Macro Assembler or the CP/M-86 assembler. In addition, it has assembly-language listings that can be keyed in and run on the IBM. The guide can be purchased separately for $18.95. Fastpak is $375.

Microware is marketing a variety of languages for use with the processor, most of which require a 128K-byte IBM PC with one disk drive and a compiler. 87Pascal, a library of floating-point routines that directly drive the 8087, is said to increase the speed and accuracy of Pascal programs. For applications demanding numerous transcendentals, roots, or powers, Microware offers 87FORTRAN. The 87BASIC package allows you to perform both single- and double-precision arithmetic with the 8087.

The timesaving 87Macro is designed for applications requiring the full power of the chip. It contains a preprocessor that generates the complete 8087 instruction set and a library of macroinstructions and subroutines to simplify writing 8087 code. A double-sided double-density disk drive and the IBM Macro Assembler are required.

Each language is available as part of Fastpak or separately for $125. For details, contact Microware Inc., POB 79, Kingston, MA 02364, (617) 746-7341.

Circle 583 on inquiry card.

Modula II Language Lifts Pascal's Restrictions

Volition Systems' Modula II is said to be a simple but powerful high-level programming language that solves the problems inherent in Pascal. Serving as an alternative to assembly language, C, and Ada for systems programming, this language was designed by Niklaus Wirth, the creator of Pascal. Modula (MODUlar LAnguage) features include modules, processes, separate compilation, dynamic array parameters, and low-level machine access. It consists of a p-code interpreter that's upward compatible with the Apple Pascal interpreter, a one-pass compiler, a library-management utility, and a standard module library.

A small language supplemented by library modules, Modula II requires a 64K-byte Apple II with the Apple Pascal operating system. The initial release provides access to the Apple Pascal file system and UCSD Pascal intrinsics by means of library modules. The compiler accepts the full Modula II language, as defined in the ETH Zurich Modula II report, with minor implementation restrictions. Programs are compiled into p-code.

Modula II costs $550. Quantity discounts are offered. Updates and user-support via electronic mail are also available. For further details, contact Volition Systems, POB 1236, Del Mar, CA 92014, (714) 457-3865.

Circle 584 on inquiry card.

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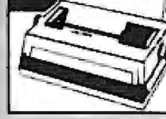

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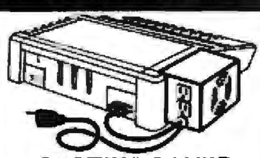

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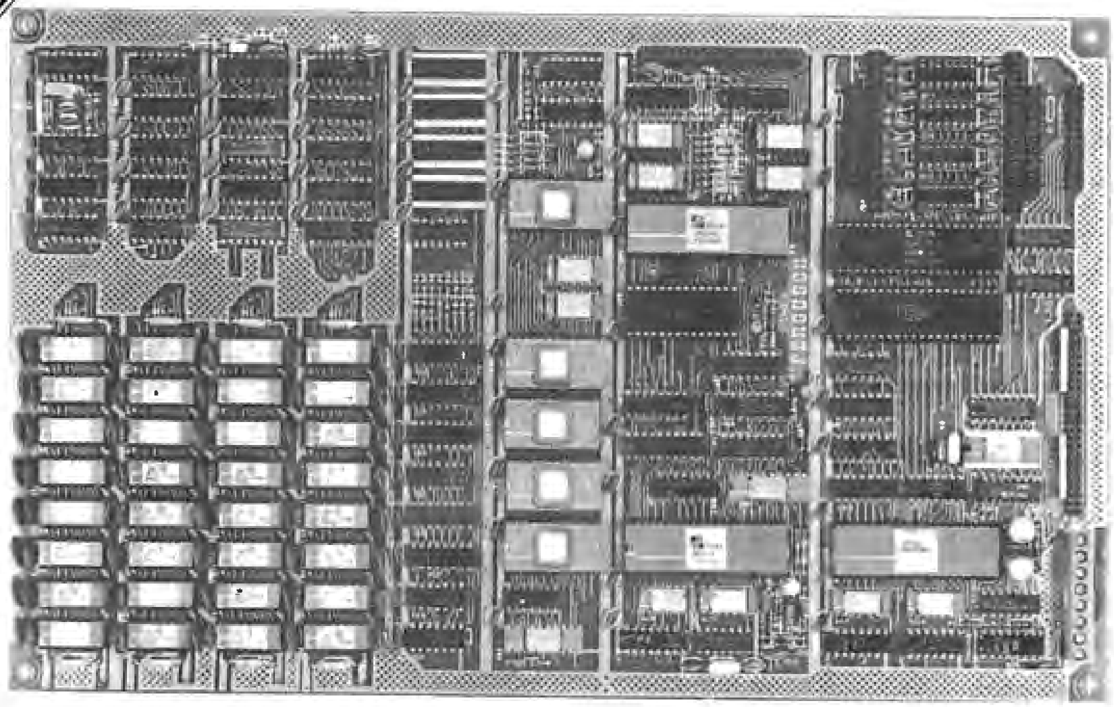

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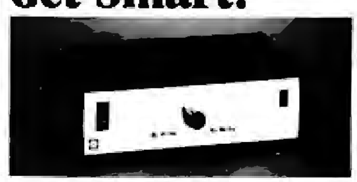

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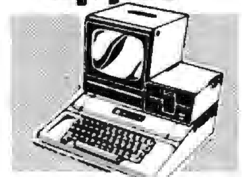

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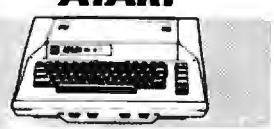

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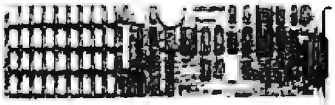

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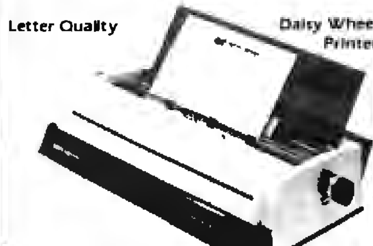

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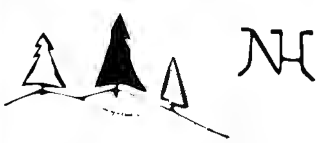

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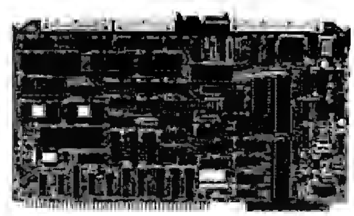

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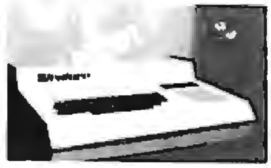

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VENTURE connects directly to a monitor or to your TV set through an RF modulator. And now for the heart of VENTURE... its video display. VENTURE has a high resolution programmable video display with up to 16,384 user-defined characters, alphanumeric symbols, special graphics or objects, such as space ships, etc. Each character is 8 pixels wide by 16 pixels high, with 2 grayscale maps; it has 256 levels of grayscale plus video invert/compliment and hidden screen update for a "snow" free display. The display is 512 x 512 pixel mapped with 2 planes of video RAM per display, VENTURE video is in short... astounding!

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Expansion Options

Floppy disk, EPROM programmer, light pen, universal user programmable music, sound board high resolution color/grayscale pixel mapped video board. General Purpose Instrument Bus, 8088 co-processor board.

Minimum VENTURE System $195.00

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The Super Elf comes complete with power supply and detailed 127 page instruction manual which includes over 40 pages of software, including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D. A monthly newsletter. Questdata is devoted exclusively to software for the Super Elf and there are many software books available at low cost.

The Super Elf computer system is now available as a series of bare boards as well as full kits and assembled.

Bare Boards: Super Elf $35.00. Super Expansion $35.00. Power Supply $10.00. S-100 Color $35.00. Dynamic RAM $40.00. Manuals $10.00. Super Basic $45.00. "Eat & Run" cassette $14.95

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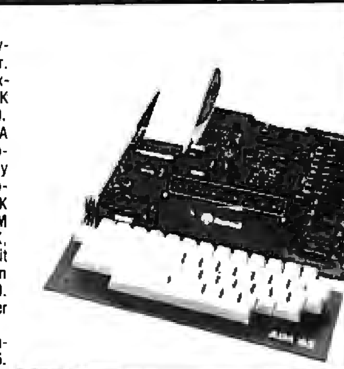

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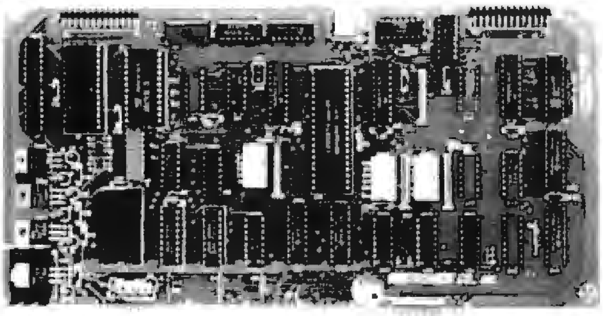

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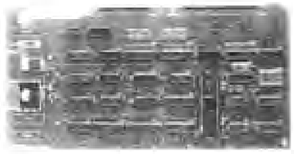

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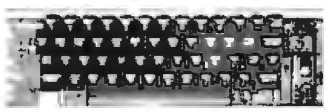

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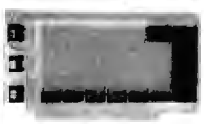

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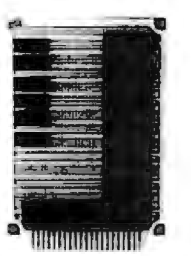

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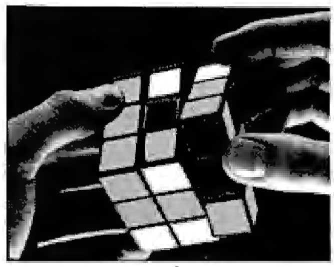

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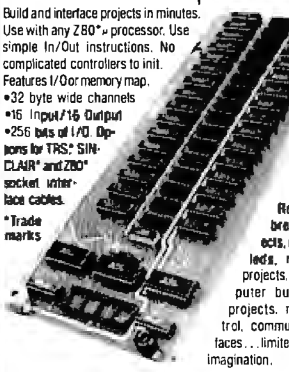

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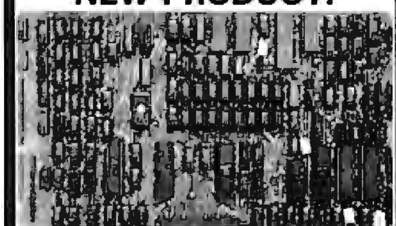

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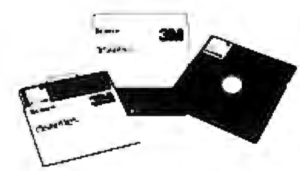

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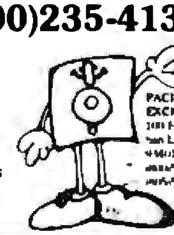

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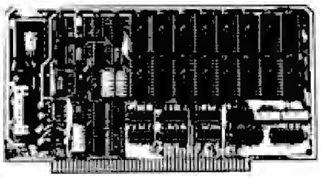

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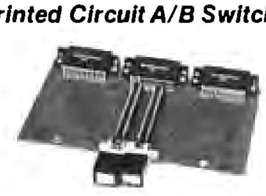

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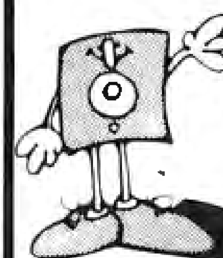

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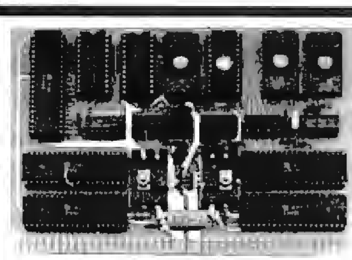

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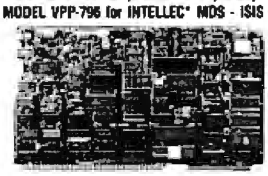

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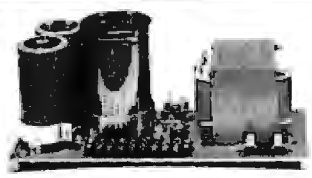

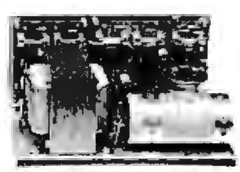

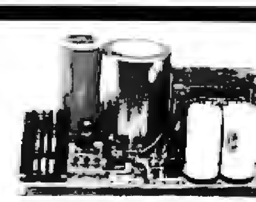

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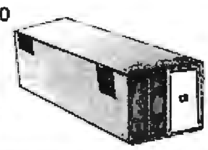

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TSX-200B *Bare board* **$59.95**
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TSX-200A *A&T* **$159.95**

S-100 CPU Boards

SBC-200 - SD Systems

4 MHz Z-80A CPU with serial & parallel I/O, 1K RAM, 8K ROM space, monitor PROM included.

CPC-30200A *A & T* **$329.95**

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2 or 4 MHz switchable Z-80 CPU board with serial I/O, accomodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600.

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2 or 4 MHZ Z-80 CPU with serial I/O port & on-board monitor PROM, front panel compatible.

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Both 8 & 16 bit CPUs, standard 8 bit S-100 bus, up to 8 MHz, accesses 16 Megabytes of memory.

CPU-20510A *6 MHz A & T* **$398.95**
CPU-20510C *6/8 MHz CSC* **$497.95**

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MICROANGELO - Scion

Ultra-high-resolution 512 x 480, 256color or black & white S-100 video board

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JADE ***Computer Products***

Circle 218 on inquiry card.

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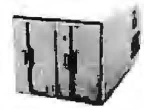
DUAL DRIVE SUBSYSTEMS



HORIZONTAL OR VERTICAL

Fully Assembled and Tested Units

w/two Shugart 801R SS/DD	$ 975.00
w/two Shugart 851R DS/DD	1225.00
w/two Qume DT-8 DS/DD	1250.00
w/two Tandon 848-1 SS/DD	995.00
w/two Tandon 848-2 DS/DD	1195.00
Cabinet A & T w/Power Supply and Accs.	235.00
Cabinet Top and Bottom	69.50

California Computer Systems SPECIAL!

CCS SYSTEM 2410 . . $1995.00

- Includes CP/M® 2.2
- 2-Serial/1-Parallel Port
- DMA Disk Controller
- Hardware Vectored Interrupts
- 2-Real Time Clocks
- Supports CP/M®, MP/M®, OASIS

CCS 2300 System, A & T . . 1695.00

- 2810 CPU . . . . *Only*—255.00
- 2422 Disk Controller . . . . *Only*—330.00
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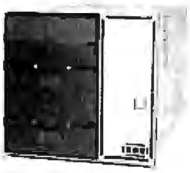
- CCS Apple Boards . . . **Call Toll Free For Prices**

S-100-4 MINI'S

Choose the System that fits your needs! A complete computer system ready to add on a terminal and printer. All Systems include CP/M® software and system manual set. Full six-month parts and labor warranty excluding drives which carry the full O.E.M. manufacturers warranty. All **S-100-4** Systems advertised are in stock assembled and tested available for immediate delivery.

MINI FLOPPY



Only $1395.00
COMPLETE

★ with 48 TPI single sided double density 5¼" . . **$1395.00**
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★ with 96 TPI double sided double density 5¼" **$1650.00**

An inexpensive but powerful system featuring a 4 slot **S-100** bus chassis with the **XOR S-100** board set; 4-MHZ Z-80 CPU ★ 64K dynamic memory ★ multi-sector mixed density disk controller ★ 2-RS232 output ports in the rear for your terminal and printer ★ 3 eight-bit parallel ports on the CPU ready to add a cable and interface to your printer ★ All above systems are in stock ★ Includes CP/M® 2.2.

CP/M is a trademark of Digital Research

HARD DISK

Only $2995.00
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These **S-100-4** Systems may be very small in size (9"H x 9½"W x 18½"L) but look at the size of the ATASI® 5¼" Winchester hard disks we offer!

4 models to choose from

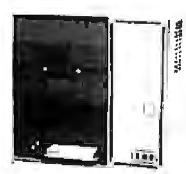
★ Seagate 5 Megabyte System $2995.00
★ #3020 15.6 Megabyte* System $3495.00
★ #3033 26 Megabyte* System $3995.00
★ #3046 36 Megabyte* System $4495.00

The above systems include a 96 TPI double sided double density 5¼" floppy as standard. The hard disk is controlled via Western Digital's controller for hard disks. Other features are the same as system at left.
*Megabyte sizes mentioned above are the available storage space after formatting.

TAPE BACKUP

WITH HARD DISK

Only $4250.00
COMPLETE



Now available through U.S Micro Sales, the **XOR IRWIN 510 S-100-4** tape backup system with 10 megabytes of hard disk storage. Back up your hard disk on a mini-tape (we're talking 10 meg.) in less than 3½ minutes! The above system includes a 96 TPI DS/DD floppy drive and this system's modular design allows you to add a second floppy for only **$395.00**.

★★★ XOR COMPATIBLE SOFTWARE ★★★

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WordStar	$275.00
MailMerge	100.00
SpellStar	175.00
Random House Thesaurus	135.00
TEX (Text Formatter)	90.00
Mince (Text Editor)	145.00
Scribble (Formatter)	145.00
(Both Mince & Scribble)	245.00
Random House Thesaurus	135.00
Final Word (Word Processor)	265.00
Peach Pack (4 Programs)	450.00
Spell Guard	225.00
WordMaster (Text Editor)	115.00
The Word Plus (Spelling Checker)	130.00

DATA APPLICATIONS

dBASE II	$595.00
Quickcode (Program Generator, Screen Builder for dBASE II	250.00
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FMS-80-11	440.00
DataStar (Data Entry & Ret.)	245.00
CalcStar (Elec. Spreadsheet)	145.00
BT-80 (Rec. Retreival)	175.00
Access Manager (For B-Tree)	250.00
SuperCalc	265.00
Mailman (M/L Manager)	119.00
NAD (M/L Manager)	90.00
Recover (Lost Data Recovery)	65.00

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MBasic-80	$290.00
MBasic Compiler	325.00
CBasic 2	100.00
CB-80 (Compiler)	455.00
Fortran-80	375.00
PL/I-80 (Language)	450.00
Pascal MT+ (Language)	445.00
Pascal MT+ (Compiler)	310.00
Cobol-80 (Language)	585.00
C Compiler (Language)	215.00
ADA (Compiler)	265.00
MAC (Macro Assem.)	85.00
Macro-80 (Macro Assem.)	150.00

Formats for XOR, NORTHSTAR, ALTOS, VECTOR GRAPHICS, Etc.

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Crosstalk	160.00
BSTAM	149.00
BSTMS	149.00
Term II	150.00

CP/M® HELPS

ATI-CP/M® Power 2.2 (Training)	75.00
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CP+ (English Language Menus)	125.00
Smart Key	50.00
Smart Print	30.00
ISIS (CP/M®) (Translator)	199.00
Disk-Edit	90.00

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General Ledger	$395.00
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Inventory	395.00
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Accounting Plus	CALL
Structured Systems	CALL
Medical	845.00
Dental	845.00
Master Tax (Prof 1040)	1500.00
Standard Tax (A 1040)	550.00

OTHER APPLICATIONS

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M-Sort	170.00
Q-Sort	89.00
Disk Doctor	89.00
Pearl 1 (Entry Lev. Prg. Gen.)	45.00
Pearl 2 (Int. Prog. Gen)	250.00
Pearl 3 (Advanced)	450.00
ATI D.B. Power (dBase II Training)	75.00
ATI SuperCalc (Training)	75.00
ATI MBasic (Training)	75.00
ATI WordStar (Training)	75.00
DeSpool (Background Print Utility)	45.00
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★ WEST ★ 6182 Garden Grove Blvd., Westminster, CA 92683

UNIVERSAL POWER SUPPLY

For Big Board, Apple or Aim 65
+5VDC @ 3 Amps
+12VDC @ .750 Amps
−12VDC @ .750Amps
−5VDC @ .500 Amps
Dimensions: 4" x 4" x 11"

$69.95

DISK DRIVE POWER SUPPLY

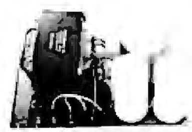
For 2 - 8" or 5" Drives
+ 5VDC @ 4 Amps
+24VDC @ 3 Amps
− 5VDC @ 1 Amp

AC Cables for 2 Drives **$7.50**

Dimensions: 4" x 4" x 11"

$59.95

S-100 POWER SUPPLY



+8VDC @ 30 Amps
+16VDC @ 6 Amps
−16VDC @ 6 Amps
PC Board Design
Dimensions: 5" x 6" x 11"

$89.50

TERMINALS

Televideo 910+ with green screen . **$575**

T.V. 925 ..... **$739** T.V. 950 ..... **$945**

Adds Viewpoint Model 3A+ **$519**

Zenith Z-19 .... **$740**

PRINTERS

Epson MX-80FT	**$549.00**
Epson MX-100FT	**$699.00**
Okidata 82A 80 column	**$465.00**
Okidata 83A 132 column	**$745.00**
C-ITOH Prowriter I	**$525.00**
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SA801R	**388.00 ea.**	Two for **379.00 ea.**
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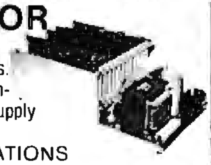
QUME DT-8	**540.00 ea.**	Two for **529.00 ea.**
Tandon 848-1	**395.00 ea.**	Two for **388.00 ea.**
Tandon 848-2	**525.00 ea.**	Two for **519.00 ea.**
Mitsubishi Model 2896 DS/DD	**475.00 ea.**	

S-100 MOD KIT by XOR



For test or systems applications. Complete **S-100** 12 Slot Mainframe with Disk Drive Power Supply for 4 Drives.

SPECIFICATIONS

Unregulated	Regulated
+8V @ 30A	+5V @ 5A
±16V @ 6A	+24V @ 3A
	−5V @ 1A

$225.00 Kit with 12 S-100 Bus Connectors

$255.00 Assem. and Tested with 12 Bus Connectors

$15.00 AC/DC Drive Cable Set for 2 Drives

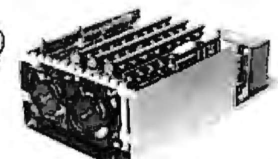
Dimensions 6" x 10" x 18" — Shipping Weight 25 lbs.

Cooling Power

4 1/8"

Low Velocity Whisper® Fans *Only* $18.00 ea.

Finger Guards $2.50 each.



XOR S-100 MOD

CUSTOMER SERVICE HOTLINE 1 - (714) 898-5525

S-100-4

$1695.00

★ 4 Slot **S-100** Bus
★ Includes CP/M™ 2.2 and Manl
★ Two Separate Power Supplies
★ All Cables Provided
★ **XOR S-100** Board Set
★ Dimensions only 9" x 9" x 18½"

S-100-4 System Complete with:

2-Tandon Thinline 8" (Model TM-848-1 SS/DD) Part#S-1000-40 .... **$1695.00**

2-Tandon Thinline 8" (Model TM-848-2 DS/DD) Part#S-1000-39 .... **$1950.00**

Now we are able to offer Mitsubishi thinline drives DSDD model 2896 for full 2.4 megabytes of formatted storage. All S-100-4 systems with these drives will include a full 6 months parts and labor warranty including the drives! Part #S-1000-34

S-100-8

$1795.00

TERMINAL

★ Feather Touch Capacitance Kybrd.
★ 60 Key Standard ASCII
★ SOROC Type Screen Attribute Set
★ 8 Special Function Keys
★ Half Intensity
★ 20 Screen Editing Keys

COMPUTER

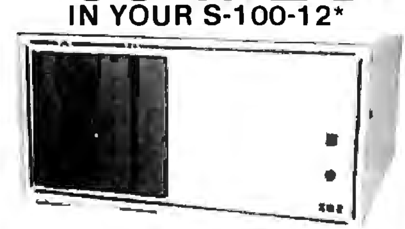
★ **XOR S-100** Board Set
★ Includes CP/M® 2.2
★ Programmable Keyboard Set
★ 8 Slot **S-100** Bus

S-100-8 System Complete With:

Shugart 801R Subsystem* (#S-1000-22)	**$2675.00**
Shugart 851R Subsystem* (#S-1000-23)	**2925.00**
Qume DT-8 Subsystem* (#S-1000-24)	**2950.00**
Shugart SA 400 Minis (#S-1000-25)	**2350.00**
Complete System, No Drives (#S-1000-21)	**1795.00**

**Available in Horizontal or Vertical Cabinet*

100 MEG! IN YOUR S-100-12*



Introducing a major breakthrough in technology... The removable cartridge disk called the **Alpha-10™**. 10 megabytes of removable storage space (14 meg unformatted) with the speed and reliability a Winchester offers. The complete system includes the **XOR Z-80** based 64K board set, the **S1-MOD** power supply/mother board, the Alpha-10™ drive (w/ 3 cartridges), sitting alongside a Shugart 851 DS/DD multi-sector floppy disk, CP/M™ 2.2 software and manuals, and we'll even throw in a 6 month parts and labor exclusive warranty.

(#S1000-75) **$3995.00**

If you already own an **S-100-12** w/2 floppies buy an Alpha-10™ upgrade package. Includes Alpha-10™ cartridge drive, cartridge control board, **S-100** interface board w/all necessary cables, software and manuals. System price includes 3 10 meg cartridges. (#S-1000-80) **$1995.00**

*Extra cartridges available (#M-2000-51). **$50.00**

ALPHA-10™ is a product manufactured by IOMEGA™ CORP.

Apple 8" Disk Controller Card **$395.00**

ZVX4 Dual Density, Single & Double Sided - Auto Boot

Disk 2 + 2 Single Density Single or Dual Sided

SVA **300.00**

Complete line of add on drives for Apple

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PMMI - MM103 300/600 Baud (**S-100**)	**359.00**

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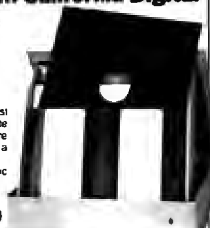
Circle 420 on inquiry card.

California Digital

Post Office Box 3097 B • Torrance, California 90503

★ FREE ★

Plastic library case supplied with all diskettes purchased from California Digital



$24.95

Private labeled for California Digital by one of the most respected producers of magnetic media. Each diskette is certified double density at 40 tracks. To insure extended media life all diskette are manufactured with a reinforced hub.
Each box of diskettes is supplied with a free plastic library case
Soft sector CAL-501. Ten sector CAL-510

Ten boxes $22.75 One hundred boxes $21.50

5¼" DISKETTES WITH LIBRARY CASE

$26.50

Your Choice
SCOTCH
MEMOREX
VERBATIM

Single Side Double Density

	Soft Sector	10 Sector	16 Sector	
SCOTCH	744D-0	744D-10	744D-16	26.50
MEMOREX	3481	3483	3485	26.50
VERBATIM	525-01	525-10	NA	26.50
MAXELL	MD1	MH1-10	MH1-16	29.85
DYSAN	104/1D	107/1D	NA	45.00

Double Side Double Density

SCOTCH	745-0	745-10	745-16	42.50
VERBATIM	550-01	550-10	NA	42.50
MAXELL	MD2-D	MH2-10D	MH2-16D	45.00
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

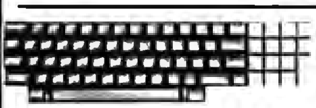
EIGHT INCH DISKETTES

Single Side Single Density		
SCOTCH	740-0	29.50
MEMOREX	3060	29.50
DYSAN	3740/1	39.50
Thirty Two Sector		
SCOTCH	740-32	29.50

Single Side Double Density		
SCOTCH	741-0	39.00
MEMOREX	3090	35.00
DYSAN	3740/D	57.50
Double side Double Density		
SCOTCH	743-0	47.50
MEMOREX	3114	39.50
DYSAN	3740/2D	65.00

Microswitch ASCII KEYBOARD $79

Each keyboard contains 81 high reliability Hall Effect keys. Outputs seven bit parallel ASCII MIC-81SD5 3 Lbs.



HITEK KEYBOARD $24.95

This Hitek keyboard is the same unit used by Lear Siegler in their model ADM CRT terminals. The keyboard features 58 unencoded metal on metal contacts (HIK-58). Matching numeric cluster with 15 keys is available for $9.95 (HIK-15). Buy both of these units for only $29.50 and save $5.00 (HIK-5815)

MEMORY

16K DYNAMIC	2732 EPROM
1.95	**4.95**
4116 150ns.	450ns.
64K DYNAMIC	**16K STATIC**
6.95	**4.95**
4164 150ns.	6116 200ns.

2764 EPROM SALE $9.95

DYNAMIC MEMORY

		1-31	32+	100+
4027 4K dynamic 250ns	ICM-4027250	1 99	1.85	1 75
4116 150ns. 16K	ICM-4116150	1 95	1 85	1 75
4116 200ns. 16K	ICM-4116200	1 75	1 65	1 50
4164 150ns 64K 128 refresh	ICM-4164150	6 95	6 50	5.90
41256150ns 256K	ICM-41256150	Available March 83		

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21L02 200ns 1K static	ICM21L02200	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 P4200ns 2K x 8	ICM-6116200	4 95	4 80	4 65
6116 P3150ns 2K x 8	ICM-6116150	5 95	5 75	5 60
6167/2167 100ns. 16K x 1 (20 pin)	ICM-6167100	8 95	8 50	7 90

EPROMS

2708 450ns 1K x 8	ICE-2708	4 95	4 75	4 55
2716 450ns 2K x 8	ICE 2716	4 95	4 75	4 55
2716TMS 450ns Tri-voltage	ICE-2716TMS	7.95	7 65	7 25
2732 450ns 4K x 8	ICE-2732	4.95	4 75	4 55
2732350ns 4K x 8	ICE-2732350	8 50	8 00	7.60
2532 450ns 4K x 8	ICE-2532	1050	9.90	9.50
2764 350ns 8K x 8	ICE-2764	10.95	1050	9.95
27128350ns 16K x 8	ICE-27128	Available March 83		

CONNECTORS

S-100 Gold $2.95

DB25P $2.50

GOLD EDGE CONNECTORS

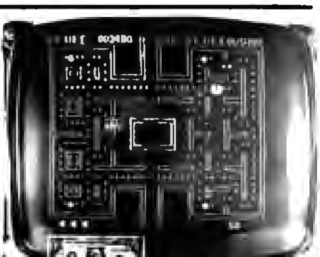
S-100 .125" centers	each	10+
Imsai solder .250" row	$2.95	$2.50
Imsai wire wrap (TI)	3.95	3.50
Sullins Hi-Rel. .250"	4.50	4.00
Sullins Hi-Rel. W/W	4.35	4.00
Sullins / Altair .140"	1.95	4.50
.156" Centers (standard)		
22/44 Kim Eyelet	2.50	2.15
36/72 Digital Group S/T	5.95	5.40
36/72 Digital Group W/W	6.80	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.45

INTEGRATED CIRCUIT SOCKETS

	Low Profile each	Low Profile 100+	Wire Wrap each	Wire Wrap 100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.45	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.43	.40	1.60	1.47

"D" Type	each	10-24	25+
DE9P male	$1.50	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.45	1.30
DB25P male	2.50	2.35	2.25
DB25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.15	1.05
DC37P male	4.20	4.00	3.70
DC37S female	6.00	5.75	5.50
DC hood 2/P	2.25	2.00	1.75
DD50P male	5.50	5.10	4.75
DD50S female	9.40	8.60	8.00
DD50 hood 2/P	2.60	2.40	2.10
CENTRONICS			
17-30360	7.05	6.75	5.75
RIBBON CABLE CONNECTORS			
17/34 5" disk	4.85	4.15	3.95
20/40 TRS-80	5.65	5.05	4.70
25/50 8" disk	5.90	5.15	4.90

23" COMPOSITE MONITOR $159



Ideal monitor for classroom demonstrations.

Ever try gathering a classroom of students around a 12" monitor? Here is your opportunity to purchase a 23" high resolution monitor at a reasonable price.
These units accept standard composite video signals generated by most personal computers including the Apple and IBM. Attach it your computer and in seconds you are shooting down Klingons in wide screen video.
MOT BW23 35 Lbs. Monitors are open frame and for safety should be enclosed. Wood grained enclosure for above $35.00 additional CAL ENC23 15 Lbs.

Eight Inch Single Sided

	One	Two	Ten
SHUGART SA801R	$395	385	375
SIEMENS FDD100-8	259	259	225
TANDON 848-1 SLIMLINE	379	369	359
Eight Inch Double Sided			
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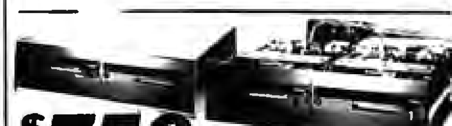
QUME DATA TRACK 8	525	495	475
MITSUBISHI M2894-63	485	475	469
OLIVETTI 802/851	369	359	349
TANDON 848-2 SLIMLINE	495	485	475
SHUGART 860 THINLINE	569	549	539
Five Inch Single Sided			
SHUGART SA400	215	209	199
TANDDN TM 100-1	209	199	195
Five Inch Double Sided			
SHUGART SA450	349	329	315
TANDON TM 100-2	295	269	259
TANDON 96TPI TM100-4	369	355	350
OLIVETTI 502 ⅔ height	239	225	215
Three Inch Rigid Floppy			
HITACHI-AMDEK	call for pricing		
Five Inch Winchesters			
SEAGATE 506 6 Megabyte	759	725	695
SEAGATE 512 12 Megabyte	995	960	960
TANDON 603SE 14 Megabyte	995	960	895
WESTERN DYNAX removable	995	960	950

Upon request, all drives are supplied with power connectors and manual



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68B45	34.00
68B50	12.00
8 MHz	
68000	95.95

9000 SERIES

9316	.95
9334	2.39
9368	3.69
9401	8.95
9601	.69
9602	1.39
96S02	1.79

MISC.

11 C 90	12.95
3242	6.95
MC 3470	7.95
MC 3480	8.95
ULN 2003	5.95
CA 3146	1.75
2513-001 up	9.69
2513-002 low	9.69

CRYSTALS

32.768 KHZ	1.90	5.185	3.90
10 MHZ	4.50	5.7143	3.90
1.8432	4.50	6.5536	3.90
2.0	3.90	8.0	3.00
2.097152	3.90	10.0	3.00
2.4576	3.90	14.31818	3.90
3.2768	3.90	18.0	3.00
3.579545	3.00	18.432	3.00
4.0	3.00	20.0	3.00
5.0	3.00	22.1184	3.00
5.0688	3.90	32.0	3.90

IC Sockets

	ST	W/W
8 PIN	.10	.49
14 PIN	.12	.50
16 PIN	.15	.57
18 PIN	.20	.85
20 PIN	.25	.99
22 PIN	.25	1.30
24 PIN	.25	1.40
28 PIN	.35	1.50
40 PIN	.40	1.80

ST = Soldertail
W/W = Wirewrap

VOLTAGE REGULATORS

7805T	.75	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.95
7824T	.85	7905K	1.39
7805K	1.29	7912K	1.39
7812K	1.29	7915K	1.39
7815K	1.29	7924K	1.39
7824K	1.29		
7905T	.85		

T = TO-220
K = TO-3

8000

8035	6.95	8239	4.75
8039	7.59	8243	4.75
8080A	3.90	8250	14.90
8085A	7.95	8251	4.50
8088	34.95	8253	8.75
8155	7.75	8253-5	9.75
8156	8.75	8255	4.50
8185	29.00	8255-5	5.20
8741	39.00	8257	8.50
8748	14.95	8259	6.85
8755	29.95	8272	39.00
8202	27.95	8275	29.00
8205	3.45	8279	9.25
8212	1.80	8279-5	9.95
8214	3.75	8282	6.50
8216	1.75	8283	6.50
8224	2.45	8284	5.50
8226	1.80	8286	6.50
8228	4.50	8287	6.50
8237	19.00	8288	25.00
8238	4.75	8289	49.00

CONNECTORS

RS232 Male	3.00
RS232 Female	3.50
RS232 Female Right Angle	4.95
RS232 Hood	1.20
30 pin Edge	2.49
44 pin Edge	2.49
50 pin Edge	2.69
86 pin Edge	3.90
100 pin ST	3.90
100 pin W/W	4.90

Power Supplies

MOUNTED ON PC BOARD
MANUFACTURED BY CONVER
+5 VOLT 4 AMP
±12 VOLT 1 AMP

34.95

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STORE HOURS:
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master charge

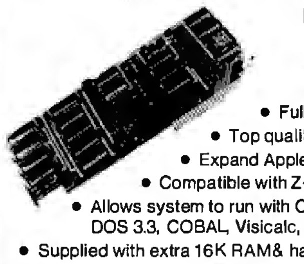
TERMS: For shipping include $2.00 for UPS Ground. $3.00 for UPS Blue Label Air. $10.00 minimum order. Bay Area residents add 6½% Sales Tax. California residents add 6% Sales Tax. We reserve the right to limit quantities and substitute manufacturer. Prices subject to change without notice. Send SASE for complete list.

Circle 152 on inquiry card.

ADVANCED COMPUTER PRODUCTS

SEND $2.00 for 1983 CATALOG

16K Apple™ Ramcard



LIST 195
ACP
$59^{95}

- Full 1 year warranty
- Top quality— gold fingers
- Expand Apple II 48K to 64K
- Compatible with Z-80 Softcard™
- Allows system to run with CP/M™, PASCAL, DOS 3.3, COBAL, Visicalc, etc.
- Supplied with extra 16K RAM& has (2) LED's

32K STATIC RAM

2 or 4 MHz Expandable Uses 2114L's

16K 4 MHz Kit	$159.95
16K 4 MHz A&T	217.95
32K 4 MHz Kit $129.95	~~289.95~~
• 32K 4 MHz A&T	• 339.00
BARE BOARD	39.95
Bare Bd w/all parts less mem.	99.95

64K CMOS RAM

S100 (200nS)

Uses 2716's or 6116's $299^{00}

Assembled & Tested **$399.00**

BARE BOARDS

S-100 Sound Board	$34.95
8080A CPU	34.95
32K Static RAM (2114)	34.95
8K EPROM (2708)	24.95
2708/2716 EPROM	34.95
ACP Proto Board	22.95
Vector 8800 Proto	22.20
Vector8803 11 slot MB	29.95
ACP Extender with connector	18.95
13 Slot Mother Board (WMC)	32.95
9 Slot Mother Board (WMC)	29.95
8 SlotMotherBd(Expandable)	34.95
Floppy PCB (8" SHUGART)	39.95
S100 (AY5-8910) Sound Board	34.95
Apple Sound Board	24.95

MOSTEK 4K RAMS

29¢ ea.

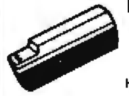
200,000 pieces in stock — priced to move. Same as MK4027 except 1mS refresh. MK4015 4Kx1 RAM

STEPPER MOTOR

Operates by applying 12VDC in one direction and then reversing polarity (or square wave). Uses 12VDC, Clock Wise Rotation, Rated 3 RPM at 4 P.P.S. with a 5 degree stepping angle.

ACP PRICE $4^{95} ea. 10 for $39.95

UV "EPROM" ERASER



Model UVs-11E **$79.95**
Holds 4 EPROM's at a time.
Model S-52T **$325.00**

4K STATIC RAM SELL-OFF

10/$9.90

Same as TMS4044 but designed specifically for Z-80 based systems. This is a full-spec 4Kx1 RAM, 450nS. Order P/N Zilog6104-4 while supply lasts.

16K Memory Expansion Kits for Apple/TRS-80

8 pcs 4116 16K 200/250nS
Specify computer **$12.95**
CALL FOR VOLUME PRICING

Zilog Z8 CPU with TINY BASIC

Debug prog. **$49.95**
Plus 6132 companion quasi-static RAM 29.95

"D" SUB CONNECTORS

Unreal price. DB37 male, DB25 female. Gold PC mount with mounting holes. Mfg. AMP. Specify 25 or 37 pins.

BD37 $2.50 DB25 $1.95

Stepper Motor

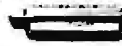
NEW
USED IN DATA PRODUCTS PRINTER
$19.95 ea.

Astec RF Modulator

for COLOR & B/W

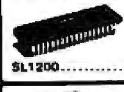
P/N 1082 Channel 3 or 4 $6.95

CONNECTORS



DB25P (RS232)	$3.25
DB25S Female	3.75
Hood	1.25
Set with Hood, Sale	7.50
22/44 S/T, KIM	2.95
43/86 S/T, MOT	6.50
50/100 S-100 Connector W/W	4.95
50/100 S-100 Connector S/T	3.95

1200 BAUD MODEM IC



Features:
- 1200 Baud
- 40 Pin
- 5Volts Only

SL1200..............**$129.00**

PARALLEL ALPHA NUMERIC PRINTER

19 Column Printer prints 16 numerical columns plus 3 columns which have math, alpha and other notations. Each wheel has 12 positions with position 12 blank. Position 11 on numerical columns have decimal point or #. Utilizes 2.75" wide adding machine tape and a dual color ink ribbon. Input data parallel with four bit BCD comparator circuit (schematic provided). Print rate, 3 lines per second. Operating voltage 22-28VDC with typical cycle time of 340mS. Size 6½"W x 3⅛"H x 5⅝"Dp. New. **$9.95 ea. 3/$27**

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Z8001	$99.00	8008-1	$14.95	6802P	14.95
Z8002	69.00	2901	9.90	8035	14.95
Z80	9.95	2901A	14.95	8039	12.95
Z80A	11.95	9900JL	49.95	8073N	34.95
F-8 (3850)	16.95	6502	9.95	8755	49.95
2650	16.95	6502A	16.95	8748	49.95
1802	9.75	HM6100	29.95	6809	30.00
8080A	4.75	6800	11.75	8086	49.95
8085	14.95	68B00	19.95	68000	129.95

RAMS

CALL FOR QTY PRICING

6116/2016	$7.95	2147	$5.99	5290	$1.99
8264-64K	5.95	411	5.99	5298	1.49
4116-2	1.89	414	4.69	6508	4.50
4116-2	8/12.95	1101	.99	6518	6.79
2101	3.89	1103	.99	6561	3.79
2102	.79	4027	4.69	6604	3.99
21L02-2	1.49	4044	3.99	6605	7.99
21L02-4	1.29	4050	4.69	9130	8.99
2111	3.49	4060	4.69	9140	8.99
2112	3.49	4096	3.99	93415	6.99
2114	1.89	4115	1.49	93425	6.99
2114L-2	3.25	4200	7.95		
2114L-4	2.29	4402	1.99		
2125	6.99	5280	4.60		

SUPPORT

8155	$9.95	8259	$8.95	88047	$22.95
8156	9.95	8275	19.95	68488	19.95
8202	29.95	8279	9.50	46505	22.95
8205	2.69	6810	4.75	6520	6.95
8212	2.75	6820	6.50	6522	9.95
8214	4.95	6821	6.50	6530-X	24.95
8216	2.75	6828	10.50	6532	17.95
8224	2.95	6834	16.95	6551	19.95
8226	2.95	6845	22.95	Z80-PIO	6.50
8228	3.95	6847	27.95	Z80A-PIO	9.50
8243	9.50	6850	5.25	Z80-CTC	6.50
8250	14.95	8852	5.25	Z80A-CTC	9.50
8251	6.50	6860	10.95	Z80-DMA	19.95
8253	11.95	6862	10.95	Z80A-DMA	27.95
8255	4.50	6875	5.95	Z80-SIO	24.95
8257	9.50	6880	2.49	Z80A-SIO	29.95

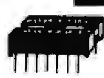
MOS PROMS

2764 (8Kx8) TS	$69.95	2708 (450nS)	$5.75
2732 (4Kx8) TS	12.95	2708 (650nS)	5.25
2716/2516; 5V (2Kx8) TS	7.95	1702A	5.75
TMS2716, 5V, 12V	17.95	MM5203AQ	14.50
2758, 5V, (450nS)	3.50	MM5204Q	9.95

HI-TECH

2513-001 (5V) Upper	$9.50	DAC08	$9.95
2513-005(5V) Lower	10.95	DAC100	9.95
2513-ADM3(5V) Lower	14.95	8038 Function Generator	4.50
MCM66710ASCII Shifted	12.95	MC4024 VCO	2.95
MCM66740MathSymbol	13.95	LM566 VCO	1.95
MCM66750 AlphaControl	13.45	XR2206 Function Generator	5.25
1771-01 8" & Minifloppy	24.95	TR1602B (5V, 12V)	3.95
1781 DualFloppy	29.95	AY51013 (5V, 12V)	4.95
1791-01 Dual Floppy	36.95	AY51014A/1612 (5-14V)	6.95
1791-02Dual Floppy	44.95	AY51015A/1863(5V)	6.95
1793DD,DS Floppy	44.95	IM6402	7.95
1797DD,DS Floppy	54.95	IM6403	8.95
1691 Data Separator	18.95	2350 USRT	9.95
2143 ClockGenerator	18.95	1671B Astros	24.95
8700 8 bit Binary	13.50	MC14411	11.95
8701 10 bitBinary	22.00	4702	14.95
8703 8 bitTS	13.50	WD1941	9.95
9400VoltToFreqConv.	7.25	COM5016	16.95
8750 3½ DigitBCD	13.95	INS8250	15.95
1408L6 6 bit	3.95	AY5-2376	13.75
1408L8 8 bit	5.95	AY5-3600	13.75
DAC01 DtoA	5.95	MM5740AAC	8.95

SOCKETS



LOW PROFILE SOCKETS (TIN)

	1-24	25-49	50-100
8 pin LP	.16	.15	.14
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
40 pin LP	.60	.59	.58

3L WIREWRAP SOCKETS (GOLD)

	1-24	25-49	50-100
8 pin WW	.55	.54	.49
10 pin WW (Tin)	.65	.63	.58
14 pin WW	.75	.73	.67
16 pin WW	.60	.77	.70
18 pin WW	.95	.90	.81
20 pinWW	1.15	1.06	.99
22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
28 pinWW	1.60	1.53	1.38
40 pin WW	2.20	2.09	1.89

LINEAR

78H05K	$5.95	LM1414N	$1.90
78M06	1.49	LM1458CN/N	.49
78M.G.	1.49	MC1488N	.99
LM108AH	2.95	MC1489N	.99
LM300H	.99	LM1496N	.89
LM301CN	.35	LM1556N	1.50
LM304H	1.98	LM1820N	.95
LM305H	1.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
LM307CN	.29	LM2111N	1.75
LM308CN	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	LM3053N	1.49
LM323K	4.95	CA3059N	3.19
LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
LM338K	6.95	LM3065N	1.49
LM339N	.95	CA3080T	1.29
LM340K-XX*	1.75	CA3081N	1.69
LM340T-XX*	1.25	CA3082N	1.89
LM340H-XX*	1.25	CA3083N	1.55
LM344H	1.95	CA3086N	.80
LM348N	1.20	CA3089N	2.99
LM350K	5.60	CA3096N	3.49
LM358CN	.98	CA3097N	1.99
LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
LM380CN/N	1.25	CA3190N	1.95
LM381N	1.79	CA3410N	.59
LM383T	1.95	MC3423N	1.49
LM386N	1.25	MC3460N	3.95
LM387N	1.40	SG3524N	3.95
LM390N	1.95	CA3600N	3.39
NE531V/T	3.75	LM3900N	.59
NE555V	.39	LM3905N	1.19
NE556N	.98	LM3909N	.98
NE561T	19.95	LM3914N	3.75
NE565N/H	1.25	LM3915N	3.95
NE566H/V	1.75	LM3916N	3.75
NE567V/H	1.50	RC4131N	2.95
NE592N	2.75	RC4136N	1.10
LM702H	1.99	RC4151N	3.70
LM709N/H	.29	RC4194TK	4.95
LM710N/H	.75	RC4195TK	5.40
LM711N/H	.39	ULN2001	1.25
LM715N	1.95	ULN2003	1.50
LM723N/H	.65	SN75450N	.59
LM733N/H	.98	SN75451N	.39
LM739N	1.15	SN75452N	.49
LM741CN/H	.33	SN75453N	.49
LM741CN-14	.19	SN75454N	.49
LM747N/H	.75	SN75491N	.89
LM748N/H	.39	SN75492N	.89
LM760CN	2.95	SN75493N	.89
LM1310N	1.90	SN75494N	.89
MC1330	1.95	TL494CN	4.20
MC1350	1.95	TL496CP	1.65
MC1358	1.75		

74S00

74S00	$ .39	74S124	3.69	74S244	$2.99
74S02	.43	74S133	.54	74S251	1.35
74S03	.45	74S134	.66	74S253	1.35
74S04	.52	74S135	1.15	74S257	1.29
74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
74S09	.49	74S139	1.29	74S280	2.79
74S10	.42	74S140	.73	74S287	2.99
74S11	.42	74S151	1.29	74S288	2.55
74S15	.42	74S153	1.29	74S373	3.10
74S20	.42	74S157	1.29	74S374	3.10
74S22	.42	74S158	1.29	74S387	2.75
74S30	.42	74S160	2.79	74S471	7.95
74S32	.49	74S174	1.49	74S472	7.95
74S38	1.19	74S175	1.49	74S473	7.95
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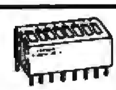
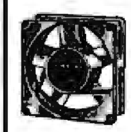
74S51	.42	74S194	1.89	74S475	9.95
74S64	.46	74S195	1.89	74S570	5.75
74S65	.46	74S196	1.89	74S571	5.75
74S74	.69	74S240	2.75	74S572	8.95
74S86	.72	74S241	2.75	74S573	8.95
74S112	.72	74S242	2.99	74S940	2.90
74S113	.72	74S243	2.99	74S941	2.90
74S114	.72				

DIP SWITCHES



2 Position	$ .99	7 Position	$1.39
4 Position	1.19	8 Position	1.49
5 Position	1.29	9 Position	1.65
6 Position	1.35	10 Position	1.69

MUFFIN® FAN



The dependable, low cost, largest selling fan for commercial cooling applications.

- 105cfm free air delivery
- 4.68" sq. x 1.50" deep. Weight - 17 oz.

SPECIAL PURCHASE
NEW **$9.50 ea.**

7400

7400	$ .19	7475	$ .38	74161	$ .88
7401	.22	7476	.34	74162	.89
7402	.22	7479	4.60	74163	.87
7403	.22	7480	.49	74164	.87
7404	.22	7482	.95	74165	.87
7405	.23	7483	.55	74166	1.20
7406	.35	7485	.65	74167	1.95
7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	.67	74285	3.90
7451	.19	74153	.67	74290	1.25
7453	.19	74154	1.19	74298	.95
7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

74LS00

74LS00S	.26	74LS113S	.43	74LS245	$2.20
74LS01	.28	74LS114	.43	74LS247	1.10
74LS02	.28	74LS122	.55	74LS248	1.10
74LS03	.28	74LS123	1.19	74LS249	1.19
74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.15	74LS266	.59
74LS14	.95	74LS148	1.49	74LS273	1.75
74LS15	.33	74LS151	.79	74LS275	4.40
74LS20	.26	74LS153	.79	74LS279	.59
74LS21	.33	74LS154	1.70	74LS283	.99
74LS22	.33	74LS155	1.19	74LS290	.99
74LS26	.33	74LS156	.99	74LS293	.99
74LS27	.33	74LS157	.85	74LS295	1.10
74LS28	.33	74LS158	.75	74LS298	1.19
74LS30	.26	74LS160	1.05	74LS324	1.75
74LS32	.33	74LS161	1.15	74LS347	1.95
74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	.26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
74LS74	.42	74LS181	2.20	74LS377	1.95
74LS75	.59	74LS190	1.15	74LS385	1.95
74LS76	.45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
74LS83A	.79	74LS193	.98	74LS393	1.95
74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS96	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.69	81LS98	1.69
74LS112	.43				

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4012	.25	4049	.45	14415	8.95
4013	.45	4050	.69	14419	4.95
4014	1.39	4051	1.10	4501	.39
4015	1.15	4052	1.10	4502	1.65
4016	.59	4053	1.10	4503	.69
4017	1.19	4055	3.95	4505	8.95
4018	.89	4056	2.95	4506	.75
4019	.45	4059	9.25	4507	.95
4020	1.10	4060	1.39	4508	3.75
4021	1.19	4066	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.29	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
4031	3.25	4078	.35	4566	2.25
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as reviewed in May BYTE pg. 266

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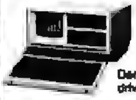

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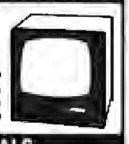
USI Computer Products



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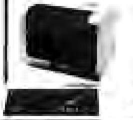
TERMINALS



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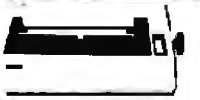

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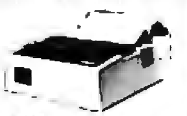

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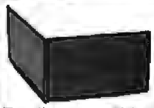

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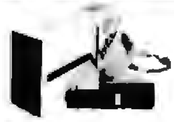

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2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns)(5v)	5.95
2716	2048 x 8 (450ns)(5v)	3.95
2716-1	2048 x 8 (350ns)(5v)	6.25
TMS2516	2048 x 8 (450ns)(5v)	5.50
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns)(5v)	7.95
2732	4096 x 8 (450ns)(5v)	4.95
2732-250	4096 x 8 (250ns)(5v)	12.95
2732-200	4096 x 8 (200ns)(5v)	16.95
2764	8192 x 8 (450ns)(5v)	16.95
2764-250	8192 x 8 (250ns)(5v)	18.95
2764-200	8192 x 8 (200ns)(5v)	24.95
TMS2564	8192 x 8 (450ns)(5v)	24.95
MC68764	8192 x 8 (450ns)(5v)(24 pin)	39.95

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

DISC CONTROLLERS

1771	16.95
1791	29.95
1793	38.95
1795	54.95
1797	54.95
6843	34.95
8272	39.95
UPD765	39.95
1691	18.95
2143	18.95

INTERFACE

8T26	1.69
8T28	2.49
8T95	.99
8T96	.99
8T97	.99
8T98	.99
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

SOUND CHIPS

76477	3.95
76489	8.95
AY3-8910	12.95
MC3340	1.49

CRT CONTROLLERS

6845	14.95
68B45	35.95
HD46505SP	15.95
6847	12.25
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

BIT-RATE GENERATORS

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	14.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95

CLOCK CIRCUITS

MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	5.95
Z80-DART	15.25
Z80-DMA	17.50
Z80-PIO	5.75
Z80-SIO/0	18.50
Z80-SIO/1	18.50
Z80-SIO/2	18.50
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	6.00
Z80A-CTC	6.65
Z80A-DART	18.75
Z80A-DMA	27.50
Z80A-PIO	6.00
Z80A-SIO/0	22.50
Z80A-SIO/1	22.50
Z80A-SIO/2	22.50
Z80A-SIO/9	19.95

6.0 Mhz

Z80B-CPU	17.95
Z80B-CTC	16.50
Z80B-PIO	15.50

ZILOG

Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

DATA ACQUISITION

ADC0800	15.55
ADC0804	3.49
ADC0809	4.49
ADC0817	9.95
DAC0800	4.95
DAC0806	1.95
DAC0808	2.95
DAC1020	8.25
DAC1022	5.95
MC1408L6	1.95
MC1408L8	2.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	24.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	7.95
8156	8.95
8185	29.95
8185-2	39.95
8741	39.95
8748	29.95
8755	32.00

8200

8202	29.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8238	4.49
8243	4.45
8250	10.95
8251	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	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

FUNCTION GENERATORS

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

INTERSIL

ICL7103	9.50
ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

6800

68000	59.9
6800	4.95
6802	7.95
6808	13.90
6809E	19.95
6809	12.95
6810	2.95
6820	4.95
6821	3.25
6828	14.9
6840	12.9
6843	34.95
6844	25.9
6845	14.9
6847	12.25
6850	3.45
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	24.95
68047	24.95
68488	19.95

6800 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	7.95
68B21	12.95
68B45	35.95
68B50	12.95

68B00 = 2 MHZ

6500

1 MHZ

6502	5.95
6504	6.9
6505	8.9
6507	9.9
6520	4.3
6522	8.7
6532	11.2
6545	22.5
6551	11.8

2 MHZ

6502A	9.9
6522A	11.7
6532A	12.4
6545A	28.5
6551A	12.9

3 MHZ

6502B	14.9

EXAR

XR 2206	3.
XR 2207	3.
XR 2208	3.
XR 2211	5.
XR 2240	3.

9000 SERIES

9316	1.
9334	2.
9368	3.
9401	9.
9601	
9602	1.
96S02	1.

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2732 32K EPROMS $4.95 EACH

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74LS00

74LS00	.24	74LS86	.39	74LS169	1.75	74LS323	3.50
74LS01	.25	74LS90	.55	74LS170	1.49	74LS324	1.75
74LS02	.25	74LS91	.89	74LS173	.69	74LS352	1.29
74LS03	.25	74LS92	.55	74LS174	.55	74LS353	1.29
74LS04	.24	74LS93	.55	74LS175	.55	74LS363	1.35
74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
74LS20	.25	74LS124	2.90	74LS197	.79	74LS379	1.35
74LS21	.29	74LS125	.49	74LS221	.89	74LS385	1.90
74LS22	.25	74LS126	.49	74LS240	.95	74LS386	.45
74LS26	.29	74LS132	.59	74LS241	.99	74LS390	1.19
74LS27	.29	74LS133	.59	74LS242	.99	74LS393	1.19
74LS28	.35	74LS136	.39	74LS243	.99	74LS395	1.19
74LS30	.25	74LS137	.99	74LS244	.99	74LS399	1.49
74LS32	.29	74LS138	.55	74LS245	1.49	74LS424	2.95
74LS33	.55	74LS139	.55	74LS247	.75	74LS447	.37
74LS37	.35	74LS145	1.20	74LS248	.99	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.25	74LS148	1.35	74LS251	.59	74LS668	1.69
74LS42	.49	74LS151	.55	74LS253	.59	74LS669	1.89
74LS47	.75	74LS153	.55	74LS257	.59	74LS670	1.49
74LS48	.75	74LS154	1.90	74LS258	.59	74LS674	9.65
74LS49	.75	74LS155	.69	74LS259	2.75	74LS682	3.20
74LS51	.25	74LS156	.69	74LS260	.59	74LS683	3.20
74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
				74LS299	1.75	25LS2569	4.25

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		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call

ZIF = TEXTOOL (Zero Insertion Force)

CONNECTORS

RS232 MALE	2.95
RS232 FEMALE	3.50
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74186	18.50
7453	.23	74190	1.15
7454	.23	74191	1.15
7460	.23	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.33	74196	.79
7475	.45	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7485	.59	74248	1.85
7486	.35	74249	1.95
7489	2.15	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.35	74276	1.25
7494	.65	74279	.75
7495	.55	74283	2.00
7496	.70	74284	3.75
7497	2.75	74285	3.75
74100	1.75	74290	.95
74107	.30	74293	.75
74109	.45	74298	.85
74110	.45	74351	2.25
74111	.55	74365	.65
74116	1.55	74366	.65
74120	1.20	74367	.65
74121	.29	74368	.65
74122	.45	74376	2.20
74123	.49	74390	1.75
74125	.45	74393	1.35
74126	.45	74425	3.15
74128	.55	74426	.85
		74490	2.55

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	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
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C911	8.95
4508	1.95	74C912	8.95
4510	.85	74C914	1.95
4511	.85	74C915	1.19
4512	.85	74C918	2.75
4514	1.25	74C920	17.95
4515	1.79	74C921	15.95
4516	1.55	74C922	4.49
4518	.89	74C923	4.95
4519	.39	74C925	5.95
4520	.79	74C926	7.95
4522	1.25	74C928	7.95
4526	1.25	74C929	19.95

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74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

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- ★ Very competitive prices!
- ★ Friendly staff!
- ★ Fast service — most orders shipped within 24 hours!

LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49

LED LAMPS

	1-99	100-up
Jumbo Red	.10	.09
Jumbo Green	.18	.15
Jumbo Yellow	.18	.15

TRANSISTORS DIODES

PN2222	NPN SWITCH	TO-92	10/1.00	100/8.99
PN2907	PNP SWITCH	TO-92	10/1.25	100/10.99
2N2222	NPN SWITCH	TO-18	.25	50/10.99
2N2907	PNP SWITCH	TO-18	.25	50/10.99
2N3055	NPN POWER	TO-3	.79	10/6.99
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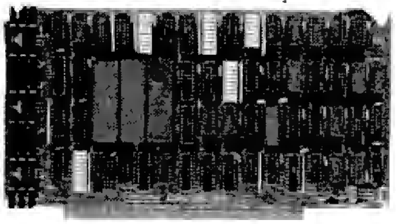

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BNGBT1612A	A&T 6MHz	$425.00	$398.89
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68K - 68000 16 BIT CPU

16 bit 8 or 10 MHz on-board sockets for 2716, 2732, or 2764 EPROMs for up to 8K x 16 of memory

BNGBT184A	A&T 8MHz	$695.00	$625.00
BNGBT184C	CSC 10MHz	$850.00	$765.00

FORTH OPERATING SYSTEM FOR 68K CPU

Requires a DISK 1, 64K of CompuPro memory, and an INTERFACER 3 or 4.

BNGBT68KOS	FORTH operating system	$200.00

CPUZ - Z80B CPU NOW 6MHz!

3/6 MHz Z80B CPU with 24 Bit Addressing. FASTEST Z80 CPU AVAILABLE!

BNGBT160A	3/6 MHz A&T	$295.00	$279.89
BNGBT160C	3/6 MHz CSC	$395.00	$374.89

*When 2 or more 8" disk drives are purchased with Disk 1 Controller.

DISK CONTROLLERS

DISK 1 FLOPPY CONTROLLER - OUR BEST!

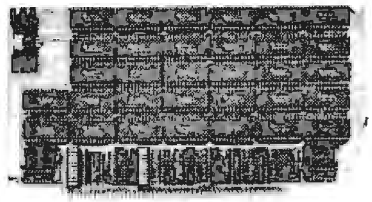
Fast DMA, Soft Sector, Controls Up To Four 8" or 5¼" Single or Double Density Drives.

BNPDB171ACPM	A&T w/CPM 2.2 & BIOS	$670.00	$495.00
	*When purchased with two 8" disk drives only.		$450.00
BNPDB171CCPM	CSC w/CP/M 2.2 & BIOS	$770.00	$595.00
BNGBT171A	Disk 1 Controller A & T	$495.00	$449.89
BNGBT171C	Disk 1 Controller CSC	$595.00	$550.00
BNGBTCPM80	CP/M 2.2 for Z80/8085 w/manual & BIOS 8" S/D disk.		$174.89
BNGBTCPM86	CP/M 2.2 for 8086 w/manuals & BIOS 8" S/D disk.		$299.89

DISK 2/SELECTOR CHANNEL HARD DISK CONTROLLER

Fast DMA 2 board set. controls 4 Shugart 4000 series or Fujitsu 2300 type drives. Includes CP/M 2.2

BNGBT177A	Assembled & Tested	$795.00	$750.00
BNGBT177C	CSC	$895.00	$850.00



CMOS RAM SALE!

RAM 17 - 64K CMOS STATIC RAM

12 MHz. RAM 17. 2 Watt. DMA Compatible 24 Bit Addressing

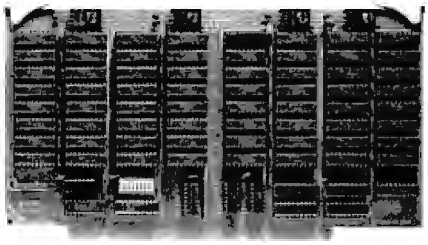
Part No.	Description	List Price	Our Price
BNGBTRAM17	64K A&T 10MHz		$319.00
BNGBT175A64	64K A&T 12MHz	$599.00	$549.89
BNGBT175C64	64K CSC 12MHz	$699.00	$650.00

RAM 16 - 32K x 16 BIT CMOS STATIC RAM

8 and/or 16 Bit

(816) 12 MHz. RAM 16, 32K x 16 or 64K x 8 IEEE/696 16 Bit 2 Watt. 24 Bit Addressing

BNGBTRAM16	64K A&T 10MHz		$349.00
BNGBT180A	64K A&T 12MHz	$650.00	$598.89
BNGBT180C	64K CSC 12MHz	$750.00	$698.89



NEW! RAM 21 - 128K STATIC RAM

(816) RAM 21 12MHz, 128K x 8 or 64K x 16 IEEE/696 8 or 16 Bit, 1.2 Amps, 24 Bit Addressing

BNGBT190A	128K A&T	$1350.00	$1225.00
BNGBT190C	128K CSC	$1450.00	$1375.00

M-DRIVE SOLID STATE DISK DRIVE, 3500% FASTER!!

Not really, but the next best thing for CompuPro 8085/88 Users Call for Details on M-Drive

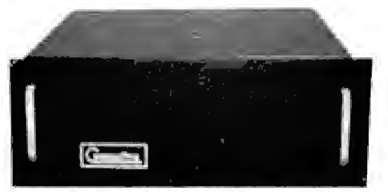
M-Drive requires a 6MHz CPU 8085/88 dual processor, Disk 1 DMA disk controller and System Support 1 Multifunction Board.

BNGBTMD128KA	128K of A&T memory & M-Drive Software	$1190.00
BNGBTMD128KC	128K of CSC memory & M-Drive Software	$1390.00
BNGBTMD256KA	256K of A&T memory & M-Drive Software	$2395.00
BNGBTMD256KC	256K of CSC memory & M-Drive Software	$2785.00

M-DRIVE/H HARDWARE LOGICAL DISK SYSTEM

Interfaces through two I/O ports, and runs at 10MHz. IEEE 696 compatible. Requires any CompuPro CPU and a Disk 1. Each board contains 512K of fast, low power (900mA) RAM. with parity checking.

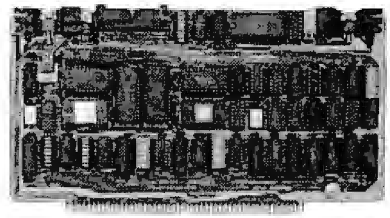
BNGBT197A	M-DRIVE/H w/software, A&T	$1895.00	$1775.00
BNGBT197C	M-DRIVE/H w/software, CSC	$2095.00	$1950.00



S-100 MAINFRAME

110V 60Hz CVT Mainframe uses famous 20 slot CompuPro Motherboard (55 lbs.)

BNGBTENC20RM	20 Slot Rackmount	$895.00	$825.00
BNGBTENC20DK	20 Slot Desk Top	$825.00	$760.00



I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

Serial port (software prog. baud), 4K EPROM or RAM provision, 15 levels of interrupt, real time clock, optional math processor

Part No.	Description	List Price	Our Price
BNGBT162A	Assembled & Tested	$395.00	$359.89
BNGBT162C	CSC	$495.00	$459.89
BNGBT6231	Math Chip		$195.00
BNGBT8232	Math Chip		$195.00
BNGBT162AM1	A&T w/8231 Math Chip		$490.00
BNGBT162CM1	CSC w/8231 Math Chip		$654.89
BNGBT162AM2	A&T w/8232 Math Chip		$490.00
BNGBT162CM2	CSC w/8232 Math Chip		$654.89

MPX CHANNEL BOARD

I/O Multiplexer, using 8085A-2 CPU on board w/4K RAM

BNGBT166A4	Assembled & Tested	$495.00	$444.89
BNGBT166C4	CSC	$595.00	$534.89
	With 16K RAM		
BNGBT166A16	Assembled & Tested	$649.00	$584.89
BNGBT166C16	CSC	$749.00	$674.89

INTERFACER 1

Two Serial I/O

BNGBT133A	Assembled & Tested	$249.00	$218.89
BNGBT133C	CSC	$324.00	$288.89

INTERFACER 2

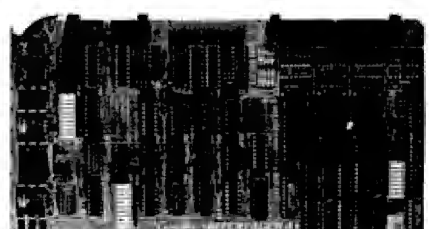
Three parallel, one serial I/O board

BNGBT150A	Assembled & Tested	$249.00	$218.89
BNGBT150C	CSC	$324.00	$289.89

INTERFACER 3

Eight-channel multi-user serial I/O board

BNGBT1748A	Assembled & Tested	$699.00	$628.89
BNGBT1748C	CSC 200 hr. 8 port	$849.00	$748.89
BNGBT1745A	Assembled & Tested	$599.00	$558.89
BNGBT1745C	CSC 200 hr. 5 port	$699.00	$628.89



INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BNGBT187A	Assembled & Tested	$395.00	$314.89
BNGBT187C	CSC	$495.00	$414.89

SPECTRUM COLOR GRAPHICS

Color Graphics board with Parallel I/O

BNGBT144A	Assembled & Tested	$299.00	$285.00
BNGBT144C	CSC	$395.00	$375.00

S-100 MOTHERBOARDS

Active termination, 6-12-20 Slot

BNGBT153A	A&T 6 slot, 2 lbs.	$140.00	$125.00
BNGBT153C	CSC 6 slot, 2 lbs.	$190.00	$155.00
BNGBT154A	A&T 12 slot, 3 lbs.	$175.00	$155.00
BNGBT154C	CSC 12 slot, 3 lbs.	$240.00	$220.00
BNGBT155A	A&T 20 slot, 4 lbs.	$265.00	$235.00
BNGBT155C	CSC 20 slot, 4 lbs.	$340.00	$310.00

Circle 342 on inquiry card.

PRIORITY ONE ELECTRONICS

CompuPro 10 MHz 64KBytes

S-100 STATIC RAM - ULTRA LOW POWER - ONLY 2 WATTS

ASSEMBLED & TESTED - ONE YEAR WARRANTY

$299*

UNBELIEVABLE! While the rest of the industry struggles to attain 6MHz, CompuPro has effortlessly jumped from 10 to 12MHz. The power consumption (400mA; 2 Watts) is still the lowest in spite of running nearly twice as fast. Priority One Electronics has purchased the remainder of CompuPro's 10MHz boards and are offering them at these unprecedented prices.

RAM 17

- Extremely low power consumption (2 watts typical)
- Flawlessly handles any DMA device per IEEE 696 specifications
- Single +5 Volt operation (requires no other supply voltages)
- Switch-Selectable choice of 24 address lines conforming to IEEE 696/S-100 extended addressing
- 2K windows, individually selectable at E000, E800, F000, and F800 permits use with older memory-mapped disk controllers or ROM (i.e., Morrow, NorthStar)
- Any 16K block may be disabled; dip switch selectable 2K disable from XXE000 - FFFF in 2K increments
- Switch Selectable PHANTOM disable

SALE PRICE: $319.00 ea.

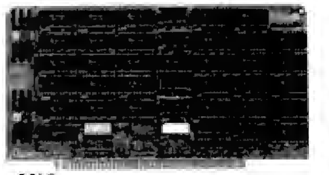
List Price: $599.00

***2 or More: $299.00 ea.**

BNGBTRAM17 Assembled & Tested

RAM 16

- Board addressable as one 64K x 8 or 32K x 16 block; DIP switch selectable on any 64K boundary
- Extremely low power consumption (2 watts typical)
- Meets or exceeds all IEEE 696/S-100 specifications
- Flawlessly handles any DMA device per IEEE 696 specifications
- Single +5 Volt operation (requires no other supply voltages)
- 24 bit addressing; conforms to IEEE 696 specifications
- 8 or 16 bit data transfer dependant on SXTRQ. Conforms with IEEE 696 timing requirements for XTRQ and SIXTN



SALE PRICE: $349.00 ea.

List Price: $650.00

2 or More: $325.00 ea.

BNGBTRAM16 Assembled & Tested

CompuPro™

NEW 16 BIT 12 USER SYSTEM 816/D

SAVE OVER $4000.00 ON SYSTEM & TERMINAL!

The **System 816/D** is a high performance, multi-user, multi-tasking 16-bit system, with the power needed for involved applications such as software development. This is the preferred system for business, industrial or scientific environments. In addition, the **816/D** delivers spooling (simultaneous printing and editing) to further increase productivity.

- 10MHz 16 bit 8086 CPU with 80130 operating system firmware component
- 512K bytes of low power RAM
- 1 megabyte of M-DRIVE/H high speed solid state logical disk system
- Fast DMA floppy controller with 2 double sided 8" disk drives; 2.4 megabytes of storage
- 20 slot desk top S-100 enclosure
- 12 serial interfaces
- 1 parallel, 1 Centronics parallel interface

Software: CP/M-86, MP/M-86, SuperCalc

Convenience features: clock/calendar; interrupt controllers; interval timers, and co-processor and Operating System Firmware option.-

This **System 816/D** is priced at $13,995.00, a savings of over $3,000 if all of the components were purchased separately.

Part No.	Description	Price
BNGBTSYS81600A	Multiuser 16 bit desk top system A&T	$13,995.00
BNGBTSYS81600C	Multiuser 16 bit desk top system CSC	$15,995.00
BNGBTSYS81600A21	Same as above with RAM 21s, A&T	$14,395.00
BNGBTSTS81600C21	Same as above with RAM 21s, CSC	$16,395.00

OASIS 16 SYSTEM 816/016

All the hardware mentioned with the System 816/D with the OASIS 16 Operating System and utilities instead of CP/M-86, MP/M-86, and SuperCalc.

BNGBTSYS8160DA	Multiuser 16 bit desk top system A&T	$13,995.00
BNGBTSYS81600C	Multiuser 16 bit desk top system CSC	$15,995.00
BNGBTSYS81600A21	Same as above with RAM 21s, A&T	$14,395.00
BNGBTSYS8160DC21	Same as above with RAM 21s, CSC	$16,395.00

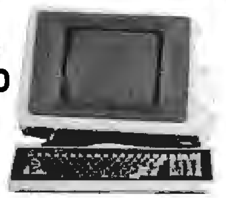
VISUAL 330 $1.00!!

With the purchase of any CompuPro System D

AN ADDITIONAL SAVINGS VALUE OF: $1049.00

VSL330GN Specifications in column at right

VISUAL 330 AND 300



SORRY TELEVIDEO, THIS IS THE NEW STANDARD

The microprocessor-based VISUAL 330 combines VISUAL ergonomic elegance with selectable emulations of the DEC VT52®, Data General D200, Lear Siegler ADM-3A, and Hazeltine 1500 terminals.

Specifications	VISUAL 330	VISUAL 300	TeleVideo 950
ANSI X3 64 Specified	NO	STD	NO
Solid State Keyboard	STD	STD	NO
Programmable Non-volatile Function Keys	STD	STD	NO
Video Attributes Require No Display Space	STD	STD	NO
Smooth Scroll, Slow Scroll and Jump Scroll	STD	STD	NO
Non Volatile Set-up Modes, "Menu" Style	STD	STD	NO
Block Graphics	STD	STD	NO
Sculptured Keycaps, Matted for Low Glare	STD	STD	NO
Programmable Non Volatile Columnar Tabbing	STD	STD	NO
Choice of Typomatic/Non-Typomatic Keyboard	STD	STD	NO
14" Screen	OPT	OPT	NO
N-Key Rollover	STD	STD	NO
CR New Line Mode	STD	STD	NO
Tilt and Swivel CRT	STD	STD	NO
User Programmable Non-Volatile Answerback, 32 Codes	STD	STD	NO
Screen Brightness Control from Keyboard	STD	STD	NO
XON/XOFF Flow Control, Split for Xmitter and Receiver	STD	STD	NO

		List Price	Our Price	2 or More
BNVSL330GN	Green Screen 12"	$1200.00	$1050.00	$ 995.00
BNVSL33014GN	Green Screen 14"	$1250.00	$1095.00	$1050.00

The VSL300 contains all of the same specifications as the 330 but with no multi-emulation capabilities. The VSL300 is ANSI X3.64 compatible

BNVSL300GN	Green Screen 12"	$1200.00	$1050.00	$ 995.00
BNVSL30014GN	Green Screen 14"	$1250.00	$1095.00	$1050.00

LOW COST DAISYWRITER 2000

WITH 40 CPS EFFECTIVE SPEED AND 48K BUFFER!

ONLY $1495.00!!

The SLMDW2000 may just be the best dollar value in a letter quality printer on the market today. Features include:

- Effective printing speed raised from 16cps to 40cps by the intelligent interface
- 48K buffer memory
- Daisyplot Graphics
- Printwheel cassettes available in 12 styles and 15 languages
- Standard IBM ribbon cartridges
- MTBF of 4000 hours at 25% duty cycle

This printer is DIP switch selectable for its personality protocols. This eliminates the need to replace a printer when the computer system is expanded, modified or adding additional printers that must be compatible with existing hardware and software. Included among the protocols that can be emulated are:

- NEC 5510 • DIABLO 630 • QUME Sprint 9
- IBM Personal Computer • ATARI (Centronics 737)

INTERFACES:

• RS232C and Current Loop • Centronics type parallel interface • IEEE/488 All are DIP switch selectable

SPECIAL FEATURES:

• Z80 CPU • 12K ROM • Standard 48K Buffer • 16 Software or hardware selectable baud rates 50 - 19.2K baud • Micro-coded alarm differentiates error conditions with pulse combinations • Intelligent bi-directional printing with logic seeking • Complete word processing features, standard • Complete self test • Autoreprint up to 255 times • Auto clear error - printer automatically resumes printing upon correction of ribbon, paper or cover open conditions • Proportional spacing • Supports Automatic justification • Complete Vector plotting routines • Sheet feeder mode - allows easy interface to most mechanical sheet feeders • Quite- 60db • Front panel forms control • Universal power supply 115/220V 50/60Hz

Part No.	Description	List Price	Our Price
BNSLMDW2000	Printer with 48K buffer	$1595.00	$1495.00
BNSLMDWVFT	Vertical Form Tractor		$ 125.00

Pre-configured cables are available. Please call for price and part number.

PRIORITY ONE ELECTRONICS

9161 DEERING AVE • CHATSWORTH, CA 91311

ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (213) 709-5111

Terms. U.S VISA, M.C. BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sale Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, please include your phone number. Prices subject to change without notice. We will do our best to maintain prices through February, 1983. Credit Card orders will be charged appropriate freight. If you haven't received your Winter '83 Engineering Selection Guide, send $1.00 for your copy today! Sale prices for prepaid orders only.

Circle 342 on inquiry card.

PRIORITY ONE ELECTRONICS

SIEMENS FDD100-8
8″ FLOPPY DISK DRIVE
SINGLE SIDED, DOUBLE DENSITY
SHUGART 801R COMPATIBLE

90 DAY WARRANTY!

ONCE AGAIN YOU RECEIVE THE BENEFIT OF OUR UNEQUALLED PURCHASING POWER!

1 $265.00
2-9 $249.00
10+ $225.00

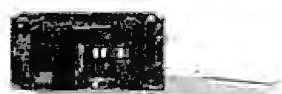
OEM INQUIRIES INVITED
(include $7.00 per drive for shipping)

ORDER NOW AND SAVE!

BNSIEFDD1008

S-100 DUAL 8″ SUBSYSTEM

BNCCS2422A	S-100 Disk Controller with CP/M 2.2	1	$399.00
BNSIEFD01008	Siemens Double Denisty 8″ drive	2	$498.00
BNIIIFDE002	Dual Horizontal Cabinet with Power Supply	1	$295.00
	and Data Cable	1	$ 35.00
			$1227.00



SAVE $232.00!!

$995.00
(Include $30.00 for shipping)

DON'T MISS OUT!

Order No.
BNPDBSIESUB1

OUR BEST DRIVES WITH THE BEST CABINET!!

MITSUBISHI ELECTRIC

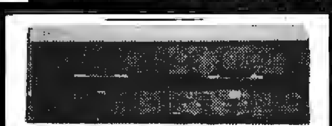
Better Than QUME! Better Than SHUGART!

8″ Double-sided, double-density, interchangeable with QUME & Shugart

BNMITM289483	Shipping Weight 16 lbs.	$450.00
BNMITM289483M	Manual	$ 10.00

2 or More: $435.00 each

INTERNATIONAL INSTRUMENTATION, INC.



DUAL 8″ FLOPPY DRIVE CABINET

- Positive Pressure Filter Cooling
- Power Supply 4A@+5V,3A@+24V 1A@-5V
- Each output is individually fused
- Hinged top for easy access
- Heavy non-flex .090 aluminum base
- Modular power connectors

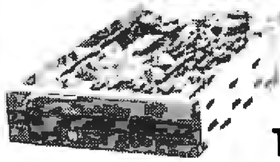
TWO MITSUDISHI 8″ DRIVES DOUBLE SIDED DOUBLE DENSITY AND CADINET TOGETHER!!!

$1150.00
BNPDBMITFDE

BNPDBMITFDEEM* Same as above with disk environment monitor $1230.00

DRIVES AND CABINET SHIPPED SEPARATELY

Tandon



8-INCH THIN LINE

Exactly one-half the height of any other model proprietary, high-resolution, read-write heads patented by Tandon
D.C. only operation - no A.C. required
Industry standard interface
Three millisecond track-to-track access time (9 lbs.)

BNTNDTM8481	Single Sided: $380.00	2 or more: $370.00 ea.	
BNTNDTM8482	Double Sided: $495.00	2 or more: $485.00 ea.	

TANDON 5¼″ DRIVES

BNTNDTM1001	Single Sided, 250KB (5 lbs.)	$220.00 ea.
	2 or More: $200.00 each	
BNTNDTM1002	Double Sided, 500KB	$295.00 ea.
	2 or More: $270.00 each	
BNTNDTM1003	Single Sided, 500KB	$295.00 ea.
	2 or More: $270.00 each	
BNTNDTM1004	Double Sided, 1000KB	$395.00 ea.
	2 or More: $375.00 each	

DUAL THIN LINE CABINET by JMR

- Fan cooled
- 24V @ 4 A/5A
- 5V @ 2A
- Scratch resistant, Baked Enamel Finish

		List Price	Our Price
BNJMRTLC	Cabinet & Power Supply *(Shipping Weight 12 lbs.)*	$200.00	$180.00

BUY THE CABINET AND DRIVES TOGETHER:

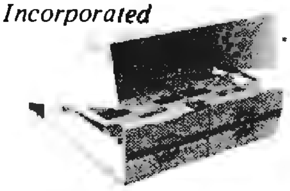
BNPDBJMRTND1	w/two TNDTM8481s *(30 lbs.)*	$920.00
BNPDBJMRTND2	w/two TNDTM8482s *(30 lbs.)*	$1150.00

Includes Power Cables

5¼″ DISK DRIVE CADINETS

BNJMR1C5	JMR Single 5¼″ Drive Cabinet (5V @ 1A, 12V @ 1.5A) Sh. Wt. 5 lbs.	$ 79.00
BNVIS9802	Vista Dual 5¼″ Drive Cabinet (+5V @ 2A, 12V@3A) Sh. Wt. 9 lbs.	$110.00

International Instrumentation Incorporated



- Positive Pressure Filter Cooling
- Power Supply:4A@+5V,3A@+24V 1A@-5V
- Each output is individually fused
- Hinged top for easy access
- Heavy non-flex .090 aluminum base
- Modular power connectors

BUY DRIVES AND CABINET TOGETHER AND $AVE!!
DUAL 8″ SIEMENS FD01008, DUAL 8″ CABINET POWER SUPPLY ANO INTERNAL POWER CABLES

IF BOUGHT SEPARATELY: $910.00

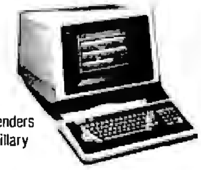
PRICED AT: $750.00
BNPOBIIISIE

ENVIRONMENT MONITOR PANEL

Temperature and voltage monitor with visual and audible alarm for overtemp condition. Direct Digital Readout of Internal temperature in C° on standard DVM

BNIIIFDE002	CABINET ONLY *(Sh. Wt. 38 lbs.)*	$295.00
BNPDBIIISIEEM	2-Drives, Cabinet & disk environment monitor	$775.00
BNIIIFDE002EM	Cabinet only with disk environment monitor	$375.00
BNPGC5DM18E18E	Dual Internal Data Cable	$31.15
BNPGC50S60S	External Data Cable	$19.77

VISUAL 50



- Low profile detached keyboard features sculptured keys with matte finish
- Screen tilts and swivels
- 80 x 24 display with 25th status line
- 7 x 9 dot matrix with full decenders
- RS-232 Serial interface w/auxillary RS-232 port
- 128 Character ASCII set and 31 character line drawing set

INTRODUCTORY OFFER!!

BNVSL50BW	Non-glare Black & White	List: $695.00	Our Price: $650.00
BNVSL50GN	P31 green display	List: $750.00	Our Price: $685.00

(Shipping Weight 37 lbs.)

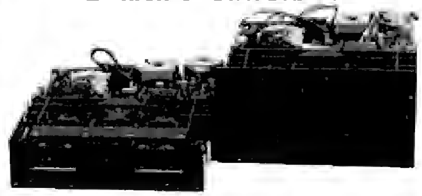
MPI NEW LOW PRICES!

5¼″ DISK DRIVES

BNMPI51*	Single-Sided Double-Density	48 TPI	$200.00
BNMPI52*	Double-Sided Double-Density	48 TPI	$270.00
BNMPI91*	Single-Sided Double Density	96 TPI	$275.00
BNMPI92*	Double-Sided Double-Density	96 TPI	$400.00

**Replace "*" when order, with "m" for MPI style bezel, or "S" for Shugart style bezel. (Shipping weight: 5 lbs.)*

2″ HIGH 8″ DISK DRIVES



The first 2″ high 8″ diskdrive allows for mounting under the keyboard on CRT, etc.
NO AC Required +5V +24VDC only
FAST 3 msec track to track!

BNMPI41M	½ High 1 side double-denisty	$380.00
BNMPI42M	½ High 2 side double-density	$460.00
BNMPI41S	Full height 1 side single drive, dble.-density	$380.00
BNMPI42S	Full height 2 sided single drive, dble.-density	$460.00
BNMPI41D	Full height 1 side dual drive, dble.-density	$760.00
BNMPI42D	Full height 2 sided dual drive, dble.-density	$920.00

(Shipping Weight: 11 lbs. per drive)

Circle 342 on inquiry card.

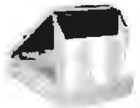
PRIORITY ONE ELECTRONICS

5" DISKETTES

SOFT SECTOR
40 TRACK SINGLE SIDED
DOUBLE DENSITY WITH
HUB REINFORCING RINGS

Package of 10: **$19.95**

BONUS!

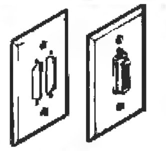


FREE!! KASSETTE 10 LIBRARY CASE WITH PACKAGE OF 10 DISKETTES
A $4.25 VALUE!! BNPRI5SDD *(Shipping Weight: 2 lbs.)*

BNPRI580 *package of 80. less Library Case* **$120.00**

EIA/RS232 WALL PLATES

(Does not include connectors)



BNIIIWPDB251 Single punched
4/$10.00

BNIIIWPDB252 Dual Punched
4/$12.00

RS-232 "D" SUB-MINIATURE CONNECTORS

		1-9	10-24	25-99	100-UP
BNCNDDB25P	25 Pin Male	$2.75	$2.50	$2.25	$1.95
BNCNDDB25S	25 Pin Female	$4.00	$3.50	$3.25	$3.00
BNCNDDB51212	1 Pc. Grey Hood	$1.65	$1.40	$1.25	$1.15
BNCNDP25H	2 Pc. Grey Hood	$1.50	$1.25	$1.10	$1.00
BNCNDDB51226	2 Pc. Black Hood	$1.75	$1.50	$1.35	$1.20
BNCNDD20418	Hardware set 2/Pr.	$1.00	$ .80	$ .70	$ .60

TEXAS INSTRUMENTS
16 PIN GOLD AND TIN DIP SOLDERTAIL SOCKETS

QTY	TIN BNTIS16LP	GOLD BNTIG16LP
50	$ 8.00	$ 10.00
1000	$ 60.00	$ 80.00
4500	$225.00	$315.00

COMPLETE CompuPro SYSTEMS
FREE SUPERCALC-86! FREE dBASEII!!
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SYSTEM 816/A
ENTRY LEVEL SINGLE-USER SYSTEM

System **816/A** is an excellent choice for an entry level, single user system that's designed with future expansion in mind. **816/A** includes Interfacer 4 (three serial I/O ports, parallel port, and Centronics/Epson-style port), two RAM 17s for 128K of fast, static memory, and System Support 1 (clock calendar, RAM/ROM/match processor options, RS-232C serial port, interrupt controllers, interval timers, and more), and Ashton-Tate's dBase Junior™, an upgradeable subset of their popular dBase II data base management software. This combination of components means superb computing today with an option for future expansion — all the way up to a multi-user system. System **816/A** is priced at $5495.00, a savings of over $1000.00 compared to all components purchased separately.

BNGBTSYS816ADA	Single User System Desk Top, A&T	$5495.00
BNGBTSYS816ADC	Single User System Desk Top, 200 hr. Burn-in	$6345.00
BNTLV910	TeleVideo 910 Black & White w/purchase of above system	$1.00

1200 BAUD AUTO-DIAL
HAYES SMARTMODEM COMPATIBLE
U.S. ROBOTICS MODEMS
$495.00

The **AUTO DIAL 212A** Modem is a direct connect 0-300 or 1200 baud modem capable of dialing and calling for you. **The AUTO DIAL 212A is compatible in function to the DC Hayes SMARTMODEM™.**

Part No.	Description	List	SALE Price
BNUSRADIAL212A	0-300, 1200 baud dialing modem	$599.00	$495.00

ACOUSTIC MODEM

The **PHONE LINK** Modem is a 300 baud RS232 compatible acoustic modem capable of operating as either an answer or originate modem. It is BELL 103/113 compatible and will accept most standard phone handsets.

BNUSRPLNK	0-300 Baud acoustic modem	$149.00	$129.00

MICRO LINK DIRECT CONNECT MODEMS

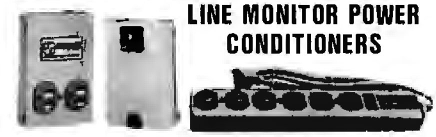
BNUSRMLNK300	0-300 baud direct connect	$179.00	$159.00
BNUSRMLNK1200	1200 baud direct connect	$449.00	$399.00

AUTO LINK DIRECT CONNECT AUTO ANSWER MODEMS

BNUSRALNK300	0-300 baud auto/direct connect	$219.00	$195.00
BNUSRALNK1200	1200 baud auto/direct connect	$499.00	$449.00
BNUSRALNK212A	0-300, 1200 baud auto/direct	$549.00	$475.00

Specs	USRADIAL212A	USRALNK212A	USRALNK1200	USRMLNK1200	USRALNK300	USRMLNK300	USRPLNK
1200 Baud	X	X	X	X			
0-300 Baud	X	X			X	X	X
Auto Dial (Hayes Smartmodem compatible)	X						
Auto Answer	X	X	X		X		
Auto Mode Select	X				X	X	
DTR Override	X	X	X	X	X	X	
RS232 pins 2&3 reversible	X	X	X	X	X	X	
LED Indicators:	X	X	X	X	X	X	X
Carrier Detect	X	X	X	X	X	X	X
Analog Loopback/ Self Test	X	X	X	X	X	X	X
Send Data	X	X	X	X	X	X	X
Receive Data	X	X	X	X	X	X	X
Terminal Ready	X	X	X		X		
Off Hook	X	X	X		X		
Answer Mode	X	X	X		X		
Ring Indicate			X		X		
High Speed	X	X					

DATAGARD™ SGL WABER
LINE MONITOR POWER CONDITIONERS



Before you plug in your computer, you'd better consider how you are going to insure or protect your investment from unwanted electrical pollution.

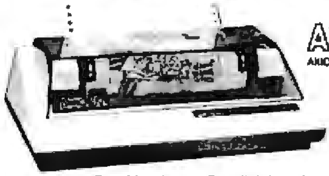
DG115 SERIES
SINGLE STAGE SPIKE PROTECTION

Part No.	Description	Wt.	List	SALE
BNWBRDG115P	Wall unit plug in	2 lbs.	$49.95	$34.95
BNWBRDG115S	6 outlet strip w/SW&LT	3 lbs.	$61.95	$42.00

DG315 SERIES
3 STAGE SPIKE FILTER AND FOUR STAGE NOISE FILTER

BNWBRDG315P	Wall unit plug in	2 lbs.	$153.95	$ 99.95
BNWBRDG315S	6 outlet strip w/SW&LT	3 lbs.	$193.95	$119.95
BNWBRDG315R	6 outlet rack sw/SW&LT	8 lbs.	$193.00	$119.95

LOWEST COST PRINTER AVAILABLE
$229.00
THIS IS NOT A TYPOGRAPHICAL ERROR!



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AXIOM CORPORATION

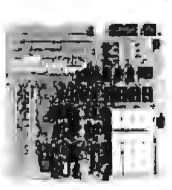
For More Details, See Page 215 of the January Issue of BYTE.

● 5 x 7 Dot Matrix ● Parallel Interface (Centronics) ● Tractor Feed ● Dot Addressable Graphics ● Up to 3-Part Paper ● Self Test ● One Year Warranty ● 30 CPS 80 Column Unidirectional ● Uses Regular Paper

BNAXMGP100A (Shipping Weight 11 lbs.)

List Price: $389.00 **$229.00**

QT COMPUTER SYSTEMS INC.



Z-80 BEGINNER KIT
Z80 CPU - 2 S-100 EXPANSION SLOTS

- Z80 CPU
- 2 S-100 slots for expansion
- Wire wrap area for custom circuitry
- On board keyboard and display
- Cassette interface for mass storage
- 2K RAM included
- 4K ROM (not included)
- RS232 port 300-19.2K baud
- Comes with ZBUG Monitor on ROM with SID driver routines
- TINY BASIC available

BNQTCZ80BEGA
LIST PRICE: $400.00
SALE PRICE:
$340.00
(Shipping weight 4 lbs)

TINY BASIC ROM:
BNQTCTBASIC $25.00

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Unclassified Ads

FOR SALE: Sinclair ZX81 computer complete with 16K memory module and Financial Program package, used for only one week. $110. Joe Bryan, 1607 Limestone Court, Montgomery, AL 36117, (205) 272-0754.

FOR SALE: IBM Selectric terminal from the IBM Saber system converted to an uppercase and lowercase printer. $200 buys printer, interface and driver for H-8, driver listing, and schematics needed to interface to other microcomputers. Tom Golway, (212) 735-2935, Monday through Friday between 9:30 a.m.–4:30 p.m.

FOR SALE: Heathkit H-14 printer with 40, 80, 96, and 132 columns. Selectable bps rate 110, 9600. Letter quality. RS-232C interface: $290. Jim Brooks, 3343 Grand River Dr., Grand Rapids, MI 49505, (616) 363-2660.

WANTED: Hardware information, service manuals, circuit diagrams, etc., for aging Wang 2200B computer; any or all peripherals and any information concerning add-on ROMs. Am also interested in reasonably priced peripherals for same. Will gladly pay for photocopies, etc., but please contact me first to avoid duplication. Phil Sutherland, POB 177, Nedlands, Western Australia 6009, or phone international + 61 9 386 4859 during office hours here (0100 to 0900 GMT).

FOR SALE: North Star floating-point board. Unused, due to incompatibility with FORTRAN compiler. Lists at $399, will sell for $250 or best offer. Mike Modest, 12651 Windward Ave., Los Angeles, CA 90066, (213) 397-4836.

WANTED: Your help bringing microcomputing awareness to rural Minnesotans. East Central Regional Library (ECRL) Computer Fund raises funds to place microcomputers and educational software in rural libraries for use by general public free of charge. Send tax-deductible contributions to ECRL Computer Fund, Attn: D. L. Deye MD, Cambridge Clinic, 626 South West 7th Ave., Cambridge, MN 55008.

FOR SALE: Apple Silentype thermal printer with interface card and connecting cable. Driven by little old lady to church on Sundays. Excellent condition. Free with purchase: one well-used but interpretable manual. Asking $425 US funds. Response guaranteed. Erik Sea, 22 Edgar Dr., London, Ontario, N6G 1K1 Canada.

FOR SALE: 54 disks of games! Complete personal collection of over 1,000 arcade, adventure, educational, space, etc. Will sell only as a unit for $850. One of a kind. E. Abrams, 6400 Hayes St., Hollywood, FL 33024, (305) 987-6889.

FOR SALE: New TRS-80 Model III with 48K, two disk drives, serial port, Scripsit Word Processor and parallel cable; best offer. Spectrum Soft Sector 5¼-inch floppy disks, excellent quality; they will work in Apple, TRS-80, and many others: $2.50 each plus sufficient first-class postage. J. Browning, 3616 Crest SE, Albuquerque, NM 87108.

WANTED: Apple II with 16K of memory or Osborne I personal computer in exchange for full tax write-off. A professional, fully registered, nonprofit theatre needs a small business computer for budget planning and control needs. Word processing and printing capabilities are not essential. Your donation is tax-deductible. David Lemos, Producing Director, San Jose Repertory Company, POB 9584, San Jose, CA 95157, (408) 294-7572.

ATARI USERS: I am currently interested in hearing from other Atari users around the states to start a users group and put out a newsletter. If you have anything to contribute to the first issue please send it to me. I am also looking for software to trade. John Conley, 11 Sunnyside Rd., Scotia, NY 12302.

FOR SALE: Attention homebrewers! I am selling many ICs and other components. Most of these ICs are memory, LSI interface, and many 7400 TTL, also some 4000 CMOS. All at low prices and guaranteed. Most are new and unused. Send SASE for a list and prices. Kevin Lovelace, 5500 Sonora Dr., North Little Rock, AR 72118.

FOR SALE: Eaton LRC 7000+ printer with manual, three new ribbons, and cable. Excellent condition. $150. John C. Daoust, 1103A East 23rd St., Texarkana, AR 75502, (501) 774-1340 after 5 p.m.

FOR SALE: Lobo Model 1850 hard disk for Apple II Plus computer. Includes in one package: 10-megabyte fixed 8-inch disk, 1.2-megabyte 8-inch floppy disk, power supply, and controller card. Brand-new condition, 6 months remaining on factory warranty: $3000. Ray Krauss, 3478 East Jamison Ave., Littleton, CO 80122, (303) 694-1931.

FOR TRADE: Software for Timex and/or Sinclair computers with 16K RAM. I have a collection of games and utilities which I would be interested in swapping for programs of equal value. They are available on cassette or in listing form. Chris Collins, 485 Willowtree Dr., Melbourne, FL 32935.

WANTED: Manual for TDL/Xitan text editor. Will pay cost of duplicating. Lloyd Larson, 38236 Sheridan Rd., Waukegan, IL 60087, (312) 244-4943, evenings; 882-3777, days.

FOR SALE: DEC M8059-KF 128K-word (16 bit with parity) memory card for Q-bus (LSI-11). Brand new in original box; manufactured April 1982. DEC list price: $2834 with 12-month delivery. Uses Hitachi 4164s. Asking $2000, price negotiable. Michael Blyler, Georgia Tech Box 32380, Atlanta, GA 30332, (404) 874-4987.

FOR SALE: New multi-user North Star Horizon with 256K bytes of memory, 18-megabyte hard disk, one quad drive, one HSIO board, and processor. Reasonably priced below wholesale. Drop a card with quote and I will call you. A. I., 74 Lincoln St., Jersey City, NJ 07307, (201) 659-0836.

FOR SALE: Exidy Sorcerer 32K, 8K BASIC pak, several games, computer instruction book, and BASIC instruction book: $550 or best offer. Development pak: $60. 64K Netronics memory board without memory (4116): $100. Heathkit ET-3400 trainer and course: $195. Would consider trade on any of the above for 8-inch disk drives or CP/M software. Nelson Lewis, 1005 Don Rovin Ln., Farmington, NM 87401, (505) 325-5426 evenings.

WANTED: CP/M software. Well-established nonprofit corporation seeks tax-deductible contributions of new and used CP/M software. Will furnish certified receipts. Philadelphia Festival Chorus, Suite 4310, 1500 Locust St., Philadelphia, PA 19102.

FOR SALE: Ball transistor-transistor logic 12-inch black-and-white monitors, little use, ready to plug into Osborne 1. Money back if not fully satisfied: $125 ($130 with manual and schematic) plus UPS shipping charges. Also, I want a biorhythm program on 5¼-inch floppy disk for CP/M operating system. Lew Yeager, 728 Seventh St., Marietta OH 45750, (614) 373-6501.

FOR SALE: Heath H-89 with single 5¼-inch floppy disk and H-14 printer: best offer. Xerox dual 8-inch single-sided disk drives, new: $1395. Sencore CB-42 analyst: best offer. Sams CB-1 through CB-125: best offer. Heathkit SB-300 and SB-401 complete with manuals: best offer. Stan Stevens, RR4 Box 26, Iowa City, IA 52240, (319) 354-9726.

WANTED: Collecting Apple II Plus one-line programs (up to five-liners) including utilities, graphic/sound routines, or illustrations of useful addresses in the Apple. If you wish a listing in return, please send a SASE with your one-liner or include a dollar (without a one-liner) to cover printing costs. James A. Sullivan, 2309 Glenn Court, Charlottesville, VA 22901.

FOR SALE: Two teletype Model 43 keyboard/printer, dot-matrix terminals, 30 cps RS-232C in mint condition, $450 each. Also, Millenium universal in-circuit emulator with 6800 personality card, $1500 (originally $7000). Ralph Guditz, 1951 Colony St., Mountain View, CA 94043, (415) 960-3462 after 10 p.m. PT.

WANTED: TRS-80 Model I/III—compatible software to swap. I have a large library of programs to trade for anything ranging from utilities to arcade games. Send a list of your programs or a cassette or disk of your better programs and I will promptly return the same. Ron Katcher, 13843 North 51st St., Scottsdale, AZ 85254, (602) 996-5454.

FOR SALE: Ohio Scientific C4P Series 2; 8K RAM and 8K ROM; color graphics. Includes full schematics and instruction manuals. Used less than 500 hours. Paid $1600 for computer and Amdek color monitor. $1250 firm. I will pay shipping. Orpheus Allison, POB 387, Mapleton, ME 04757.

FOR SALE: 48K Apple II Plus computer with radio-frequency modulator and tape recorder. Lots of software plus all manuals and demonstration programs: $900. Geoff Emerson, 3 Spaulding Court, Saugerties, NY 12477, (914) 246-9770.

FOR SALE: OSI C1P with 8K RAM, 32/64 video modification, new ROMs, RS-232C port, dual joysticks, and sound port. Good condition: $375 or best offer. Also, Micro Communication Corp. digital tape drive and nine 50-foot tapes (similar to Exatron Stringy/Floppy), barely touched: $125. Send SASE. Michael McInerny, 75 Coachman Dr., Penfield, NY 14526.

FOR SALE: Cromemco Z-2 with dual 8-inch floppy disks, 128K bytes of memory, digital-to-analog and TV Dazzler boards, two joysticks, SOROC IQ 120 terminal, and GE Terminet 300 printer. Software: FORTRAN, assembly, Database, Word Processing, BASIC, Dazzler games and graphics, LISP, and Ratfor. Originally $8000, asking $3600. P. Baum, 11410 Lombardy Lane, Sunnymead, CA 92388.

WANTED: Broken or unwanted computers, printers, and other peripherals. I am a high school student, but will pay for shipping and handling. Greg Ham, 4048 Southwest 8th St., Plantation, FL 33317, (305) 792-4204.

FOR TRADE: One or more new Xerox 820 computer systems with dual 8-inch disk drives (retail $3900 each) and/or one or more Xerox #400 Telecopiers (retail $1695 each). We need three letter-quality printers of 40 cps or better; also a Televideo display and keyboard; and/or a hard-disk system to link with our Altos 8000 processor. Call if you are interested in bartering! Mary Lombardi, 547 Mission Vineyard Rd., San Juan Bautista, CA 95045, (408) 623-4576.

FOR SALE: PET 2001 with 24K bytes of memory (8K plus 16K expansion). Can insert additional 16K in memory-expansion board. Commodore 2040 dual-disk drive. One built-in cassette drive and added full-sized keyboard. All manuals included: $975. Neil Omvedt, 3036 Asbury St., Roseville, MN 55113, (612) 633-5743.

FOR SALE: Apple III including black-and-white monitor and additional disk drive. Also, Pascal, Visicalc, and Business BASIC software packages. Less than one year old and in perfect condition. $4000. R. Michael Tague, 200 Don Allen Rd., Louisville, KY 40207, (502) 895-4508.

WANTED: User manual, schematics, etc., for Compu/Time CT-100-1 calculator and digital clock S-100 board. I will pay reasonable reproduction and mailing costs. Jim Wolfe, POB 6601, Torrance, CA 90504, (213) 376-2931.

FOR SALE: NEC 12-inch monitor and Microsoft 16K RAM card, unused, new: $100 each or best offer. A. Morton, 1340 Laffer Ave., Akron, OH 44305, (216) 784-9697.

UNCLASSIFIED POLICY: Readers who have computer equipment to buy, sell, or trade or who are requesting or giving advice may send a notice to BYTE for inclusion in the Unclassified Ads section. To be considered for publication, an advertisement must be noncommercial (individuals or bona fide computer clubs only), typed double-spaced on plain white paper, contain 75 words or fewer, and include complete name and address. This service is free of charge; notices are printed once only as space permits. Your confirmation of placement is appearance in an issue of BYTE as we engage in no correspondence. Please allow at least three months for your ad to appear. Send your notices to Unclassified Ads, BYTE/McGraw-Hill, POB 372, Hancock, NH 03449.

Unclassified Ads

FOR SALE: Ohio Scientific Challenger 4P color computer. Excellent condition with Quasar solid-state black-and-white converted TV/monitor and cassette recorder. Includes all manuals and OSI home-taped programs: $550 or best offer. Barry Sitek, 140 Morningside Ave., Park Ridge, NJ 07656, (201) 391-6015.

ADVICE NEEDED: I have an 8085-based homebrew and I would like to implement a BASIC interpreter. I will buy or swap parts or ideas. I have many homebrew microcomputer circuits. B. Shaffe, 98 Onieda Ave., Centereach, NY 11720.

FOR SALE: TRS-80 ModelIII 48K with disk drive: $1550, only 4 months old. Leave a message and I will call back. Robert Linza, (713) 332-7480.

FOR SALE: 3-year-old TRS-80 with four disk drives, high-speed daisy-wheel printer with optional tractorfeed, RS-232C, uppercase and lowercase adapter, data separator, 64K Omikron Mapper with CP/M. Excellent condition. Software includes Scripsit, Script, Chextext, NEWDOS, NEWDOS-80, TRSDOS, CP/M-22, C-BASIC, MBASIC-80, Wordstar, BASIC Compiler, TDAM, Sort-Merge, AIDS III, and much more. New cost was $11,000 asking $4675. Tom Hamilton, 1998 Collingswood Rd., Columbus, OH 43221, (614) 488-7771.

FOR SALE: S-100 boards in working condition: 16K North Star RAM for $225, 16K Memory Merchant static RAM for $150, 16K CCS Model 2116C static RAM for $225, Morrow Switchboard for $200, SSM 104-2 parallel, 2 serial I/O for $225. R. E. Clark, 712 South Ninth, Memphis, TX 79245, (806) 259-2232 after 8 p.m.

WANTED: Wang 2200 SVP-BB, MB DSDD disk, two M8 fixed disks, 2236 DE interactive terminal, and 2235 matrix printer. Joe Showers, 1315 North Union St., Wilmington, DE 19806, (302) 655-6224, collect during day.

WANTED: Used S-100 computer for college student. I will accept any excess you have: drives, mainframe, memory, etc. I will send my 5-year-old stamp collection as a donation toward a running disk system. Call before sending. Tom Knox, POB 111305, Nashville, TN 37211, (615) 333-3627 after 5 p.m.

FOR SALE: Two 5¼-inch Shugart Model SA400 disk drives together in case with power supply; includes cables, manual, and dustcover: $360. Also, one SEA-16 16K-byte memory board for KIM, SYM, AIM, or any KIM-4 bus machine: $100. Both in mint condition. Tim J. Ingham, 2540 College Ave. #302, Berkeley, CA 94704, (415) 548-5370.

WANTED: Any learning information appreciated as I have access to a Hewlett-Packard 2647A and a SWT 6800 System with flex. Trying to learn while in prison. Stafford B. Bright, POB AE-1146, San Luis Obispo, CA 93409.

FOR SALE: KIM system: KIM-1: $80, RCA keyboard: $50, TVT-6 video board: $25, TRS-80 video monitor: $40, Econoram II-A 8K RAM: $80, Trendcom 100 printer with Apple interface: $225. Complete computer system up and running, with all technical manuals, Tiny BASIC, assembler, and much additional software: $400. Will sell all or part. Joel Aycock, POB 209, Kula, HI 96790, (808) 244-9108 (work).

WANTED: Used, working S-100 or multibus mainframe with motherboard and power supply, with or without cards. Also need wire-wrap boards for the above. David Langmann, 2900 Connecticut Ave. NW, Washington, DC 20008.

FOR SALE: Teletype Model 43 KSR, sprocket feed, with (internal) 16K-byte Edge Technology Inc. Telebuffer-43 ASR. Excellent condition: $1300. F. T. Grover, 8201 Hamilton Spring Court, Bethesda, MD 20817, (301) 365-0969.

FOR SALE: Word processor: Addressograph 425 with full-page 54-by-80 green monitor; letter-perfect Oume daisy-wheel printer and tractorfeed; dual 8-inch drive. Complete with mail merge, sort, select and arithmetic options, 150 floppy disks, and manual. Excellent condition. New $9000, will sacrifice for $4200. Soaring Bear, 2509 North Campbell, Tucson, AZ 85719, (602) 432-3081.

FOR SALE: Complete set of BYTE magazines. Over 80 issues from premier 1975 issue to latest issue (August 1976 missing). $210 postpaid. Greg Aharonian, 307 Willow Ave., Ithaca, NY 14850, (607) 256-4940.

WANTED: Graduate student wishes to correspond with anyone interested in cognitive sciences. Looking for exchange of techniques, ideas, and opinions on topics such as artificial intelligence, languages (LISP, Logo, Planner, etc.), and psychology. I have background in psychology and programming. Conrad Sanford, 135 State St. 768-360, Auburn, NY 13021.

FOR TRADE: Apple owners! Send me a list of your software programs and I will send you mine. I am especially interested in recreational software. Please include a SASE. T. I. Chienroi, POB 855, Islington, MA 02090.

FOR SALE: Hewlett-Packard HP 41-C calculator, card reader, four memory modules, math and stat modules, and several application books: $425. Dr. Alan Grant, 530 44th St., Brooklyn, NY 11220, (212) 436-1714.

FOR SALE: Software for the Apple II Plus. The Comptroller, General Business System, A/R, A/P, and G/L. Nate Brown, (717) 822-6184.

FOR SALE: Exidy Sorcerer 32K-byte computer with BASIC ROM cartridge. Excellent condition, in original carton, with manuals, schematics, and two years of newsletter issues: $590. Multibus interface for above, makes it Multibus Master: $80 with cable. Intel 8086 University Kit, all the Integrated Circuits required to build an 8086 system (includes monitor in ROM), unused: $90. Robot parts: two Slo-Syn 5.5V, 3.25-inch diameter, 50-ounce-inch torque steppermotors and platform for the above made of ⅛-inch machined aluminum: $95. Bill Georgiou, 6661 Berkshire Terrace #31, Goleta, CA 93117.

FOR SALE: Back issues of BYTE. August 1977 to December 1980. David Yost, 13329 Pearl Rd., Strongsville, OH 44136, (216) 238-0644 after noon.

BOMB

BYTE's Ongoing Monitor Box

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19	458	A Terminal Program for the TRS-80 Model III	James

MPX a Winner

Readers of the November BYTE voted overwhelmingly for Steve Ciarcia's "Build the Circuit Cellar MPX-16 Computer System, Part 1." Ciarcia will receive the $100 first-place award for his project on designing an 8088-based system than can run any peripheral device designed to be installed in the IBM Personal Computer. Second place goes to Peter Sørensen for "Tronic Imagery," in which he described the development of the computer-generated graphics in the movie Tron. He will receive $50. Third place goes to Jerry Pournelle for his User's Column "Terminals, Keyboards, and How Software Piracy Will Bring Profits to Its Victims."

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