WORLD'S LARGEST COMPUTER MAGAZINE

Computers & ELECTRONICS

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Bring Mainframe Data to Your Micro

risons of Pointing Devices

s: Leading Edge PC & TRS80

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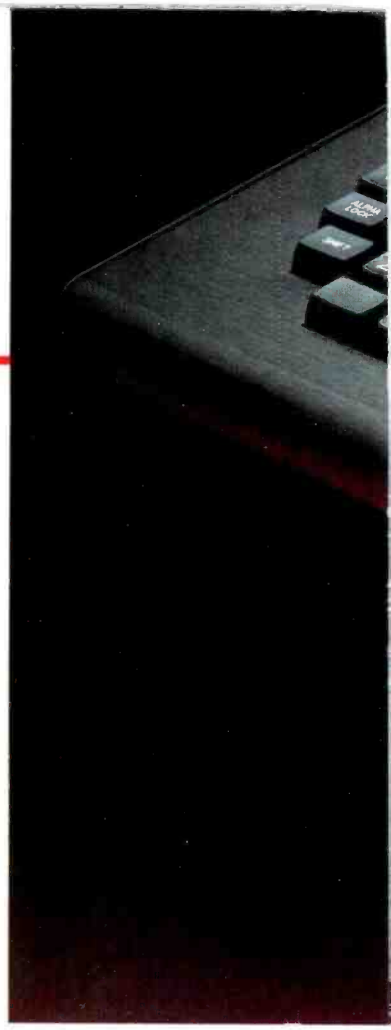
Introducing the MTX512

A World Apart from the Ordinary.



It begins with the sense of touch.

With the sleek black metal housing. Cool to the touch. Cool to the advanced circuitry and components contained within.

And the solid feel of people-sized keys set up in a field that gives you room to work and space in which to think.

But the difference only begins with what you see and feel. Where it ends...well, that's really up to you.

In a very practical sense, the only limits you'll experience with the MTX512 are those you choose to accept.

64K To 512K RAM – A Look On The Inside

Take a close look at the MTX512.

We could tell you it offers the greatest performance and versatility of any micro in its price range, but we think you're smart enough to draw your own conclusions.

The design is elegant in its simplicity. Remarkable for the power and complexity it represents. 64K RAM built in, with total expansion to 512K. And that doesn't include 16K of video RAM controlled by its own processor.

Speaking of video, keep in mind this is no ordinary monochromatic, single screen system. The MTX starts off where other micros end up. Delivering vivid screen capabilities with 256 x 192 pixels that crisply define interference-free high resolution graphics. 16 brilliant colors that can be displayed simultaneously. In a format powered by 32 easily movable, user-defined graphics characters. Graphics capabilities you'd find impressive in a system that gives you a single screen to work in. With the MTX, you have eight.

Yes, eight.

Eight definable windows to operate independently or in tandem. And still maintain full screen capabilities. Thus, you can manipulate spread sheets on the MTX and see the impact of changing variables in graphics at the same time. Eight separate windows on the world. We call them Virtual Screens. You'll call them extraordinary.

Far from ordinary as well are the built-in system outputs that come standard on the MTX. The Centronics parallel printer port. The two industry-standard joystick ports. The uncommitted parallel I/O port. The Cassette port with 2400 baud. Separate TV and Video Monitor Ports. The 4-channel sound hifi output. We've even installed a ROM cartridge port for word processing and other dedicated programs.

Interactive Languages And Routines – A Look At The Way All Micros Will One Day Perform

Forget the way all other micros perform. This is the way they should.

Interactively.

With the MTX, you can create and manipulate programs using four different languages in dynamic interaction, all coordinated through the FRONT PANEL DISPLAY. Interweaving elements as you would in creating a symphony.

And take a serious look at the languages housed in the MTX's 24K ROM. MTX BASIC, a more powerful form of BASIC that allows you to use all standard BASIC programs. MTX GRAPHICS, with straight forward commands, eliminates the tedium and difficulty of creating complex graphics programs. NODDY, an 11-command "easy learn" language that can transform real world programming into a child-friendly activity. And MTX ASSEMBLER, which enables sophisticated programming in assembly language. Something else the advanced programmer will appreciate is our ASSEMBLER/DISASSEMBLER, tied to BASIC, which provides unprecedented display and keyboard access to Z80 CPU storage locations, memory and program.

If you're hungry for more, PASCAL and FORTH are also available as add-on ROM packs.

On the keyboard side of things, you'll find a number of operator-oriented features that speed up and ease up the operation of the MTX. The separate numeric pad with quadri-directional cursor control and full editing functions. The eight dual function keys.

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The auto repeat function on all alpha-numeric keys. Add to this such programmer-saving features as the use of abbreviated BASIC commands, a built-in syntax verifier, automatic cursor-honing to errors, auto-line numbering and automatic scrolling, and you begin to see the MTX not only opens a lot of doors that other micros leave closed, but speeds you through them as well.

The 160 Megabyte Connection – A Look At The System

To build a good system, quality must be designed in at every level.

We designed the MTX and its complete line of system peripherals using proven, standard components. Striking a strategic balance between power, versatility and dependability. Our Z80A processor, running at 4MHz, gave us the high performance characteristics we were striving for, plus the ability to expand into the MTX Hard Disc, MTX Silicon and Floppy Disc CP/M operated systems. Systems that could provide up to 160 megabyte storage capacity. More power than you'll probably ever need, unless you take full advantage of the MTX's impressive system capabilities.

Systems hookup is as simple as every other MTX procedure. By merely plugging in the twin RS232C Serial interfaces and the Node software, sold optionally, you're ready to create a disc-driven interactive communications network (OXFORD RING®) that can link up to 255 units.

Software? You'll never worry about software availability with the MTX. Dozens of MTX-dedicated programs have already been created, supplementing the vast landscape of CP/M applications software currently available. And advance word of the MTX's technical capabilities has precipitated an MTX software "push" on the part of many leading software manufacturers.

Word Processing For $999 – A Look At A Great Deal

Look first at the capabilities, then at the price.

This is word processing the way it should be. Quick. Easy. Professional. A package that includes the MTX512; the powerful New Word,™ word processing ROM cartridge; and the Memotech DMX80 correspondence quality printer.* An exceptional value!

And that brings us to the bottom line.

A Look At The Price

There's a very simple equation that covers the pricing of the MTX512.

The more engineering you put in a system, the less it will cost to produce. As you've already seen, the MTX is a pure product of advanced, innovative engineering.

Which is why we can sell it for $595.**

And why we can confidently back it up with a full one-year warranty.

Make no mistake. When you turn this page, you'll be returning to a world very different from this one.

A world in which all microcomputers will suddenly seem very different.

Suddenly very ordinary.

For more information about the MTX512, or to find out the location of the MTX dealer nearest you, contact Memotech Corporation, 99 Cabot Street, Needham, MA 02194; or phone (617) 449-6614

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With IBM, on the other hand, you get charged extra for everything. Even for the PC DOS disk that makes it run (an extra $40)... and $170 just for the time of day (a calendar/clock that's standard with Leading Edge). In short, the basic package comes to you as a very expensive paperweight.

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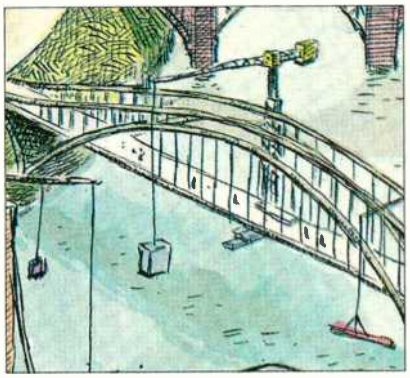

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IBM PC Software: the value of choosing

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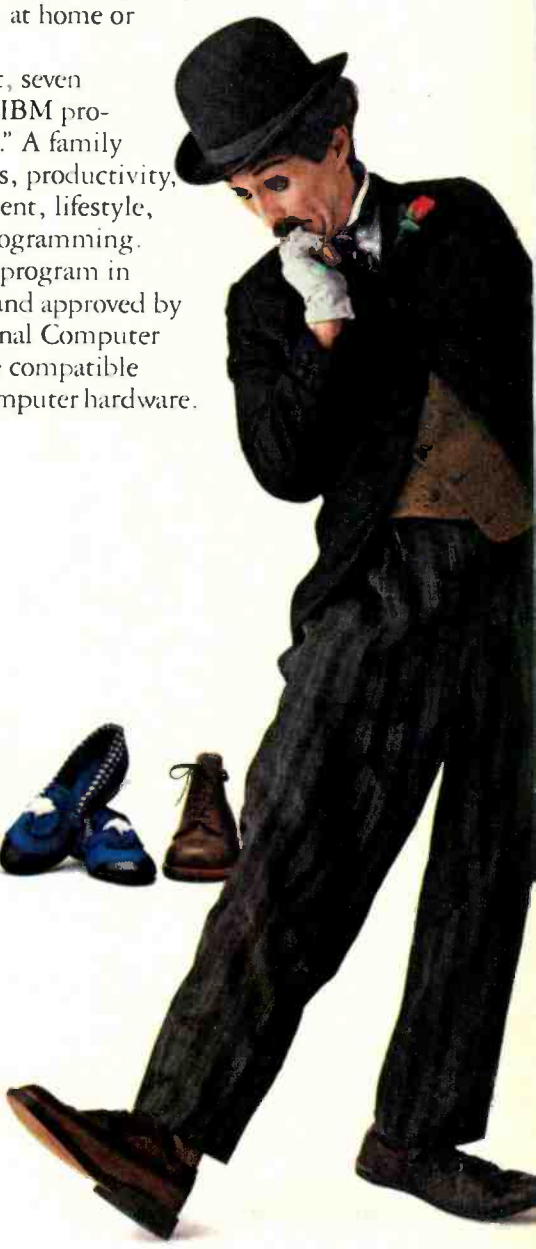

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programs that fit.

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LETTERS

Kudos for Mims

I seldom write fan mail to authors but, since I have been a fan of Forrest Mims's from the time I read his first Radio Shack books, I wanted to let you know how valuable his work has been and how we are planning to use the pressure sensitive resistors discussed in the "Project of the Month" of November 1982.

I work in an institution for severely mentally retarded/physically handicapped people, many of whom spend their days in wheelchairs. Because of the lack of sensation in the lower parts of their bodies, they don't shift their weight when tissues begin to break down and therefore develop complications similar to bed sores.

Since many of the clients have various hip and spine deformities, the high-pressure areas when they sit are not always predictable. When we design cushions or wheelchair seats, it would help to have this information.

So we are working on a cushion made of approximately 260 small foam potentiometers. Using the comparator circuit in your article and some sort of monitoring device (a computer with video display or LEDs), we hope to get a visual presentation of the high-pressure areas on the client's body and of the movement patterns and how they affect weight distribution.

—SCOTT A. ALLNER
New York, NY

Hey, Doc, Which Way Did the Glitch Go?

While working with my computer and a black-and-white monitor, I happened to be munching on a raw carrot. Suddenly, I noticed a faint glitch on the screen. Each time I took a bite of the carrot, another glitch was produced. Thinking the transient was due to mechanical vibration in the TV, I tried simulating the noise, but nothing happened. Checking for static charges, I stuck the probes of a FET VOM into the carrot and got 85 millivots. Over a period time, the polarity of this voltage changed from negative to positive. By inserting copper and zinc electrodes into the carrot, I measured 850 mV and this remained constant overnight. The output current measured about 50 microamperes. Several checks were made to determine whether the transient voltage was reaching the TV directly or through the computer. All indications point to the computer. The glitch is not serious but quite puzzling. I plan to plant carrots this spring, wire them in series/parallel and use them as an alternate source of low-voltage energy for IC experiments.

—R. N. MUFFLY
Wenatchee, WA

Have you tried celery?—Ed.

Strong Functionoid

Thanks for your mention of our functionoid in your March "Bits & Bytes." Your readers might be interested to know that, while it has been designed for possible military applications to spare humans the dangers of the battlefield; it has commercial, industrial, and business applications as well. For the record, it can lift 2000 lb—not the maximum 100 noted in your write-up.

—LES GOLDBERG
Odetics Inc.
Anaheim, CA

Electronic Mail

As noted in your article "From One Computer to Another" (March 1984), the electronic mail marketplace is undergoing tremendous change, with a variety of players vying for their respective shares of the market. Western Union, with its Easylink electronic mail, is one of the key players in the game. (This is in addition to Telex, Infocom, and Teletex.) There are approximately 35,000 Easylink users in the U.S. By means of a wide variety of personal computers, communicating word processors, and intelligent terminals on Western Union's network, these users can communicate with one another via the public telephone system.

—GUY B. PIERCE
Western Union Corp.
Upper Saddle River, NJ

Kaypro Hardware

In your review of the Kaypro 4 Plus 88 computer (March 1984), it was stated that plug-in expansion slots are not available. This is true but the following hardware can be used with piggy-back expansion methods: 16-bit 8088/8087 coprocessor conversion kit; external drives C & D add-on, 5-MHz CPU hop up kit; real-time clock kit; built-in 300-1200 modem; 800K disk drive upgrade; 1M semiconductor disk (RAMdisk); 8" DS/DD disk drives; 640 × 250 pixel bit-mapped graphics; and external video monitor and hard disk drives.

—MELVIN F. PEZOK
Novato, CA

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MBC 1250

MBC 1150

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Bit/Ram	8/64K	8/64K	16/128K-256K
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Operating System	CP/M80	CP/M80	CP/M86
CPU	Z80A	Z80A (Two)	8086&MS-DOS
Parallel Port	STANDARD	STANDARD	STANDARD
Serial Port	STANDARD	STANDARD	STANDARD
15 Function Keys	STANDARD	STANDARD	STANDARD
12 Inch Screen	STANDARD	STANDARD	STANDARD
Detachable Ergonomic Keyboard	STANDARD	STANDARD	STANDARD

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So, whether you are writing a thank you letter to your aunt, a business letter to your partner, or a book for publication, Sanyo is here to help.

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industrial control as

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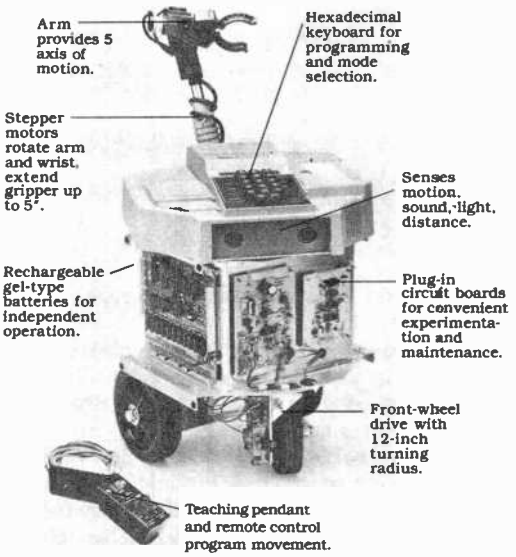

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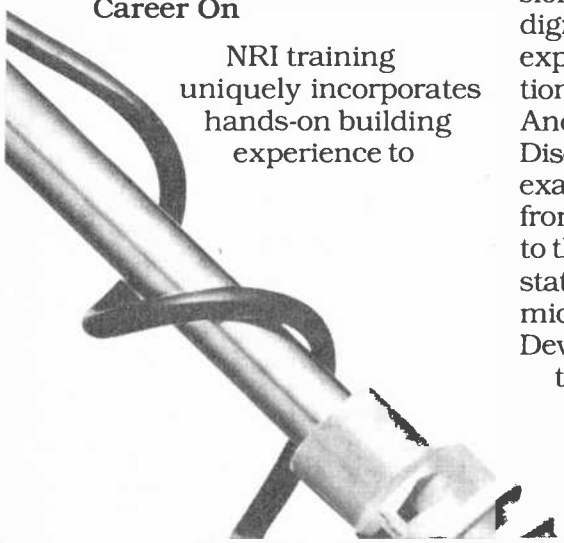

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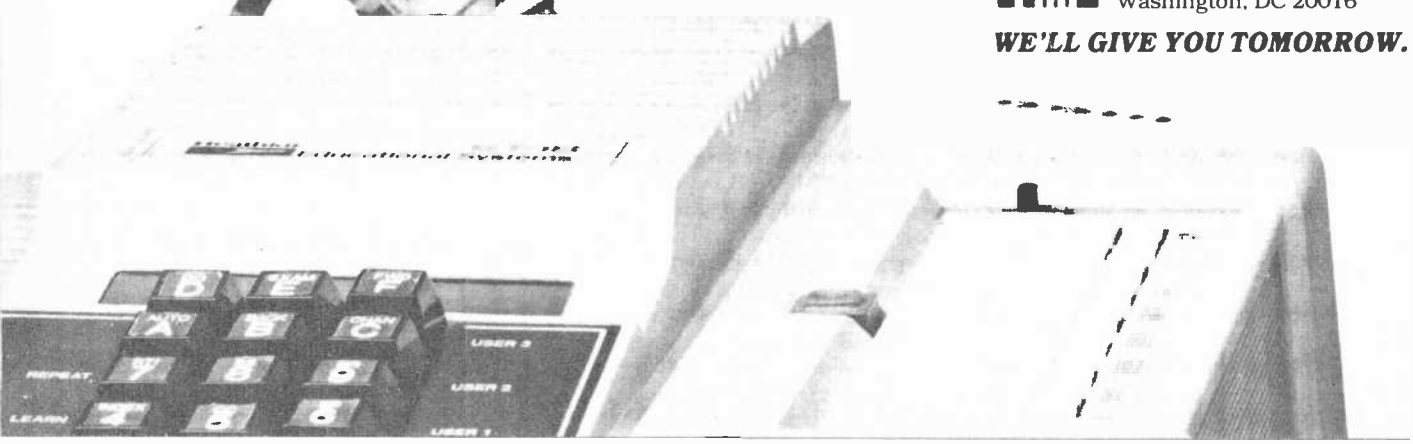

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SETH R. ALPERT

EDITORIAL

OF MICROS AND MAINFRAMES

THE article "Getting Mainframe Data to Micros" by Jan Gugliotti and Elliot Weitz in this issue of C&E has set me thinking about those two classes of machines. Like anyone who has been in computing for a fair number of years, I got my start on mainframes. In those days, they were the only game in town and so were simply called computers. Big expensive things they were, and only the privileged could go near them, much less submit decks of cards for batch runs.

The advent of timesharing systems in the early seventies made computers more accessible and can in many ways be considered the start of personal computing. Gone were the hours of waiting to get your batch run back only to find that one card had a spelling mistake and the job had to be resubmitted. Gone too was the arcane JCL (Job Control Language) that accompanied every job and constituted one's interaction with the operating system. Advanced languages for end users rather than programmers became available, making it easier for even larger numbers of people to use and benefit from computers.

The widespread use of microcomputers and the explosive growth of easy-to-use software for them have carried this trend one step further. Micros have proliferated to such a degree that large businesses are facing some serious dilemmas about connecting them to corporate mainframes for purposes of sharing data or computing resources. Gugliotti and Weitz discuss the issues involved here quite ably. I would like to discuss two related issues.

Micros vs Mainframes

As micros get more powerful, it will be harder to define how they differ from mainframes. Of course, we will continue to think of IBM's biggest machines, like the 3081, as mainframes and its smallest machines, like the PC*jr*, as micros. But for other machines, the distinctions have begun to blur.

Let me cite a number of examples. Microcomputers can now provide around a megabyte of main memory and around 100 megabytes of disk storage, figures which are growing rapidly. Microprocessors with true 32-bit performance and virtual memory management will greatly enhance microcomputer processing power in the near future. As local area networks and supporting software become more prevalent, micros will begin replicating the shared databases and communications now available only on mainframe computers.

On the software side, operating systems for micros are gaining multitasking and multiuser capabilities, just like the operating systems for the big guys. Indeed, Unix may soon be running on everything from microcomputers to the largest mainframes. Similarly, applications software is rapidly growing in sophistication. In fact, mainframe software considerably lags that for micros when it comes to ease of use.

A machine that personifies these blurred distinctions between micros and mainframes is the IBM PC-XT/370. In addition to running PC-DOS, the XT/370 runs a version of IBM's mainframe operating system VM/CMS and can use a half megabyte of real memory and up to four megabytes of virtual memory. That is enough horsepower for a goodly number of existing mainframe applications.

The Future of Mainframes

These observations on the fuzzy line between micros and mainframes lead one to wonder what the future of mainframes will be. It seems safe to predict that the actual number of mainframes in existence will probably remain fairly stable in the coming years, but they will contribute an ever smaller percentage of the world's available computer power.

Mainframes will continue to be of great importance because of their unique abilities in carrying out certain specialized tasks. For one thing, their sheer processing power is essential for work that requires a lot of number crunching, like sophisticated computer graphics or animation, or that requires vast amounts of real memory. Similarly, mainframes will continue to be required for managing massive, shared data banks.

There is also a compelling business reason for corporations to go on running mainframes, as Jan Gugliotti has pointed out to me. The software that is used to run corporate America represents an enormous investment of money and man-years and virtually all of it is built to run on mainframes. Much of it isn't even that well understood by the companies using it, having been written by programmers who have long since moved to other positions without leaving behind very good documentation. Even the richest companies cannot afford the cost, to say nothing of the risk, associated with converting this software legacy to run in a new and incompatible environment.

Getting it all Together

I hope that at some point true distributed processing will be the order of the day. Then end users will no longer have to worry about which type of computer to use for a given task. Instead, the user will sit at a workstation that is his gateway to a network composed of many different computers and data bases. When he wants to accomplish a given task, he will simply enter a request and the network will decide which processors and data bases are best used to get the job done. Distinctions between micros and mainframes will no longer be a major concern for most of the world. ◇

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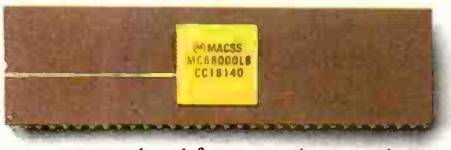
Introducing Macintosh. What makes it tick. And talk.

Well, to begin with, 110 volts of alternating current.

Secondly, some of the hottest hardware to come down the pike in the last 3 years.

The garden variety 16-bit 8088 microprocessor.

Macintosh's 32-bit MC68000 microprocessor.



Some hard facts may be in order at this point:

Macintosh's brain is the same blindingly-fast 32-bit microprocessor we gave our other brainchild, the Lisa™ Personal Computer. Far more powerful than the 16-bit 8088 found in current generation computers.

Its heart is the same Lisa Technology of windows, pull-down menus, mouse commands and icons. All of which make that 32-bit power far more useful by making the Macintosh™ Personal Computer far easier to use than current generation computers. In fact, if you can point without hurting yourself, you can use it.

Now for some small talk.

Thanks to its size, if you can't bring the problem to a Macintosh, you can always bring a Macintosh to the problem. (It weighs 9 pounds less than the most popular "portable.")

Another miracle of miniaturization is Macintosh's built-in 3½" drive. Its disks store 400K—more than conventional 5¼" floppies. So while they're big enough to hold a desk full of work, they're small enough to fit in a shirt pocket. And, they're totally encased in a rigid plastic so they're totally protected.

And talk about programming.

There are already plenty of programs to keep a Macintosh busy. Like MacPaint,™

a program that, for the first time, lets a personal computer produce virtually any image the human hand can create. There's more software on the way from developers like Microsoft,® Lotus,™ and Software Publishing Corp., to mention a few.

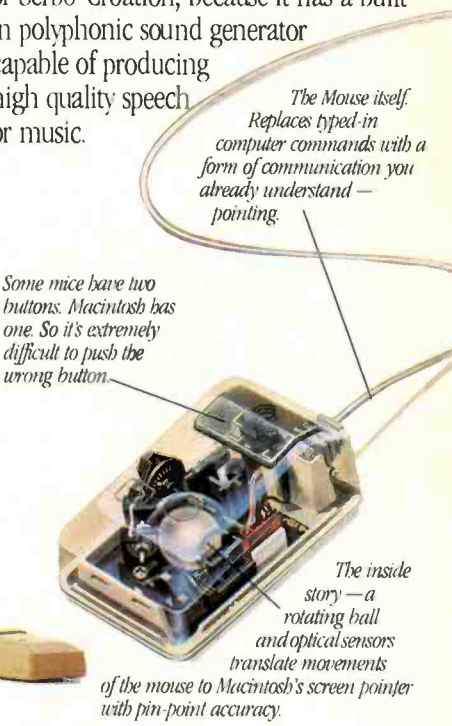
Macintosh automatically makes room for your illustrations in the text.

MacPaint produces virtually any image the human hand can create.

Microsoft's Multiplan for Macintosh.

And with Macintosh BASIC, Macintosh Pascal and our Macintosh Toolbox for writing your own mouse-driven programs, you, too, could make big bucks in your spare time.

You can even program Macintosh to talk in other languages, like Yiddish or Serbo-Croation, because it has a built-in polyphonic sound generator capable of producing high quality speech or music.



The Mouse itself. Replaces typed-in computer commands with a form of communication you already understand — pointing.

Some mice have two buttons. Macintosh has one. So it's extremely difficult to push the wrong button.

The inside story — a rotating ball and optical sensors translate movements of the mouse to Macintosh's screen pointer with pin-point accuracy.

All the right connections.

On the back of the machine, you'll find built-in RS232 and RS422 AppleBus serial communication ports. Which means you can connect printers, modems and other peripherals without adding $150 cards. It also means that Macintosh is ready to hook in to a local area network. (With AppleBus, you will be able to interconnect up to 16 different Apple computers and peripherals.)

Should you wish to double Macintosh's storage with an external disk

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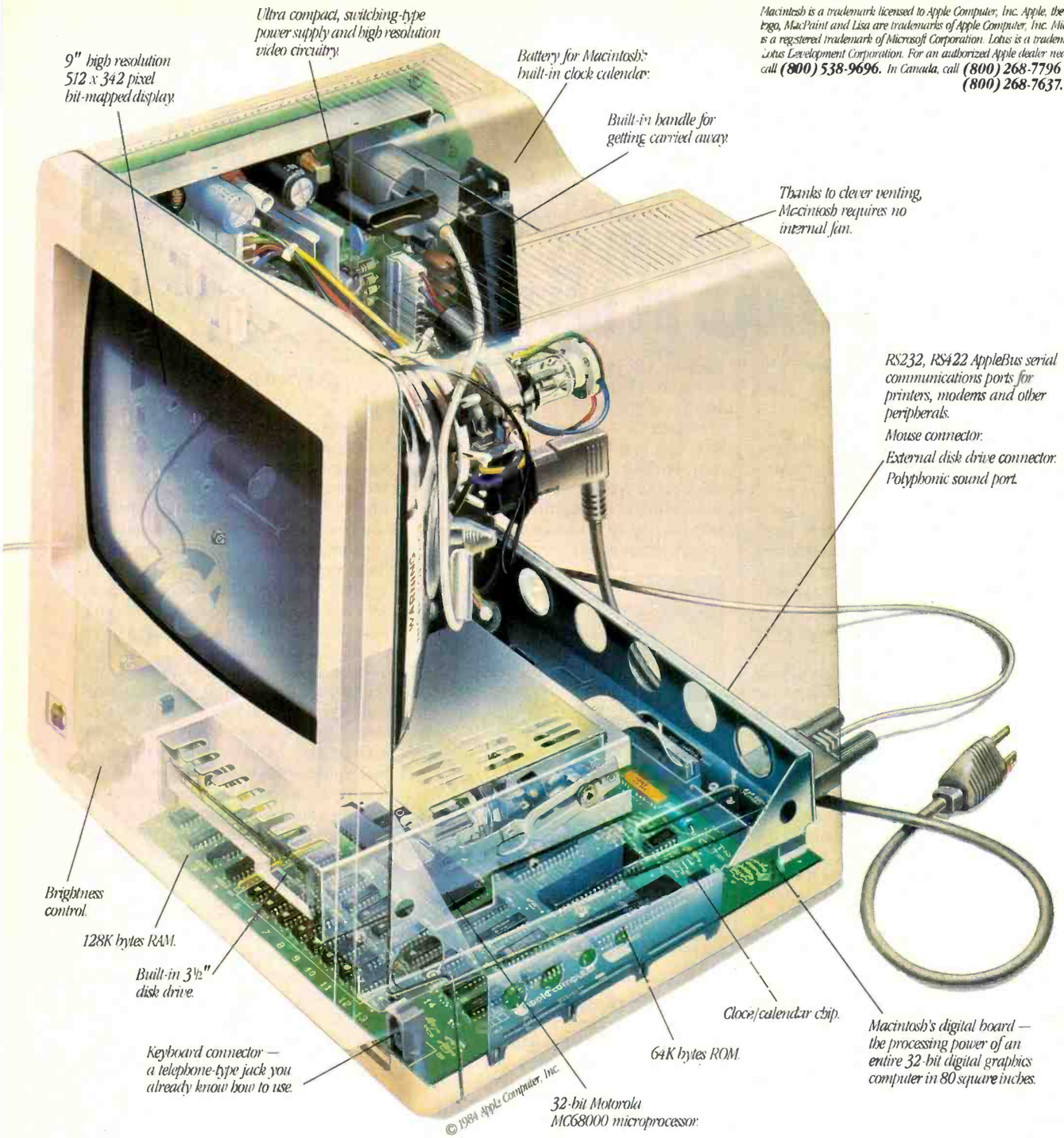

drive, you can do so without paying for a disk controller card—that connector's built-in, too.

There's also a built-in connector for Macintosh's mouse, a feature that costs up to $300 on computers that can't even run mouse-controlled software.

One last pointer.

Now that you've seen some of the logic, the technology, the engineering genius and the software wizardry that separates Macintosh from conventional computers, we'd like to point you in the direction of your nearest authorized Apple dealer.

Over 1500 of them are eagerly waiting to put a mouse in your hand. As one point-and-click makes perfectly clear, the real genius of Macintosh isn't its 32-bit Lisa Technology, or its 3½" floppy disks, or its serial ports, or its software, or its polyphonic sound generator.

The real genius is that you don't have to be a genius to use a Macintosh.

You just have to be smart enough to buy one.

Soon there'll be just two kinds of people. Those who use computers. And those who use Apples.

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LES SOLOMON ON COMPUTER HARDWARE

LOGIC IS OUR BUSINESS AND BUSINESS COULD BE BETTER

THOSE of us in the computer business pride ourselves on being pretty sharp when it comes to hardware and software.

We tell ourselves, and other people, that we are successful because we are so logical and fully understand a problem before we attack it.

Taking a look at the wealth of super hardware that is currently available and the abundance of great software that is obtainable to support it, I guess we're doing pretty well. The industry is certainly thriving and we can do great things with the devices and programs that we have. It all seems logical and well-planned. However, Lord help the person who buys one of our wonderful products and tries to figure out how to use it by reading accompanying instruction manuals, for this is where the logic of the people who run this business appears to fall apart. It is the one area that seems to defy our clear thinking; and if it is neglected, it may well cause problems.

I am talking about technical manuals written in English by technically oriented Americans. These are the manuals that come with over-the-counter computers, plug-in boards, and other peripherals. They also accompany most software packages.

Help!

Maybe I am naive, but I have always felt that an instruction is supposed to help the user. Unfortunately, like too many others, I tend to turn to the manual only as a last resort. But what do I do when the manual is more confused than I am?

If you don't know what I am talking about, you probably haven't bought a new piece of equipment recently. If you have—be it hardware or software—the odds are pretty good that you may have been somewhat puzzled as to how to use the manual, much less the equipment. Even when you think you know what is going on, you wonder, "What the heck does that paragraph on page 33 have to do with what's on the rest of the page."

It seems that the writing specifications used by too many manual writers are based on the fog index—sometimes known as the "look how smart I am" syndrome. The source of the problem (and this is even more disturbing) may also be that the instruction manual wasn't even considered until the last possible minute before the product was shipped and so it wasn't written to any specifications at all.

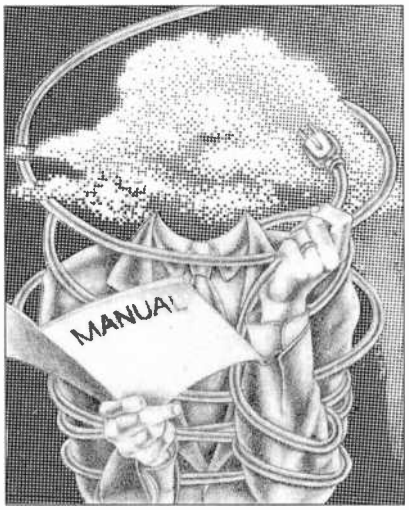

ILLUSTRATION BY RACQUEL BALIN

The Foggy Outlook

As I sat down to write this column, I was prepared to illustrate my point with some examples of the foggy impressions I had gleaned from manuals accompanying recently purchased equipment. But the more of these books I looked at, the more confusion I found.

Then I thought, "Maybe it's just me. I'll ask around." Well, I found that a lot of other people agree with me. In fact, at one computer store, I started a very lively discussion just by asking, "And what did you think about the manual?"

Of course, I must point out that not all manuals are confusing. There are still a few companies around that care. But there are so many that make the picture very cloudy that I decided that it would be unfair to single out a few to pick on. Go ahead and read the manuals and make up your own mind.

A Word to the Source

Manufacturers, please have a heart. You spend so much time and money designing a beautiful new product and advertising it; please spend a little more time looking at the user manuals that accompany your product. Manuals are your interface with the customer in his home or place of business. They should not be considered to be simply a necessary evil that is relegated to creation and printing during the last week before shipping the product.

Even if you have the best product in the history of mankind, if a customer can't get it up and running in a reasonable time, he may speak badly of you and your product. And he shouldn't have to make phone calls to ask you how to hook it up or to find out what he's supposed to do with some extraneous piece of stuff. If he gets it going, likes the way it works, and can understand your instructions, he will be happy and he will tell others, about it.

Word-of-mouth is good (and free) advertising. On the other hand, it can be disastrous if it is negative.

If you are a manufacturer of any computer products that require a manual, take one of them right now and start at page one. Put yourself in the position of a first-time reader—one who doesn't have your computer expertise and is trying to get your product to work as you claim it does in your ads. Remember, the customer paid good money to be helped, not confused.

Another possibility—and a good one—for the manufacturer is to get a nontechnical person to read the user manual. Obviously, the technical level of the manual reviewer should be representative of your typical customers. The reviewer shouldn't be one of the guys who works on development product.

Try it out. Pass your manual around for reading before shipping it with your product. You may be surprised at some of the questions that will be asked by readers of your "simple to understand" manual. ◇

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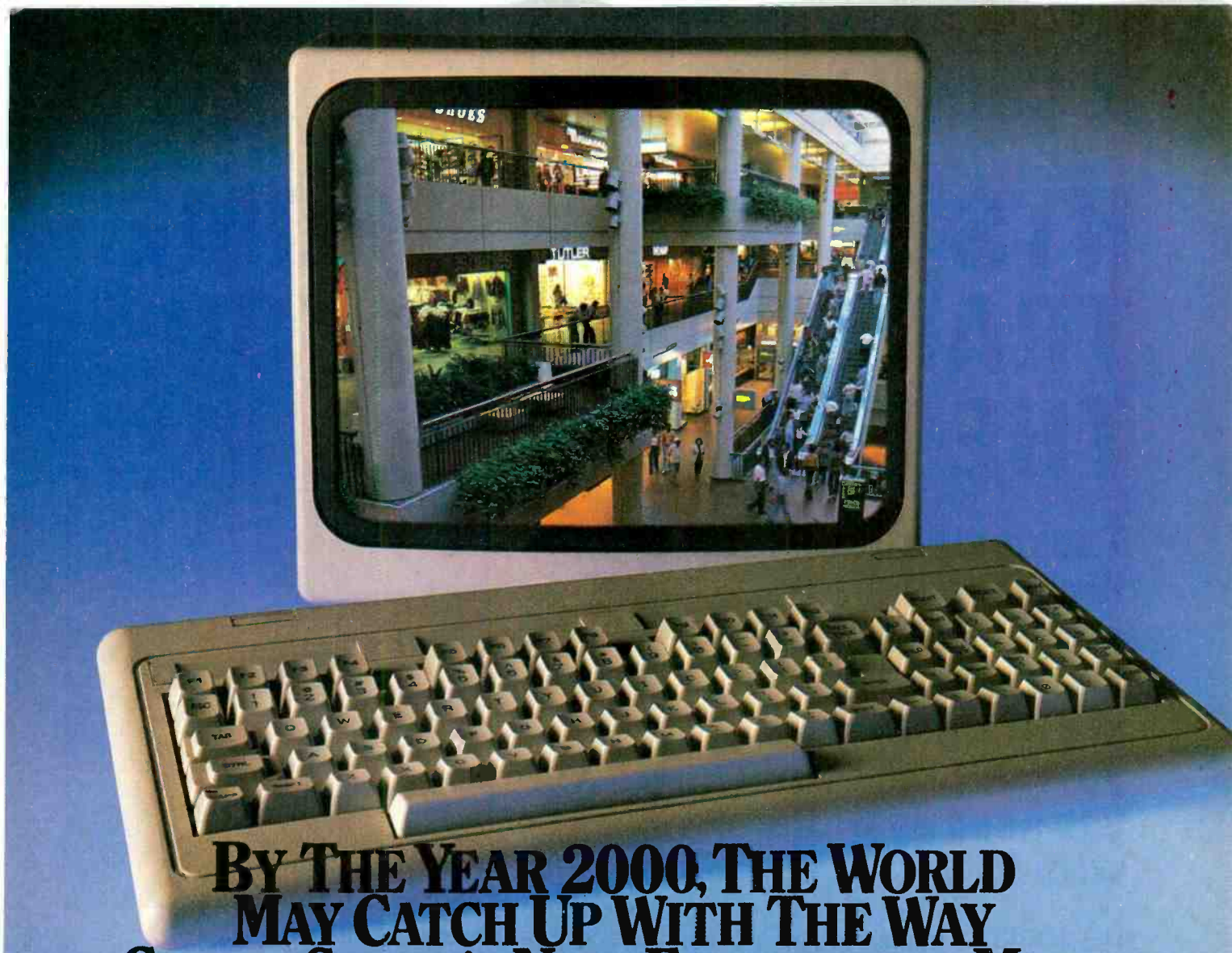

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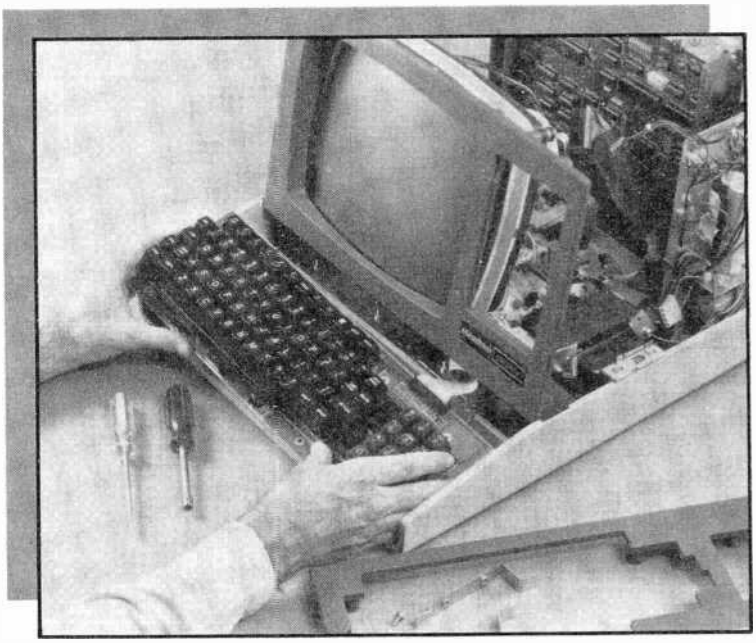

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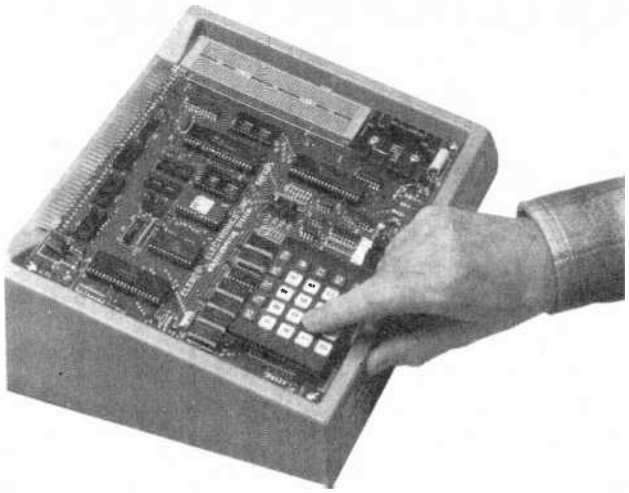

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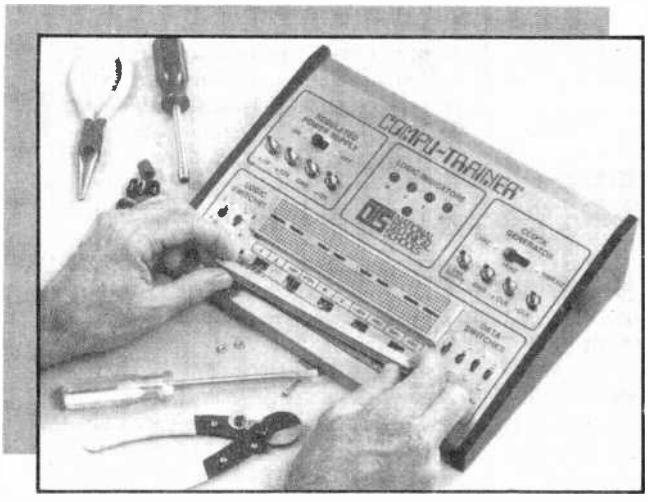

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Rumors & Gossip

► Radio Shack is expected to shortly introduce the Model 200 Portable Computer, an upgraded version of the popular Model 100. Reportedly, it will be identical in size to the 100, have an 8 line by 80 character display and offer some IBM-PC compatibility. . . . Samples of Zilog's new Z800 and Z80,000 microprocessor chips will not be available until late this year. The Z800 is a greatly enhanced version of the popular Z80-bit microprocessor; the Z80,000 is a new 32-bit microprocessor. Details on both chips appeared previously in this column. . . . Digital Research will reportedly augment their recent contract to port Unix System V to the Intel IAPX family with an agreement to add such productivity tools as graphics, additional languages and a library of applications packages. . . . Also expect Digital Research this month to announce 10 to 15 consumer-oriented applications packages to run under its new Personal CP/M system. They will be sold via mass merchandisers. . . . The first Japanese home computers using Microsoft's MSX operating system will probably be introduced at next month's Consumer Electronics Show in Chicago, where dealers will be placing orders for the Christmas buying season. Expect machines by Matsushita and Toshiba and by U.S. maker Spectravideo. . . . Look for NEC to soon introduce a battery-operated disk system for its knee-top computer. And Data Corp., Dallas TX to introduce a similar product for the Radio Shack and NEC machines. . . . NEC is also rumored to be readying a new computer with MAC-like characteristics. . . . Spectravideo is expected to introduce next month a knee-top portable with an 80-column display that is compatible with the Radio Shack and NEC machines, and to offer CP/M and MS-DOS as optional operating systems. Summer introductions of knee-top machines with 80 column displays should also come from TI, Casio, Radio Shack, Compaq and Commodore.

New Flat-Panel Display Technology Yields Color & 3-D

► Binary Star Inc., Bellevue, WA, has disclosed details of their new flat panel display. It is less than a half inch thick and capable of producing high-resolution color and 3-D at prices competitive with CRTs. The display consists of single or multiple transparent substrates, containing color filters and incandescent light elements that are sandwiched between glass faceplates. The tungsten light elements are smaller than grains of sand, have little thermal inertia, and develop little heat. Each element requires about 0.1 mW at 5 V and brightness is over 20 times that of a conventional CRT. There can be over a million elements on a panel.

Multi-level color displays which provide true three dimensional images have already been constructed by Binary Star for military use. The company also claims to have developed low cost drive electronics.

IBM Announces Unix For PC

► As previously rumored in this column, IBM has introduced a single-user Unix operating system for the PC/XT. But the big surprise is that they did not go with Microsoft's Xenix. Instead they chose to have Interactive Systems Corp., of Santa Monica, CA transport their implementation of Unix for VAX machines to the PC. The operating system will be called "Personal Computer Interactive Executive" or "PC/IX." There is no doubt that this is a precursor of multiuser versions of Unix for other IBM machines.

ISSCC Features Papers On New IC Devices

► At the International Solid State Circuits Conference held in San Francisco in February, papers were presented on many new IC devices currently in development. Fujitsu, Hitachi and NEC described their new 1-megabit dynamic RAM chips. The NEC chip was organized as 128K x 8.

Stanford University, the University of California at Berkeley, and Digital Equipment Corporation presented papers on new 32-bit microprocessors. The SU unit is a pipelined NMOS device. The Berkeley device featured a reduced instruction set.

Other devices described at the conference were new image sensors, GaAs circuits, data acquisition, high-speed analog and data processing circuits, dedicated signal processors, non-volatile memories, and many others.

IBM Sues Two Rivals On PC-ROM Copyright

► IBM filed copyright-infringement suits against Corona Data Systems and Handwell Corp, charging they copied the software contained IBMPC BIOS ROM and used it in "look-alike" machines. The companies quickly reacted

ILLUSTRATIONS BY CARL WESLEY

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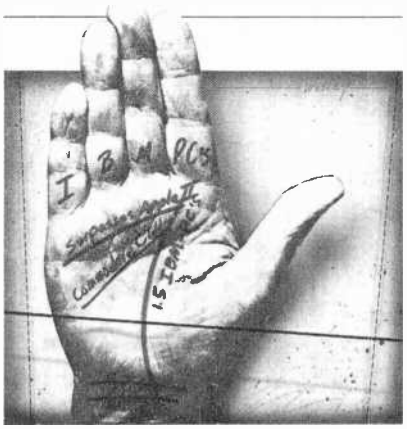
by agreeing to cease marketing machines that use the chip. Handwell is a California importer of Taiwanese machines.

Setting an industry precedent, Apple computer has filed suits against more than 50 companies (most outside the U.S.) charging similar copyright infringement. One case, against the U.S. micro manufacturer, Franklin Computer, dragged through the courts for over two years. Apple finally won and Franklin agreed to cease producing the chips and pay Apple damages. Nonetheless, there has been a virtual flood of Apple II computer copies arriving from Taiwan, Korea and Europe. The U.S. customs service has confiscated many, but a substantial number have slipped through. Thus, it is common to see Apple II clone computer kits being sold at computer hobbyist flea markets for about one third the list price of Apple's machine. The same may happen with the IBM PC.

Unix News

► Motorola has announced the completion of its port of AT&T Unix System V to the 68000 microprocessor and has submitted the product to Bell Labs for final acceptance testing. Motorola is the first semiconductor manufacturer to do this. Intel, National Semiconductor and Zilog also signed agreements with AT&T to port Unix System V but have not as yet completed their ports. Intel has entered into an agreement with Digital Research to have them to do the port to the 80286.

Microsoft and National Semiconductor have announced that the Xenix operating system will soon be available for the National Semiconductor 16032 and 32032 microprocessors.



Predictions

► Industry prognosticators predict that IBM will manufacture between 1.5 and 2 million IBM PCs this year. If they can do it, then by the end of the year 2.3 to 2.8 million IBM PCs will be in operation. Thus, the number of IBM PCs will have exceeded the number of Apple II machines sold and will approach the number of Commodore C-64 machines sold. Of course, in dollar terms IBM-PC sales are almost equal to the combined sales of both the Apple II and C-64.

DRI Drops CPM-86-Plus

► CP/M-86-PLUS, a greatly enhanced version of CP/M-86, which Digital Research Inc. has had in beta testing for several months, will not be released for sale. The new version would have offered the features currently available in CP/M-80-PLUS. Reports from the beta test sites were that this would have been the fastest DOS available for 8088/8086 systems and would have offered many system enhancements.

In dropping CP/M-86-PLUS, after investing several man-years of work, DRI is conceding that CP/M-86 has achieved too limited a market to justify the expense of introducing and supporting it. DRI will now concentrate its efforts on its new windowing version of Concurrent CP/M-86 (CCP/M-86), which they demonstrated at the Comdex show last November, and which should be released by the time you read this column. CCP/M-86 will also be capable of running all PC-DOS software that follows proper interfacing rules and it is expected that IBM will market the new version.

CP/M-80-PLUS, for 8-bit machines, was released almost a year and half ago by DRI. Despite its extended features and speed enhancements it has met with very limited acceptance. Only a handful of OEMs have adopted it and most users are content to run the old Version 2.2 of CP/M-80, which sold well over 2 million copies. For very low cost home computers using Z80 microprocessors, DRI is releasing a new version of CP/M-80 called "Personal CP/M." Reportedly, Zilog will soon release a new version of the Z80 microprocessor with most the CP/M code ROMed in the microprocessor chip itself. In addition, late this year Zilog is expected to introduce a "super" Z80 chip, called the Z800, that will add powerful features such as memory management and hardware multiply/divide, etc. Thus, CP/M-80, is expected to dominate the 8-bit micro world and to continue its popularity for many years to come.

Motorola And DRI Announce Software Agreement

► Motorola has announced its commissioning of Digital Research to implement Concurrent CP/M, with windows, on the 68000 and to implement its family of languages to run under Concurrent CP/M-68K and Motorola's new version of Unix Version V. This arrangement should allow software developers to easily port source code applications programs developed using DRI's C, Pascal MT+, CBasic, Fortran 77, and PL/I languages between the IBM PC running either PC-DOS or CP/M-86 and 68000-based systems running either CP/M-68K or Unix Version V. Puportedly, Digital will complete the project by year-end and the software packages will be sold by both Motorola and DRI.

Random News

► Digital Research and Coleco have announced an agreement for Coleco to implement Personal CP/M in ROM for the Coleco Adam home computer. . . . There are reports that prices on 256K RAM chips, which are still in very limited supply, have already dropped over 50% from their initial $110 prices to $38. Further price decreases are expected this year as availability increases. Thus, we may see the devices being used in personal computers before the end of the year. . . . Amiga Corp., Santa Clara, CA, a maker of peripherals for video games, has announced that this fall it will introduce a 68000-based home computer with 128K of RAM and a 320K disk drive that it expects will retail for under $700.

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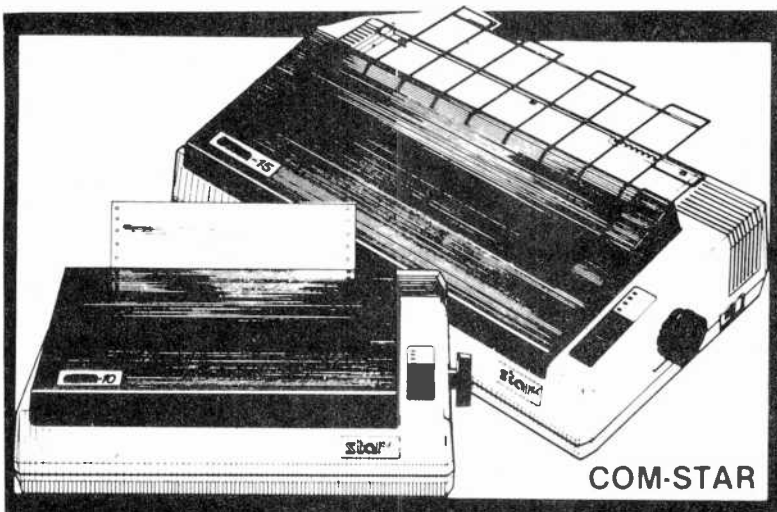

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FORREST M. MIMS, III

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EXPERIMENTING WITH COMPUTER ART

THOUGH pen plotters are primarily used to generate hard-copy business, engineering, and scientific graphics, many users enjoy programming their machines to create multicolored pen and ink compositions. The results, which we'll refer to as *plotter art,* can be intricately complex and spectacularly beautiful.

First-time plotter users are usually surprised to discover that striking examples of plotter art can be created by relatively simple programs. Considering the very high resolution of most pen plotters (up to 0.001 inch), the possibilities for plotter art programs are essentially endless.

Types of Plotter Art

Most programs for creating plotter art are based on one of the following:

1. Mathematical formula
2. Random number generation
3. Man-machine interaction
4. Sketch/paint manual control mode

I've used several different computers and a high-resolution HP7470A plotter to explore all of these categories. While the specific programs and art that accompany this column were generated with a Radio Shack TRS-80 Model 100, the programs can be easily revised for many other computers. Other plotters can also be used simply by revising the lines containing plotter instructions.

Each program includes a line that opens a file for establishing the computer-plotter communications protocol.

For the Model 100-HP7470A combination, the line is: OPEN "COM:48N2E" FOR OUTPUT AS 1. Each program also contains a line that closes the opened file when the program is complete.

As you experiment with plotter art, you may sometimes find that, when a program that's been temporarily stopped is restarted, the plotter fails to respond or begins plotting in an incorrect location. The plotter may also neglect to retrieve a pen from its stall, thereby producing lots of action but no drawing.

These problems can usually be eliminated by stopping the program and either sending the plotter a default command or switching it off and then back on. Now, when the program is run from the beginning, the correct plotter protocols will be reestablished and the plotter should perform properly.

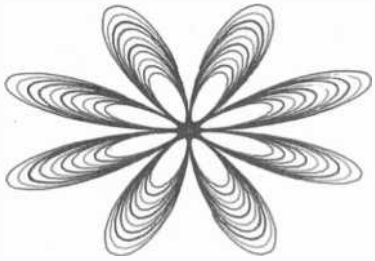

Fig. 1. Spectralipse.

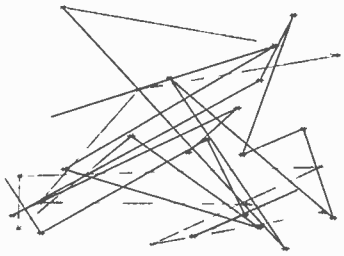

Fig. 2. Connections.

Fig. 3. Asterisk Mosaic.

Other pitfalls await the neophyte plotter artist. Fortunately, none is major, and you can find out more about them in the following discussion.

Equation-Based Plotter Art

The graphs of the standard equations presented in analytical geometry and calculus textbooks are a gold mine for the plotter artist. The symmetry of The Astroid and the beauty of The Four-Leaved Rose are enough to attract even those artists intimidated by the simplest formula.

Jerry O'Dell, a professor of psychology at Eastern Michigan University, is an expert at converting mathematical equations into plotter art. Professor O'Dell has described some of his work in *80 Microcomputing* ("The Artful Plotter," September 1983). One of his more striking creations is an eight-leaved rose made by superimposing two offset four-leaved roses.

Figure 1 ("Spectralipse") is a three-color example of a modified eight-leaved rose generated by the program in Listing 1. The lines that draw the rose (130-220) are adapted from a program given in Professor O'Dell's article.

I've selected *Spectralipse* as an initial example of plotter art since it nicely illustrates some of the practical problems that may befall the novice plotter artist. The first is time. Plotters draw straight lines very fast, but curves require considerably more time, particularly when each tiny increment is calculated in BASIC. This explains why the HP-7470A required slightly more than one hour to draw Spectralipse.

Another problem is color selection and availability. Note that Listing 1 provides only two pen selections. Since the plotter works so slowly, pens of other colors can be placed in the unoccupied stall while the plotter is drawing.

Caution: Be sure to use care when substituting pens while the plotter is operating. Blocking the pen carriage or placing a pen in the wrong stall or in both stalls may damage the plotter.

Making plots with more than two colors is simplified by using plotters having three or more pens. In any case, the paper upon which the pens draw will be subjected to considerable stress when a complex figure having a common origin is drawn. Multiple layers of ink laid down over the origin and other intersections can soak through the paper and cause stains. Furthermore, excess ink can so soften the paper that it can be torn by pen motion.

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This problem can be alleviated by using a good grade of coated plotter paper and by placing strips of transparent tape behind trouble spots on the back side of the paper. If these precautions don't solve the problem, you may have to manually execute a Pen Up command from the plotter's control panel each time the pen reaches a potentially soggy intersection. A more complicated but even better alternative would be to revise the program to automatically lift the pen over potential problem areas.

Random Art

To create the modified eight-leaved rose in Fig. 1, the computer followed a precise set of instructions that transformed the relevant equation into a hard-copy graph. In other words, the computer processed the instructions, calculated the plotter coordinates and controlled the plotter. Therefore, the general appearance of the end result was known *before* the plotter drew the first line.

The random number function of most computers makes possible the creation of plotter art with a final appearance which *cannot* be planned or predicted in advance. Figure 2 ("Connections"), for example, was made by instructing the plotter to draw an asterisk at thirty random locations. By keeping the pen in the down position while it was moved to the next random point, all the asterisks were linked by a continuous line. The pen was changed after each ten asterisks to make the composition more colorful.

As you can see by referring to Listing 2, the program that draws Connections is very simple. Line 60 establishes a plotting window, outside of which the pen will not move. This leaves a blank strip along the bottom of the drawing for a title and byline. Line 60 also scales the plotter.

Line 70 specifies the size of the asterisk (0.5 × 0.5 centimeters) and selects the plotted character (*). Both the character and its dimensions can be easily changed.

Lines 80-110 select the random numbers used as coordinates for two successive random locations.

The program in Listing 3 is a modified version of the previous program. It produces the interesting pattern in Fig. 3 ("Asterisk Mosaic"). Like Listing 2, it draws asterisks at randomly selected locations. But they are much larger (10 × 10 centimeters; see line 100) and are oriented according to their location (see line 110). The program draws forty asterisks in two colors.

Figure 4 ("Asterisk Flats") is a variation of Fig. 3. Here, the random character rotation command (line 110 in Listing 3) is omitted. The remainder of the program is unchanged.

Figure 5 ("Arrows") shows one possible result of an additional revision to Listing 3. Here, the asterisk in line 100 is replaced by the "greater than" symbol (>). Also, the dimensions of the symbol are controlled by a third random numbered instruction contained in a new program line. Here are the two lines added to Listing 3 to create "Arrows":

```
 90 T=RND(1)*8
100 PRINT #1, "SM>;SI"
    T,T";"
```

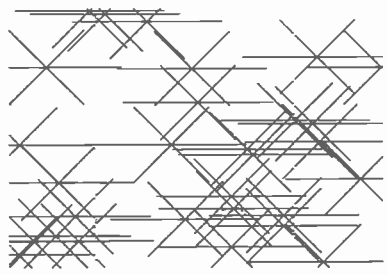

Fig. 4. Asterisk Flats.

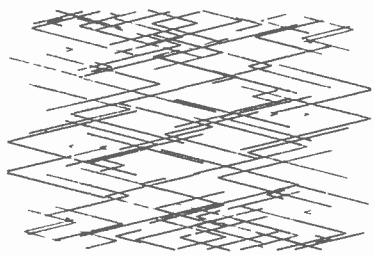

Fig. 5. Arrows.

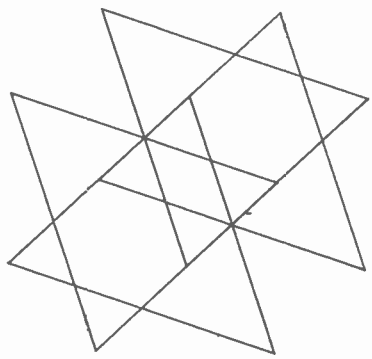

Fig. 6. Interconnected Triangles.

The program draws arrows pointing in one direction. The arrows pointing in the opposite direction (Fig. 5) were produced by reversing the position of the paper in the plotter and running the program a second time.

Interactive Plotter Art

The programs in Listings 1-3 have a mind of their own. Though some of their parameters can be varied, when these programs are run, they draw without operator intervention.

Interactive plotter art programs allow you to revise drawing parameters *as the plotter draws.* This allows a relatively simple program such as Listing 4 ("Do-It-Yourself") to produce plotter art having amazing diversity.

When Do-It-Yourself is run, the computer display asks "A,B,C,D?" (line 100). The four numbers entered by the user are then used as plotter coordinates in line 110. After the pen draws the figure, using the coordinates (see line 110), the computer asks for a new set of values, and the cycle is repeated.

Figure 6 ("Interconnected Triangles") is a simple example of interactive plotter art. This composition was produced by running Listing 4 and making the following entries:

A	B	C	D
90	100	110	120
100	110	120	130
	(change pen)		
130	120	110	100
120	110	100	90

Adding more entries and changing the starting point will give a diagonal string of interconnected triangles. Reducing the step size will reduce the size of the individual triangles and allow more to be drawn.

Modifying the sequence, order and step of the A,B,C,D inputs of "Do-It-Yourself" can provide an amazing diversity of compositions. Figure 7 ("Counterpoints"), for instance, is a pair of back-to-back, stepped sequences of triangles. Counterpoints was drawn by making the following entries into "Do-It-Yourself":

A	B	C	D
50	50	50	95
60	60	60	95
70	70	70	95
.	.	.	.
.	.	.	.
140	140	140	95
	(change pen)		
55	55	55	95
65	65	65	95
75	75	75	95
.	.	.	.
.	.	.	.
135	135	135	95

(Continued on page 32)

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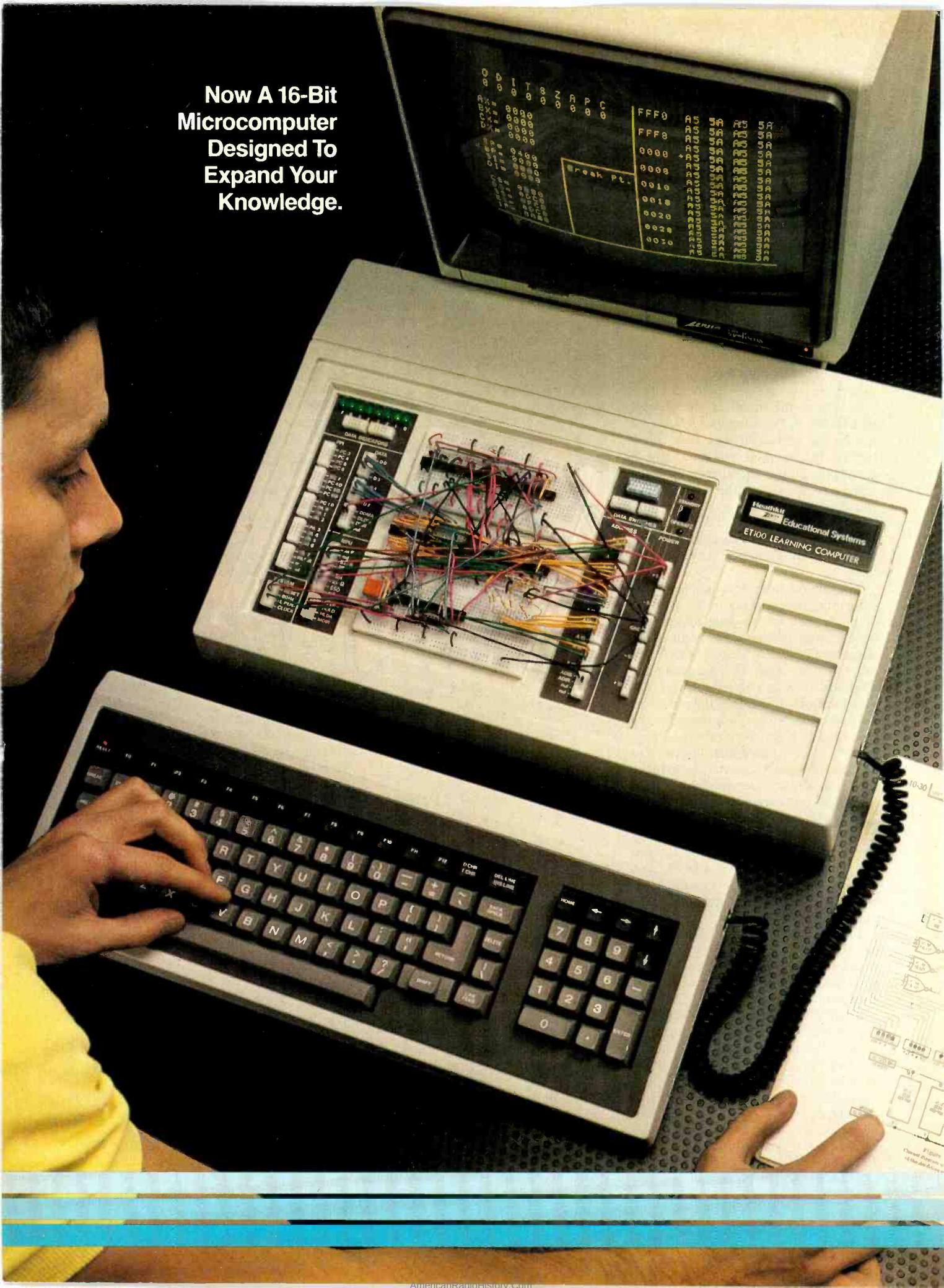

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Computer Scientist

(Continued from page 27)

A very different array of triangles is shown in Fig. 8 ("Prisms"). Actually, only the smallest figure is a triangle. The remainder are four-sided figures having a common off-axis side. The unintended result is that all these figures appear to have part of one side blocked by the triangle. The visual effect is the masking of so-called *hidden lines*. "Prisms" was produced by entering this sequence into "Do-It-Yourself":

A	B	C	D
40	50	60	70
40	50	60	75
40	50	60	80
.	.	.	.
.	.	.	.
40	50	60	130

"Prisms" is prettier if you change the pen color between entries.

A very different product of "Do-It-Yourself" is Fig. 9 ("Acceleration"). Resembling an impossibly stylized swept/delta-wing aircraft, "Acceleration" requires a more complex series of entries than Figs. 6-8:

A	B	C	D
70	80	90	100
65	85	85	105
60	90	80	110
.	.	.	.
.	.	.	.
40	110	60	130

Figure 10 ("Spacewarp") is among the most spectacular and complex drawings I've coaxed from "Do-It-Yourself." Look closely and you'll see a four sided polygon rotated in uniform increments inside a square. All the lines are perfectly straight, but when viewed together they form four distinctive arcs.

Spacewarp is identical in appearance to a popular string art design. The computerized version is just as pretty and much easier to make. Here are the entries:

A	B	C	D
150	150	10	10
150	140	10	20
150	130	10	30
.	.	.	.
.	.	.	.
150	20	10	140
	(change pen)		
150	145	10	15
150	135	10	25
150	125	10	35
.	.	.	.
.	.	.	.
150	15	10	145

Do-It-Yourself can be easily modified to produce many other kinds of drawings. The modifications can be as simple as lifting the pen between two adjacent coordinate pairs to provide a three-sided figure when a four-sided one would otherwise have been drawn. Figure 11 ("Arcle") is a good example. This figure was produced by revising line 90:

90 PRINT #1, "PA"A,B"PD,"BC,CD,DA,"PU,"A,B";"

Here are the entries that produced "Arcle":

A	B	C	D
10	150	150	150
20	150	140	150
30	150	130	150
.	.	.	.
.	.	.	.
80	150	80	150
	(change pen)		
15	150	145	150
25	150	135	150
35	150	125	150
.	.	.	.
.	.	.	.
75	150	85	150

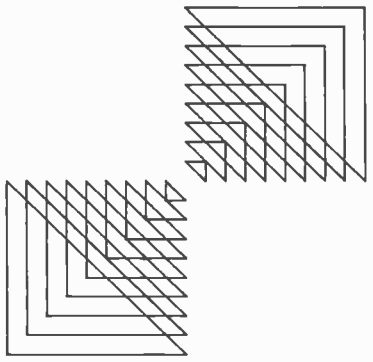

Fig. 7. Counterpoints.

Fig. 8. Prisms.

Fig. 9. Acceleration.

Fixed "Interactive" Plotter Art

Many kinds of plotter art can be planned in advance using graph paper. Test programs can then be run and simple modifications made until a desired effect is achieved. Since revisions to such programs require only a few seconds, they can be considered interactive.

Figure 12 ("Trispangle") is an example of a drawing that was perfected by making minor modifications to a program during a series of trial runs. The program is given in Listing 5.

The two-color, offset effect was achieved by first making an initial plot and then changing pens. The paper was then moved slightly away from its initial position, and the program was run a second time.

Manually Controlled Plotter Art

It's fairly simple to develop programs that cause a plotter's pen to follow the movements of a joystick or cursor control keys. With such programs you can create an electronic version of the Etch-A-Sketch toy. Though I've experimented with manual control programs, the results have not been nearly as appealing as the plotter art generated by using the other methods outlined above. Nevertheless, you may wish to explore this approach on your own.

Titling Your Creations

I would not be surprised to see a market develop for good examples of plotter art. In any event, examples of plotter art make nice gifts for friends and relatives, especially those who have glared at your computer and asked "What do you use it for?"

Listing 6 will let you label your creations with a title and your name. You can even include a copyright notice, serial number or other information.

The PA (Plot Absolute) coordinates in line 100 determine where the pen will begin labeling your title. The spaces after T$ in line 110 determine the distance between the last letter of your title and your copyright notice.

Of course you can alter these parame-

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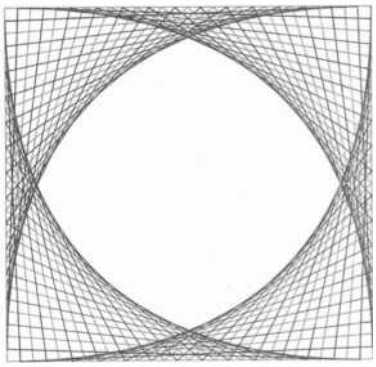

Fig. 10. Spacewarp.

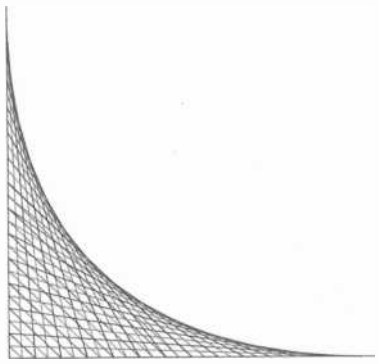

Fig. 11. Arcle.

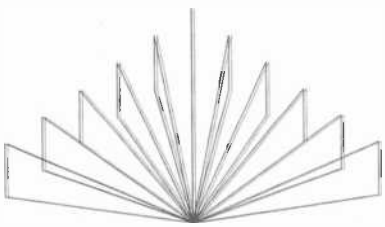

Fig. 12. Trispangle.

ters to suit your purpose. For instance, to place your title near the left side of the page, change line 100 to PA1000 or a similar value.

Going Further

If you decide to give plotter art a try, don't be afraid to experiment. That's the method I used to develop most of the accompanying examples of plotter art.

As a reminder, the programs presented here, though designed for the HP7470A plotter and the TRS-80 Model 100 computer, can be easily adapted for many other computer-plotter combinations.

No matter which plotter you use, be sure to become familiar with its instruction set. You will then be fully prepared to exploit its capabilities as a versatile robot artist. ◇

PLOTTER ART LISTINGS

Listings below were used to draw the plots in Figs. 1 through 12

LISTING 1

```
10 'SPECTRALIPSE
20 'FOR MODEL 100 AND HP7470 PLOTTER
30 'LINES 130-220 ADAPTED FROM "ROSE
   PROGRAM"
40 'BY JERRY O'DELL (80 MICRO, 9/83)
50 CLS
60 PRINT "SET P1 TO CENTER OF PAPER."
70 FOR N=1 TO 500: NEXT N
80 PRINT "PRESS R TO RUN."
90 IF INKEY$="R" THEN 80 ELSE 70
100 OPEN "COM:48N2E" FOR OUTPUT AS 1
110 PRINT #1,"SC0,500,0,500;"
120 PRINT #1,"SP1;"
130 S=100
135 REM SIZE OF INITIAL ROSE
140 P=4
145 REM NUMBER OF PETALS/2
150 RA=57.3
155 REM DEGREES IF ONE RADIAN
160 FOR L=1 TO 10
165 REM NUMBER OF ROSES
170 S=S+15
175 REM SIZE OF NEXT ROSE
180 FOR I=0 TO 360 STEP 1
185 REM PLOTTING INCREMENT
190 Q=I/RA
200 R=S*SIN(P*Q)
210 X=R*COS(Q)
220 Y=R*SIN(Q)
230 PRINT#1, "P1;PD;PA"INT(X),INT(Y)";"
240 NEXT I
250 PRINT #1, "SP2;"
260 NEXT L
270 PRINT #1,"SP0;":CLOSE #1:END
```

LISTING 2

```
10 "'CONNECTIONS"
20 'COPYRIGHT 1984 BY FORREST M.
   MIMS, III
30 'FOR MODEL 100 AND HP7470 PLOTTER
40 CLS
50 OPEN "COM:48N2E" FOR OUTPUT AS 1
60 PRINT #1, "IW250,500,10250,7479;SC0,100,
   0,100;SP1;"
70 PRINT #1,"SI.5,.5;SM*;"
80 R=RND(1)*100
90 S=RND(1)*100
100 T=RND(1)*100
110 U=RND(1)*100
120 N=N+1:PRINT N
130 IF N=10 THEN PRINT #1, "SP2;"
140 IF N=20 THEN PRINT #1, "SP1;"
150 IF N=30 THEN PRINT #1, "SP0;"
160 IF N=30 THEN CLOSE #1:END
170 PRINT #1, "PD;"
180 PRINT #1."PA"R,S";PD;"T,U";"
190 GOTO 80
```

LISTING 3

```
10 "'ASTERISK MOSAIC"
20 'COPYRIGHT 1984 BY FORREST M.
   MIMS, III
30 'FOR MODEL 100 AND HP7470 PLOTTER
40 CLS
50 OPEN "COM:48N2E" FOR OUTPUT AS 1
60 PRINT #1, "IW250,500,10250,7479;SC0,100,
   0,100;SP1;"
70 R=RND(1)*100
80 S=RND(1)*100
100 PRINT #1,"SM*;SI10,10;"
110 PRINT #1, "DI"R,S";"
120 PRINT #1,"PA"R,S";"
130 N=N+1:IF N=20 THEN PRINT#1, "SP2;"
140 IF N=40 THEN PRINT #1,"SP0;"
150 IF N=40 THEN CLOSE #1:END
160 GOTO 70
```

LISTING 4

```
10 "'DO IT YOURSELF"
20 'COPYRIGHT 1984 BY FORREST M.
   MIMS, III
30 'FOR MODEL 100 AND HP7470
40 CLS
50 PRINT "PRESS Q TO QUIT."
60 FOR N=1 TO 500:NEXT N
70 OPEN "COM:48N2E" FOR OUTPUT AS 1
80 PRINT #1, "IW250,500,10250,7479;"
90 PRINT #1,"SC0,206,0,153;SP1;"
100 INPUT"A,B,C,D";A,B,C,D
110 PRINT #1,"PA"A,B,"PD,"B,C,C,D,D,
   A,A,B"PU;"
120 FOR X=1 TO 500
130 IF INKEY$="Q" OR INKEY$="q" THEN
   160
140 NEXT X
150 GOTO 100
160 PRINT #1, "SP0;"
170 PRINT "DONE.":CLOSE #1:END
```

LISTING 5

```
10 'TRISPANGLE
20 'COPYRIGHT 1984 BY FORREST M.
   MIMS, III
30 'FOR MODEL 100 AND HP7470 PLOTTER
40 CLS
50 OPEN "COM:48N2E" FOR OUTPUT AS 1
60 PRINT #1,"SC0,100,0,50;"
70 PRINT #1,"SP1;"
80 PRINT #1,"PA50,50;"
90 Y=50
100 FOR X=0 TO 50 STEP 10
110 Y=Y-5
120 PRINT #1,"PD;PA"X,Y,X,Y-10,"50,50;"
130 NEXT X
140 Y=5
150 FOR X=50 TO 100 STEP 10
160 Y=Y+5
170 PRINT #1,"PD;PA"X,Y,X,Y+10,"50,50;"
180 NEXT X
190 PRINT #1,"SP0;"
200 CLOSE #1:END
```

LISTING 6

```
10 'TITLE LINE AND COPYRIGHT NOTICE
15 'FOR MODEL 100 AND HP7470 PLOTTER
20 CLS
30 OPEN "COM:48N2E" FOR OUTPUT AS 1
40 PRINT "PEN 1 SHOULD BE BLACK WITH
   0.3 MM TIP."
50 PRINT ""
60 INPUT "WHAT IS THE TITLE";T$
70 PRINT "ARE YOU SURE (Y OR N)?"
75 A$=INKEY$:IF A$=""THEN 75
80 IF A$="N" OR A$="n" THEN 60
90 IF A$="Y" OR A$="y" THEN 100 ELSE 60
100 PRINT #1, "SI.1,.15;SP1;IP;PA1500,0;"
110 PRINT #1, "LB"T$" COPYRIGHT 1984 BY
   (YOUR NAME)"CHR$(3)
120 PRINT #1, "SP0;"
130 CLS
140 PRINT "DONE.":PRINT ""
150 PRINT "CHANGE PEN 1 TO DRAWING
   PEN."
160 PRINT "":CLOSE #1
170 END
```


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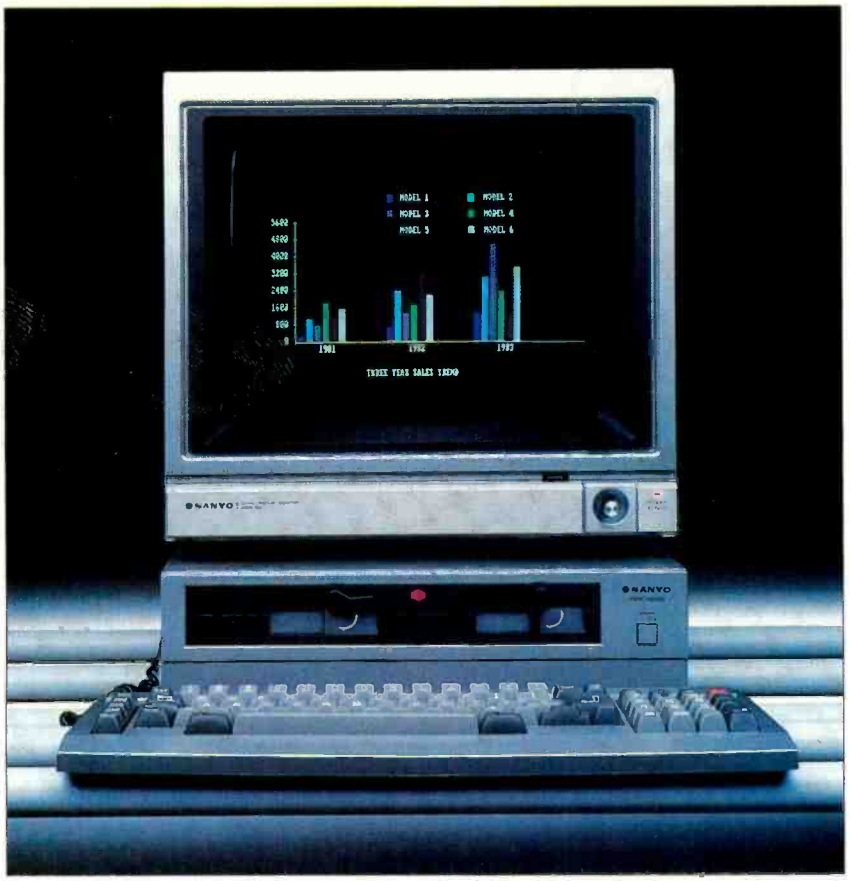

THE SANYO MBC 550

New low cost micro runs MS-DOS operating system

BY BILL BARDEN

OF the many IBM PC compatible microcomputers currently on the market, none is more intriguing than the Sanyo MBC550. And the reason can be summed up in one word—price. Sanyo offers its system with 128K RAM, the same high-resolution color graphics as the PC, a built-in Centronics parallel port, two word processors (WordStar and EasyWriter I), and a spreadsheet called CalcStar—all for a suggested retail price of $995. The cost of a comparably equipped IBM PC is roughly three times as much.

"What's the catch?" you might ask—and rightfully so. The word "compatible" is sometimes used loosely by companies trying to gain a foothold in this market. If the machine is not "fully" (99%) compatible, questions arise. Will the computer gain enough of a market share to encourage software companies to rewrite their software for it? Is the computer a viable product at the price, regardless of the degree of compatibility? We'll try to answer these and other questions about the Sanyo in this review.

The Basic System

The Sanyo MBC550 consists of a main computing unit and a detached keyboard. The main unit has one single-sided double-density 5¼" disk drive. This is a "half-height" drive that fits nicely into the right-hand side of the unit; a second drive can be added in place of a storage compartment on the left-hand side.

The main unit does not have IBM PC expansion board capability, but it does have a bus connector internally for external devices (as yet undefined by Sanyo). The motherboard in the main unit holds 256K of memory. It's relatively easy to expand to this amount by adding 64K RAM chips to the basic configuration. (The manual provides the procedure for this.)

The Sanyo is compact. Its "footprint," or area taken up by the system base and keyboard, is about 330 sq in. This is quite a bit smaller than the 450 sq in. of the IBM PC, and makes it easier to fit the Sanyo on a small desk.

The rear panel of the main unit has plugs and connectors for the system. There's a standard Centronics connector for a system printer, and an optional RS-232C DB-25 connector for a serial interface. (The serial interface is $100 and can be added internally in about 5 minutes.)

There's both an RCA-type monochrome jack and a DIN-type RGB jack on the rear panel, along with a plug for the keyboard. Other rear-panel connectors include the line cord, a female ac plug for another piece of equipment, the main power fuse, and a "knock-out" plug for an optional joystick.

The keyboard on the MBC550 has 85-keys with 5 function keys on the left-hand side and a numeric keypad on the right-hand side. The LOCK and GRAPH keys have red LEDs that signify when they are active. The feel of the keyboard compares very favorably with the feel of the IBM PC although the keys are somewhat noisier in operation. The keyboard has two brackets that can be swung down to provide a better operating angle.

There's a built-in cooling fan that is not excessively noisy. (I prefer a completely silent system, however, and am not favorably disposed towards any fans.)

Connecting a second disk drive is easy. It's a 15-minute operation that is fully described in the operating manual, and you can use the TEAC drives that come with the Sanyo or a variety of other Shugart compatible half-height disk drives. Currently, though, the choice of a second drive may take some deliberation, and we'll tell you why.

Second Drive or Not?

The most apparent difference between the Sanyo and the IBM PC is in the disk drives. The Sanyo MBC550 and MBC555 (the two-drive version) come

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with *single-sided* double-density disk drives. The MS-DOS 2.0 version of the IBM PC, however, comes with *double-sided* double-density disk drives. Thus, the Sanyo user is faced with a dilemma.

If you buy the two-drive version of the Sanyo, you'll get two single-sided drives. You won't be able to upgrade to double-sided drives unless you buy new drives. Why would you want to upgrade? To use the new Sanyo MS-DOS 2.0 version of MS-DOS, of course. This isn't out yet and the stateside factory won't say when it will be coming out, but it is rumored to be in the works. Why not, then, buy a single-drive system and a second double-sided drive and install it yourself? A good idea, but then you won't get the second portion of "bundled" software available with the purchase of the second drive. This portion includes SpellStar (a spelling checker), InfoStar (a data manager), and Mailmerge (a program that can be used for form letters). The Sanyo user at this point, then, must either be prepared to buy the second drive and bundled software (for another $399) and then upgrade to two new drives when MS-DOS 2.0 becomes available or he can buy a second double-sided drive without the bundled software.

For those unfamiliar with MS-DOS, the 2.0 version includes support for double-sided drives and a more powerful structure for disk directory files. The remaining commands are largely the same as the 1.1 version. There's no question, however, that the double-sided disk capacity for the 2.0 version is a great convenience for storage.

The profile of the MBC550 shows its clean, modern styling.

System Internals

Like the IBM PC, the Sanyo uses an 8088 microprocessor. The 8088 is basically an 8-bit microprocessor as far as the system bus or memory accesses go, but it does perform 16-bit arithmetic. The clock rate of the MBC550 is 3.6 MHz compared to the 4.77 MHz of the PC.

There is a socket on the main computing board for an 8087 processor. The 8087 is a coprocessor that operates independently of the 8088 to perform operations such as floating-point additions, subtractions, multiplications, and divisions. Obviously, Sanyo plans to incorporate the 8087 into the MBC550, which is a big plus for the system, although the 8087 processor is not currently supported.

As mentioned, the MBC550 comes with 128K of RAM and can be upgraded on the motherboard to 256K. The memory map of the MBC550 is different from the IBM PC in that the BASIC interpreter is loaded from disk instead of being in high-memory ROM as it is on the PC. Most other system addresses, such as those of the I/O devices, are the same as on the PC.

Sanyo's keyboard layout differs from that of the IBM PC.

Graphics Capability

Like the IBM PC, the Sanyo MBC550 is capable of 640 pixels horizontally by 200 pixels vertically in eight colors. Unlike the PC, however, color capability is included in the basic system at the base price. Like the PC, the Sanyo has commands relating to graphics such as CIRCLE, which draws a circle, ellipse, or arc; LINE, which draws a line, box, or filled-in box; GET/PUT, which defines a video area for storage and later retrieval; and PAINT, which colors a portion of a figure.

As in the latest release of PC BASIC, the Sanyo includes the powerful WINDOW and VIEW graphics commands. It allows you to operate in a logical coordinate system for graphing in which the coordinates could be as large as 32767 by 32767 (with a full complement of external RAM). You can select any portion of this logical area for display by the WINDOW command, which would display a 640 by 200 pixel area. Within the window, you could then VIEW any portion of the area and use this as your working space to plot points or draw figures, enabling you to perform instantaneous zooms or reductions at will. There are software packages that will allow you to do this on other systems, but this is a powerful capability that is integrated into the BASIC and is a definite plus for the system.

The Sanyo has full-screen editing capability, which means you can move the

(Continued on page 106)

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THE LEADING EDGE PC

A well-known marketer enters the compatibles arena

BY ROBIN WEBSTER

MOST people will recognize the name Leading Edge Products—it's the company that sells the low cost Gorilla Banana dot-matrix printer and a host of other computer support products. Now, for the first time, Leading Edge is marketing a personal computer—one that is compatible with the IBM PC. I say marketing because the Leading Edge PC is actually manufactured by the giant Japanese computer maker, Mitsubishi.

While the Leading Edge machine offers a fair degree of IBM compatibility (it will run IBM format WordStar, for example), it is also described in one advertisement as having "a whole lot more." Translated, this means that, instead of the standard machine with just the same bare necessities as the IBM PC (64K of main memory, one low-capacity disk drive, no serial port, etc.), the Leading Edge PC comes with enough features to be put to serious use immediately.

The machine comes with 128K of main memory, seven internal expansion slots; a serial and a parallel communications port; a system clock/calendar; two half-height floppy disk drives (320K each); and a monochrome monitor. Additionally, Leading Edge has decided to include the following software: the MS-DOS 1.25 system disk, including the Microsoft GW BASIC programming language and the Leading Edge Word Processing package (which can also be used on the IBM PC or other MS-DOS machines).

That's a good line-up as IBM compatible machines go, particularly when you consider that this can all be yours for $2895. But let's look at how all this equipment works together as a system.

Hardware

The Leading Edge PC is not for users with a refined sense of aesthetics. Although it comes with the usual set of parts—a system unit, a monitor, and a keyboard—it is evident that Mitsubishi didn't really dwell too much on the external design of the product. The front part of the square, sharp-cornered, system unit is moulded from the predictable corporate grayish-beige plastic. However, most of the front panel is covered by a sheet of satin finish aluminum with the Leading Edge logo set off to the left. I mention the logo merely in case anybody notices a startling similarity between the Leading Edge machine and the brand new machine from Sperry Univac.

The Leading Edge and Sperry machines are essentially the same Mitsubishi-built product and, as far as I could tell in a short and not too involved comparison, the only major differences (apart from the fact that the Sperry version is more expensive) are that one has a Leading Edge logo and an IBM-style keyboard and the other has a Sperry logo and a Sperry-designed keyboard.

Since the Leading Edge PC uses half-height disk drives, they occupy just a little more space than one normal drive would in the far right-hand corner of the system unit. The drives never failed to read from or write to disks correctly during the review, but it was occasionally troublesome to remove disks from the actual drives themselves. Normally, floppy disk drives have a simple latching mechanism (a flip-down door, or a small latch like those that you find holding up refreshment trays on the back of aircraft seats) that retains the disk securely in place. To remove the disk after use, you have to take it out manually.

With the Leading Edge PC drives, disks are first held in place by a spring-loaded mechanism and then gripped in the center by an arm that the user has to lower into position manually. It's all very precise. Occasionally, though, I had to fight with the mechanism to get the disks out. It would sometimes take two or three routines of opening and closing the drive doors before a disk would be

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launched back into my hands by the reluctant springs. Obviously, this is not a serious problem, but it can be annoying when you're working with a number of disks, say, during a copying operation. The other problem I noticed was that the drives were rather noisy: you could tell when the machine was switching from disk to disk by the clunking noises that occurred.

Below the drives on the right side of the system unit is the power switch, a simple on/off rocker unit. A small red light next to the switch indicates whether the power is on or off. At the front-left corner of the system unit is the keyboard

The Leading Edge PC can be put to use just as it comes out of the box

connector. This is a five-pin plug into which the coiled, telephone cable keyboard lead is inserted. Unfortunately, the connector plug sticks out towards the user, preventing the keyboard from being positioned as near to the system unit as one might require. Also, the coiled lead itself does tend to get in the way.

The Leading Edge PC's 83-button keyboard is totally compatible with that supplied with the IBM PC, even down to the awkward arrangement of many keys and the confusing use of arrows on the tab, return, and backspace key caps. However, it is a little bit more like a surfboard than IBM's version, measuring 18" across and 8" deep. According to Leading Edge, the keyboard on the Mitsubishi machine uses as "inductive technology." The importance of this is that there are no contact points and hence no wear or danger from spilled liquids.

With some systems, you can change the resting angle of the keyboard on a flat surface by adjusting little "legs" at both ends: the Leading Edge keyboard is no different. But it is an all-or-nothing adjustment—it's either completely flat on its back or canted at a preset angle.

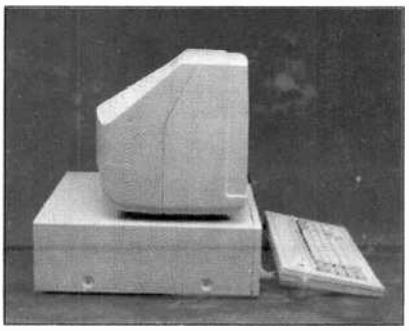
It's hard to say which is the better keyboard: the Leading Edge version feels rather lighweight, but performed well; the IBM model has a professional look and feel to it, but it was designed by an engineer instead of a user and clicks a bit too much for my taste.

All the input/output connectors are arranged along the back of the system unit. To the left (looking from the back), there is the three-pin socket from which the monitor obtains its power. Next to this there is the power socket for the main system. Grouped to the right are all the I/O connections and switches: an RS-232C serial interface port; an 8-switch microswitch unit; an external disk drive interface port; a parallel printer port; and a 9-pin video monitor connector (for the monochrome or color display). The monochrome monitor bundled with the system has a 12" green phosphor screen, capable of displaying 80 columns by 25 lines.

To gain access to the inside of the machine you only have to remove five small screws that secure the top aluminum casing to the main chassis. Once these screws are removed, you slide the casing toward you and then lift if off—it comes away without a struggle. Internally, the components are laid out quite neatly—all the wiring is routed from point-to-point sensibly, and the heavier components (the power supply and two half-height drives) are securely held in place. Interestingly, most disk units are normally encased in a sheet metal casing to reduce electronic interference, but the drives on the review machine were not separately covered at all.

The machine uses a version of the Intel 8088 microprocessor (the 8088-2) which can be set to run at one of two operating speeds: 4.77 MHz (as with the IBM PC) or 7.16 MHz. The speed is changed by the user by means of the microswitch panel on the back of the main system unit.

There are seven expansion slots designed into the main motherboard which is quite large and lies horizontally along the bottom of the system unit. Two of



Profile shows simple design.

the slots are occupied with the video and disk controller cards, leaving five slots available for further expansion. Unlike the simple push-in/pull-out method of installation that you get with the Apple II, for example, the Leading Edge cards are first pushed in and then bolted securely into place (as with the IBM PC). This should reduce the possibility of system malfunction if the machine is ever jostled while in transit.

Using the Leading Edge PC

After switching on the system unit, the Leading Edge PC goes through a diagnostics routine. The time taken to complete the test will depend on factors such as the amount of memory installed (you may have between 128K and 640K of RAM). If everything checks out OK and you have the system disk in drive A, the machine will beep once (it has a

The keyboard is totally compatible with IBM PC.

small internal speaker), display the Microsoft system messages, and ask for the current date. If, for some reason, the system loader code could not locate a disk or any system tracks on the current disk, then the machine will display the message:

```
E-FD20-TIME OUT ERROR
```

All this means is that 20 seconds have elapsed since the first attempt was made to load the MS-DOS system. This happened a couple of times during the review, but a second try overcame the problem.

After loading the system disk, I listed the directory to see what files were available. All the usual files such as COMMAND.COM and FORMAT.COM were on the disk along with a number of demo programs that either showed off the machine's ability to combine graphics and sound, or its color generation facilities. Since I didn't have the color monitor connected, I just ran a couple of the monochrome programs to make sure everything was working correctly.

The FORMAT.COM program obviously follows IBM specifications since a blank disk formatted by this program can be accessed and used to store information on an IBM machine. As far as

(Continued on page 130)

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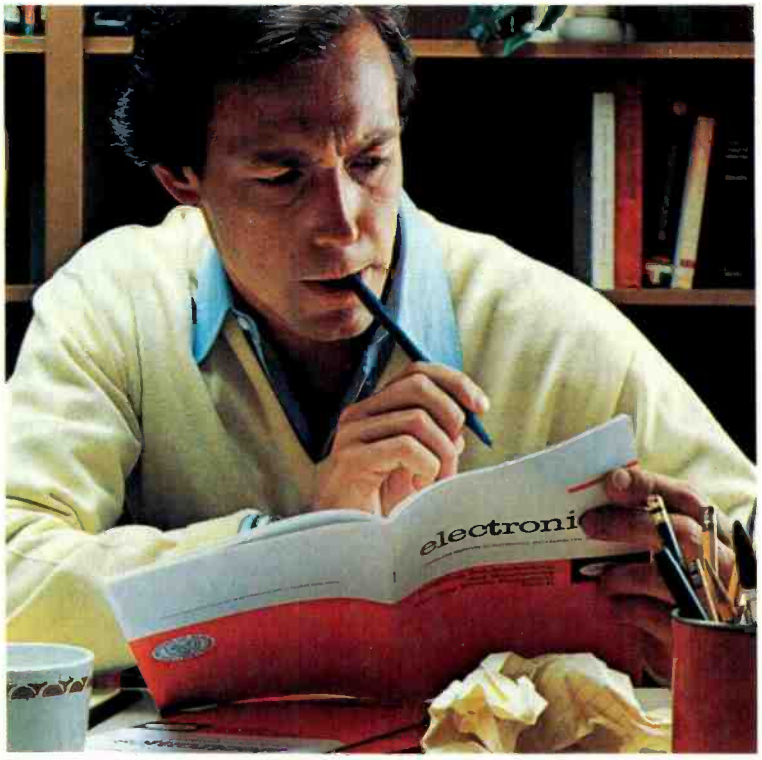

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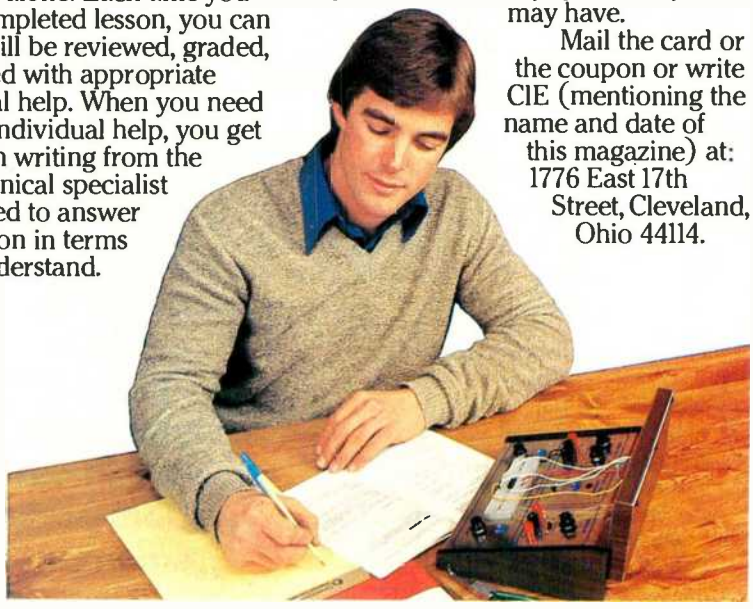

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TRSDOS and CP/M compatibility in a transportable computer

BY J. SMITH-RICHARDSON

IT is interesting to speculate what the state of the portable computer marketplace might be if Radio Shack's Model 4P had been the first "transportable" machine to appear on the scene. Quite likely, the models that have a tendency to lean like the Tower of Pisa when set on the floor or that have external hardware and controls that tend to snag and bump up against things would never have appeared.

Appearance is not all, though. This compact transportable computer is an excellent performer, able to use both Radio Shack's TRSDOS and third-party CP/M 2.2. And it is almost totally software compatible with Radio Shack TRS-80 Models I, III, and 4.

Hardware Characteristics

The Model 4P portable is derived from Radio Shack's Model 4 desktop computer. It has a Z80 microprocessor that operates at either 2 or 4 MHz, depending on the operating mode, and 64K of RAM, expandable to 128K. Built in are two "thinline" half-height 5¼" single-sided, double-density floppy-disk drives, each capable of storing 184K of data. A 9" white-phosphor CRT, Centronics-compatible parallel printer port, RS-232C serial port, an I/O bus for future expansion, and a prewired compartment for a user-installable 300-baud plug-in modem round out the electrical hardware features of the Model 4P.

Housed in a heavy-duty plastic cabinet, the computer weighs slightly more than 27 pounds and measures 16½" × 13¼" × 9¾". The Model 4P's cabinet has to be the best-thought-out design for a transportable computer anywhere. Its pop-up handle is positioned off-center, over the center of gravity rather than the physical central axis, to evenly distribute the weight and provide the most comfortable grip for transporting the computer.

The front cover is *really* a front cover. It is secured with steel clamps—not the usual plastic snaps. This cover contains a storage area for the computer's ac line cord and separate storage bins for diskettes and/or documentation.

The CRT screen is centrally located in the computer's front panel. To the left of the CRT is a combination power switch/indicator assembly, RESET switch, and BRIGHTNESS and CONTRAST controls for the CRT display. To the right of the display are the two vertically mounted floppy-disk drives.

The 4P is a magnificent machine . . . almost the ideal portable computer

Stowed in a compartment under the 4P's front panel is the detached keyboard that slides in and out and is safely secured for transport when the cover is attached. The cable tether between keyboard and computer is 16" long, which is barely sufficient to allow lap operation. Two pivoting "legs" at the bottom rear of the keyboard assembly permit keyboard typing angle to be adjusted for desktop use. The keys have the sculpted look of the IBM Selectric II typewriter keyboard and have a very satisfactory "feel."

All I/O connectors and the modem compartment are concealed behind a flush door that spans almost the entire rear of the cabinet. Though Centronics compatible, access to the printer port is through a card-edge-connector arrangement, rather than the more common DB-25 connector. The RS-232C serial port, however, has the standard DB-25 connector arrangement. The I/O expansion bus and modem compartment are protected by a removable steel plate inside the compartment.

Modem installation is very simple. After removing two screws that secure the steel plate, the connector on a revealed cable plugs into the modem, which then slides into its own compartment, where it becomes an integral, though removable, part of the computer.

On the bottom-rear of the cabinet is a threaded leg, similar to that found on slide projectors, for adjusting the tilt angle of the front panel (actually, the entire computer). The leg is designed to combat potential reflection and glare from room lighting on the CRT's screen. There is a real need for this arrangement, because the CRT screen is as far forward as it can be inside the computer housing and is particularly sensitive to reflections from ceiling lighting. Though the leg can be effective in reducing some of the glare, a small slide-out hood or a lip on the front edge of the cabinet over the screen area would have been much more effective.

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Operation Details

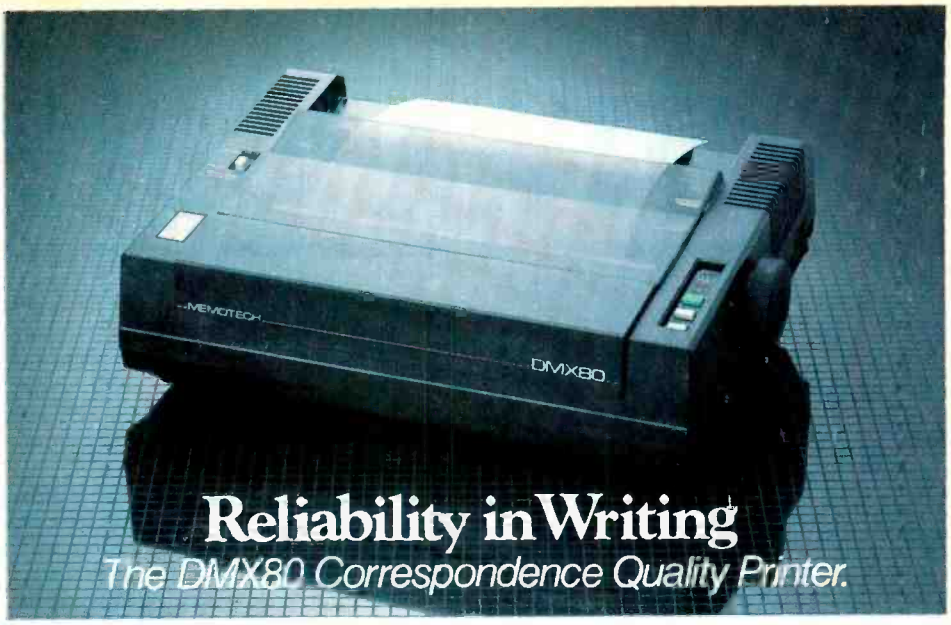
Like the Model 4, the Model 4P automatically accommodates both the CP/M and TRSDOS operating systems. TRSDOS support is provided for both the Model 4P's own Version 6.0 and Model III TRSDOS. TRSDOS Version 6.0 runs the Z80 at 4 MHz and provides a screen display of 80 or 40 × 24 characters, while Model III TRSDOS runs the Z80 at 2 MHz and provides a 64 or 32 × 16-character display. By making the Model 4P accommodate both TRSDOSs, Radio Shack maintains compatibility with its rather extensive line of existing Model I software, because the Model III computer can convert much of the Model I software to its mode.

Though derived from the Model 4 desktop computer, the Model 4P accesses the two TRSDOS modes in a totally different manner. The desktop machine contains the ROMs from the Model III and will function as a Model III when booted from Model III DOS or an aftermarket DOS like NEWDOS. When booted from a Model 4 TRSDOS or CP/M disk, the ROMs are switched out by the computer and 16K of RAM is substituted. Since no ROMs are provided in the Model 4P, the computer must use *software* to create an image of the Model III ROMs in the first 16K of RAM.

Having Model III ROMs, or creating their image in RAM, is required for the Model 4 series to maintain software compatibility as hardware and software upgrades are made. With the Model I computer, Radio Shack reserved all RAM from 0000 up to the first 16K boundary for future use. This made it possible for Radio Shack to easily upgrade its computers, without having to overlay already utilized memory locations. The major disadvantage of reserving low-end RAM, however, was that it prevented use of the CP/M operating system, which requires memory to start at memory address 0000 and work upward.

With the Models 4 and 4P computers, Radio Shack departed from the earlier design philosophy by freeing up memory all the way down to address 0000. This makes the computers both TRSDOS and CP/M compatible. The company handled the TRSDOS-CP/M mismatch in the Model 4 by including the ROM set from the Model III. When a Model 4 TRSDOS or CP/M disk is booted, the ROMs are switched out to free up the low-end memory locations to give access

(Continued on page 105)



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SOFTWARE REVIEWS

THE LEADING EDGE WORD PROCESSOR

A powerful package with many text editing features

By Robin Webster

I WAS looking forward to reviewing the Leading Edge Word Processing package because the company has invested a large amount of money in marketing the product in computer and related publications. It has also generated a lot of interest at exhibitions around the country.

Most readers will be familiar with the avertisement that begins by stating: "History will record as a profound irony that the most powerful word processing package ever created for the IBM Personal Computer can be worked with two fingers." Another ad even suggests that the LE Word Processing package will transform your PC "into something with the speed and power of dedicated word processors costing $10,000 and more . . . "

There is some truth to the latter statement since Leading Edge—like the developers of the Multimate word processing package for the IBM PC—has drawn quite heavily on the word processing concepts developed by office automation companies like Wang. On the Wang Office Information System (OIS) range of machines, the word processing facilities are completely menu driven and are based around a proprietary keyboard design. Users are presented with a main menu which allows them to EDIT an old document, CREATE a new document, PRINT a document, and so on.

You are not required to type in any complex commands. You just place the cursor next to the menu option desired, enter the document number and the name of the library in which the document resides, then press the EXECUTE key. Depending upon your menu selection, documents for further editing are listed, or sub-menus with further, more specific, options are displayed. If at any time you want to escape from a menu selection, you press the CANCEL key and respond to prompts that usually appear at the top right of the screen.

While using the LE Word Processing package, I was constantly made aware of similarities with the Wang environment. Rather than having documents reside in libraries, however, Leading Edge has decided to adopt the more current concept of storing documents in "folders," which are, in turn, stored in file cabinet "drawers."

Because the Leading Edge and IBM-type personal computers do not have sufficiently high-resolution screens, they are really unable to display visual representations of desktop objects in the same manner as the newer computers with bit-mapped displays. Instead, the folders are given as a list of names; when one is selected, all the documents contained in that folder are shown as a further list. There may be up to 32 named folders per disk (or "drawer," as Leading Edge refers to them in this context) depending on the size of saved documents.

When you start up the LE Word Processing package, you will find that the system already contains an initial folder (the Initial Document Folder) ready for use. Also, a first default format document is created by the system (the LE Standard Document) so that you don't need to worry about learning all the margin settings and format options before you even write your first few words.

Since every subsequent document created by the package will conform to the initial document layout, once you have learned your way around the system, you can go in and alter the default document to suit your own personal preferences. This approach to automatic document formatting is similar to the "prototype documents" that are created with dedicated word processors.

Features

Rather than having menu options listed as "Edit a document," or something similar, the LE Word Processing package employs the menu selection area at the bottom of the screen that Lotus 1-2-3 or Multiplan users will be familiar with.

A couple of lines are given over to a set of command words, such as "EDIT," "CREATE," "DELETE," "COPY," and "PRINT," and as you place the cursor over each word it is highlighted in reverse video. Additionally, as each command is selected by the cursor, further text is displayed to explain the effect of each command.

Earlier, I mentioned that Wang word processing systems used a proprietary keyboard design. This greatly simplifies the typist's job since special keys have

The Word Processor comes with an overlay for the IBM PC keyboard.

PHOTOGRAPH BY STEVE BORNS

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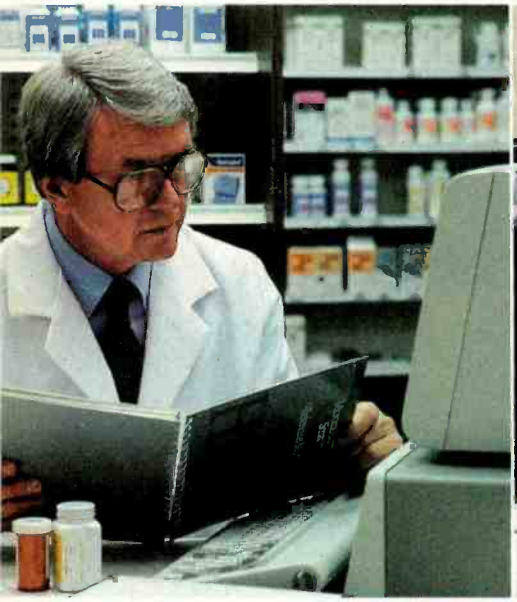

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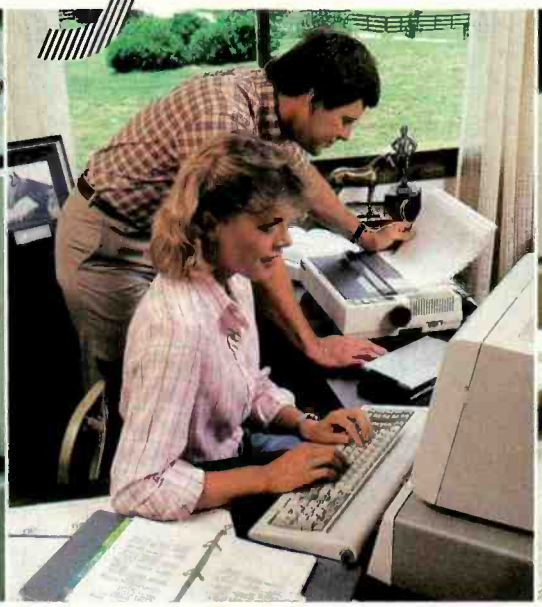

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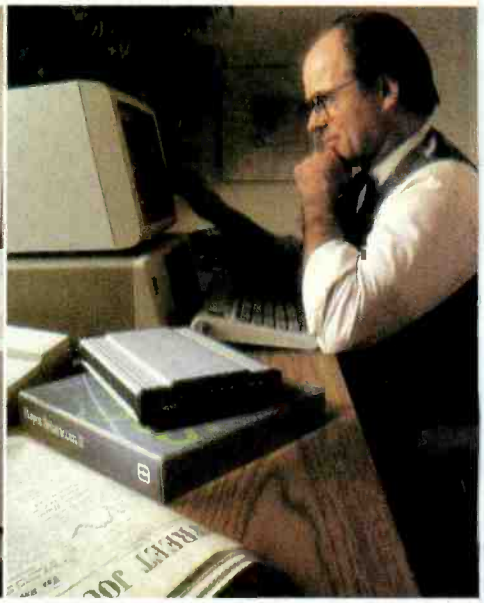

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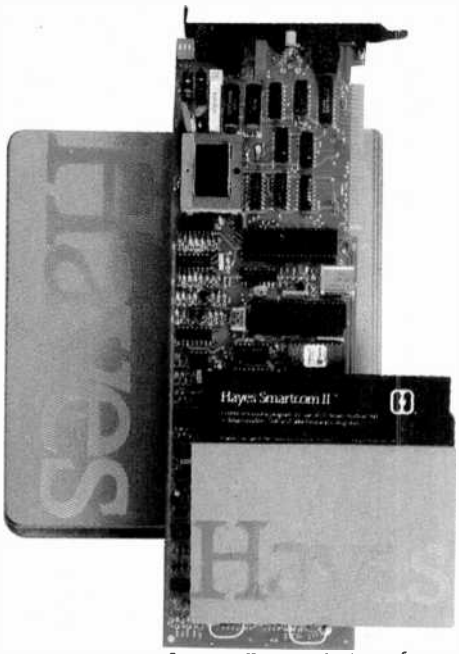

Smartcom II communications software.

NOTE: Smartmodem 1200B may also be installed in the IBM Personal Computer XT or the Expansion Unit. In those units, another board installed in the slot to the immediate right of the Smartmodem 1200B may not clear the modem; also, the brackets may not fit properly. If this occurs, the slot to the right of the modem should be left empty.

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Leading Edge WP

(Continued from page 44)

been designated for every major editing task. If you want to go to the next page in a large document, you simply press the "GO TO PAGE" key and respond to the "WHICH PAGE?" prompt with the relevant number. If you want to go to the end of a document of unknown size, you simply respond to the latter prompt with an absurdly high number like "999."

Wang uses special keys to center, indent, insert, and move text around within a document. There is even the so-called glossary feature, which allows users to write simple word processing "programs" that will automatically format a document according to pre-determined settings (say, inserting a page break every 33 lines and indenting the first line of each paragraph by three spaces).

While the LE Word Processing package has almost all these features, it does run into trouble because it must cope with the limitations of an IBM style keyboard. Leading Edge has decided that the best way to tackle this is to provide a multiple color keyboard template, which fits around the keyboard and lists the effects of the various function keys when used alone or in concert with special, or "booster," keys.

The Escape (ESC) key has been chosen as the CANCEL key and the plus (+) key on the numeric pad has been chosen as the EXECUTE key.

One aspect in which the Leading Edge product differs from the Wang word processing systems is that you can select whether or not you wish to be in INSERT mode (insert words in the middle of sentences without overwriting what's already there), or OVERTYPE mode (current text is overwritten by new text).

On the Wang systems you are always in overtype mode and must press the insert key to make additions in the midst of text. The problem is that all text after the insertion point is temporarily wiped off the screen, making it a little difficult to gauge the effect of the additional material on the document layout. I much preferred the Leading Edge way of doing the job since you can immediately see how your new text fits in with the old.

It is also possible to split the word processing screen into two working areas, or windows, and edit more than one document at a time. By using the cut and paste options it is also possible to transfer data from one document to another. There have been many times that I needed to work in this way and, although recent "windowing" products such as the Apple Lisa or Macintosh systems—as well as the DesQ and Visi On software packages—naturally do the job a lot better, I found the LE Word Processing package coped well with the task.

There are far too many functions available with the LE Word Processing package to cover them all in this review; but it might be useful to indicate some of the features assigned to the ten function keys (F1 to F10). They are as follows:

- F1: obtain help information and list the main command menu.
- F2: the decimal tab key.
- F3: edit a current format line, insert a new format line.
- F4: set the type of text indentation.
- F5: set text attributes such as bold, and underline.
- F6: center text.
- F7: carry out search and replace operations.
- F8: insert page breaks.
- F9: select an area of text to move, or cut.
- F10: paste an area of text previously selected by a cut.

The exact result of each of these keys changes when they are used in conjunction with the CTRL, ALT, and SHIFT keys.

Additional Functions

There is a very wide selection of other specialized text editing features. You can, for example, transpose two characters that are typed in the incorrect order by placing the cursor to the immediate right of the characters and pressing the ALT and SHIFT keys. If you ever need to, you can also switch lower-case letters into upper-case letters (and vice versa) by pressing the SHIFT and CAPS LOCK keys, highlighting the text to be switched, and then pressing the EXECUTE (+) key. Groups of words that are hyphenated, but which would normally be split by the end-of-line word wrap, can also be kept together by a "required hyphen" facility.

It's not that everyone will need such a range of options—many people would rather retype the two transposed characters than worry about learning the special command—but it's nice to know that such a toolkit is there if needed.

Again, unlike word processing software on some of the newer bit-mapped machines, the LE Word Processing package is not capable of displaying special text attributes on-screen. So, when you underline a section of text—single underline, double underline, or underline in red—it is merely highlighted. (Whenever you place the cursor within the highlighted area, a brief message appears at the top of the screen to indicate

(Continued on page 84)

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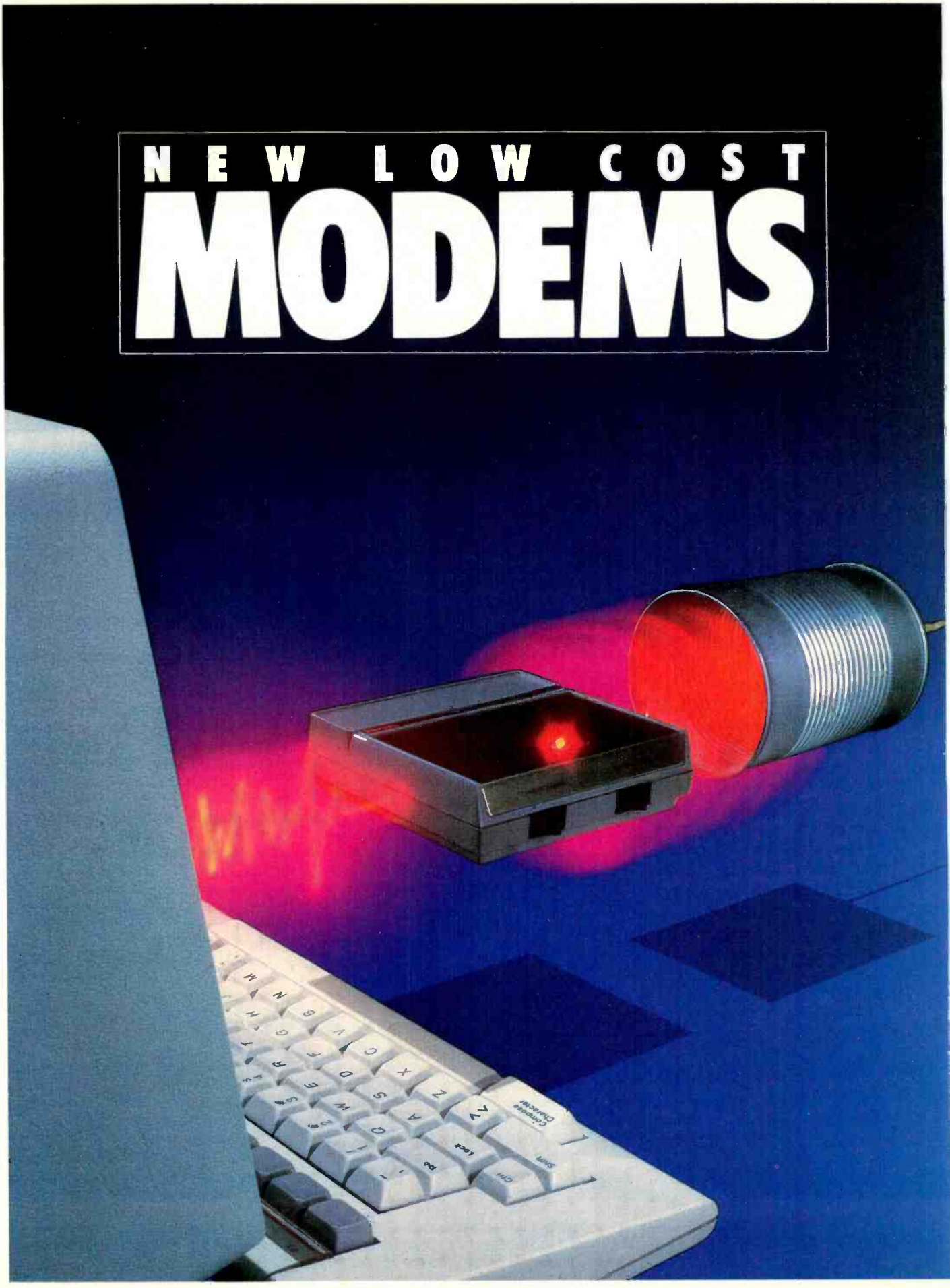
NEW LOW COST MODEMS



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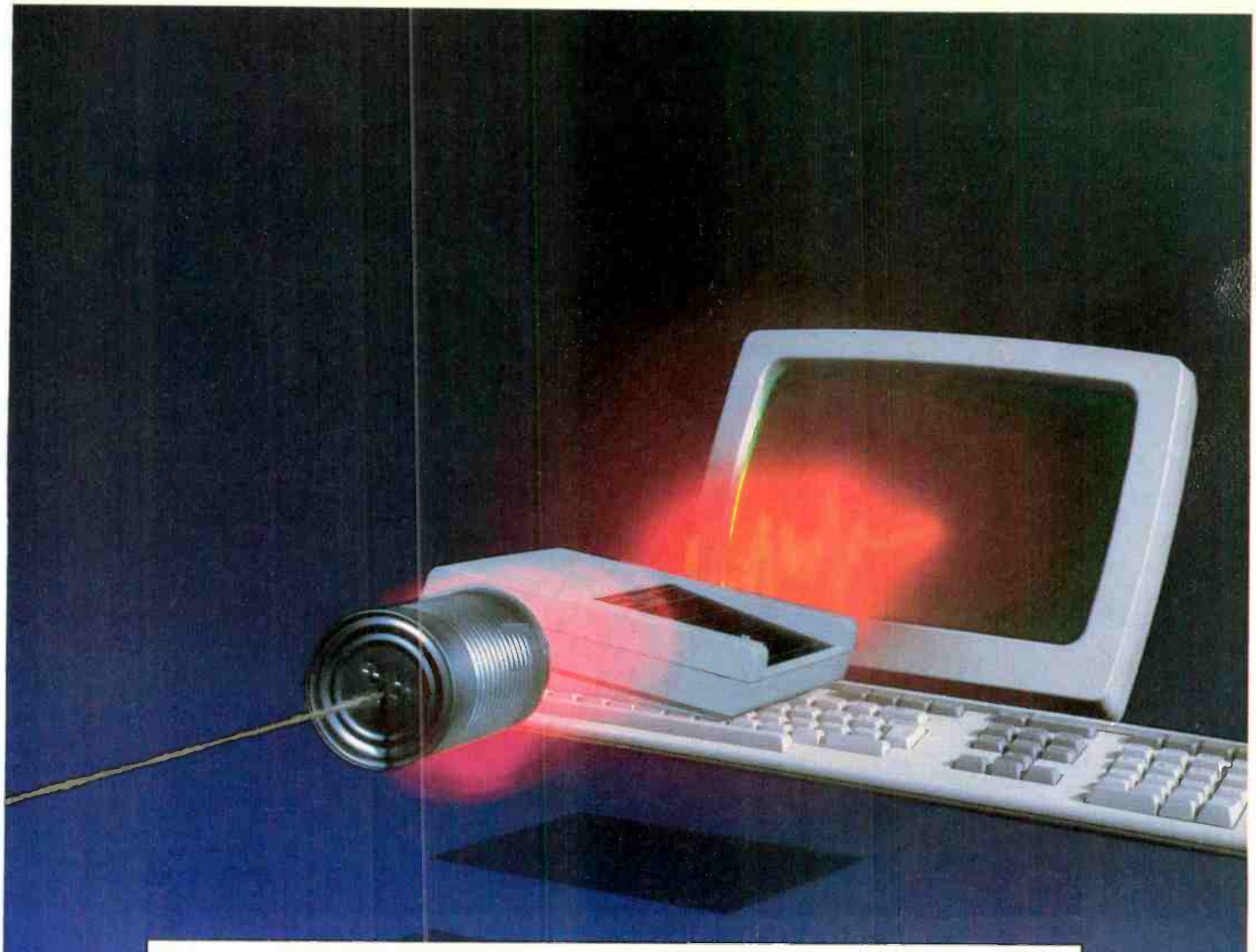

Modems have become less expensive and more capable. Here's a roundup of products that retail for less than $100.

BY TJ BYERS

YOUR personal computer has been heralded as the ultimate communications device. Out there in the vast beyond are promises of home banking services, telephone catalog sales, and up-to-the-minute stock quotes.

Presently, hundreds of database sources and community bulletin boards are available to the computer owner. All are but a phone call away.

Ah, but there's the rub. Unless you have some way to couple your computer to your telephone, these conveniences may as well not even exist.

Fortunately, the situation is easily resolved with an ingenious device called a modem. A modem gives your computer the freedom to talk to other computers, access databases, and generally keep you in touch with the world.

Modems come in many different shapes and sizes, with a wide range of prices. Recently, low cost modems have appeared on the market—budget modems, which retail for under $100.

But does a lower price tag reflect an inferior product? Can you use one with your system? To answer these questions, we need to look first at modems in general.

TJ Byers is the author of numerous books on electronics and computers.

Modems

Basically, the job of a modem is to transfer digital information from your computer to another computer, and vice versa. It does this over a telephone line (Fig. 1).

To our dismay though, we find that telephone lines are not equipped to handle digital

PHOTOGRAPH BY BARRY BLACKMAN

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Clockwise, from top: Radio Shack Modem 1B, Volksmodem, HESModem1, Westridge 6420, Signalman Mark I; Center: Teledata TD-200

conversations. They are designed, instead, to carry audio signals in the range of 300 to 3500 Hz. This is intentional.

As we know, telephones are designed for the human voice, which falls within this narrow frequency range. By limiting bandwidth, and chopping those frequencies that carry little information, the speech patterns become very clear and intelligible.

This frequency cropping, though, severely attenuates digital pulses, making it impractical to send such pulses over telephone lines. They just can't get through.

But there is another way. Using the audio characteristics of the telephone line to its own advantage, the modem is able to communicate digital data. It begins by taking your digital pulse and encoding it into a frequency. One specific frequency is used to represent a logic 1 and a different frequency represents a logic 0.

As the train of pulses enters the modem, the pulses are changed into audio tones, the frequency of each tone corresponding to a logic state, and sent over the phone lines in serial form. The resulting output is a characteristic "doo-dah" sound. This form of encoding is called *frequency shift keyed* (FSK) modulation, appropiately enough. It is a specialized form of FM (frequency modulation) as illustrated in Fig. 2.

At the receiving end of the conversation is another modem, which takes the tones and converts them back into digital pulses.

By using different pairs of tones, a modem can both transmit (originate) a message and receive (answer) one. To do so, the modem must contain a modulator and a demodulator. Hence the acronym, modem.

The data is commonly sent at 300 bits per second, or 300 *baud*. When using the standard ASCII format, 300 baud translates roughly into 30 characters (letters) per second. An average word takes about one-fifth of a second to send, resulting in 300 words per minute.

Typical Modem Cycle

The best way to understand the operation of a modem is to actually put one through its paces. Of course, you need a computer. Let's say you wish to access a database, such as The Source. This is how it's done.

You begin by dialing the telephone number of The Source (which they gave you) and securing a connection. You can do this manually or the modem can do it automatically.

The Source responds to your call with a carrier tone, which the modem recognizes. The modem then returns a greeting carrier tone and the link is established. Next, you instruct The Source to serve up its menu. The modem makes this instruction clear to The Source by modulating its frequency according to the pulse commands.

Likewise, The Source responds with the requested information in tone format, which your modem decodes and displays on your CRT screen. If you were to listen to the conversation, it would sound like a cacaphonous four-note symphony by some obscure modern composer.

To prevent the transfer of erroneous data, a certain signal integrity must be maintained. In other words, you can't have the carrier signal fading in and out on you, otherwise valuable pieces of in-

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formation will be lost. Therefore, a threshold is set, below which incoming data is ignored. This is the carrier-detect limit, and it is usually established right around −42 dBm. If the carrier is absent for too long, the link is broken altogether.

At the end of the conversation, the modems say their goodbyes and hang up the phones. All modems, cheap or expensive, are capable of doing what we've so far described.

Why, then, is there such a widespread difference in the prices of modems if they all do the same thing? What makes one modem cheaper than another? These are all good questions.

The answer is twofold.

Dedicated Chips

The development of VLSI (*V*ery *L*arge *S*cale *I*ntegration) chips has a lot to do with it. Using this process it is possible to incorporate all but a few of the modem's operations into circuits on a single chip of silicon. And it's a proven fact that multifunction chips cost little more to manufacture than single-function ones.

Therein lies the biggest gain. A modem chip, by itself, is a conglomerate of digital functions. It processes the digital input, converts it to an audio signal, and transmits the signal over the telephone lines. The modem chip is also responsible for the reception of the incoming signals, their decoding, and subsequent digital output to the computer. That's quite an undertaking for just one device.

Well, in fact, it does have a *little* help. Until very recently, it has not been feasible to include all of the modem functions on only one chip. Filters, in particular, are not readily adaptable to multi-function designs because of the many parameters involved. Not in the filter design, but in their ultimate use. Without filtering, there is a chance that cross modulation could generate a spurious signal that the modem would mistake for a data bit.

But separate filter chips have been developed. Until their advent, the function of filtering the telephone signal was performed by several operational amplifiers. A single filter chip can replace up to 18 such amplifiers. That's quite a saving.

The final result is a modem chip set made up of two VLSI chips: a modem and a filter.

Frills

But dedicated chip sets are only part of the answer. Many of the expensive modems also use chip sets in their design. In fact, most modems on the market today are designed around a modem chip.

OK, so what *does* separate the expensive models from the budget modems? Frills.

Frills are those things that add convenience to life, but aren't essential to performance. They can best be compared to the service on an airplane trip. There are economy coach flights and champagne flights. Despite the difference in price, they both accomplish the same end: getting you where you are going.

In a modem, frills amount to "gadgets."

Oh, gadgets are neat things to have—if you need them. Most of us don't. It was this lack of need that sparked the budget modem revolution. Let's look at some of these convenience items, why they exist, and what they mean to you.

Probably the most frivolous of modem gadgets are the added monitors, cassette outputs, and TTL ports. I'm sure that, in their day, they were well-received additions to a bare-bones computer. But, those days are pretty well past.

Most personal computers nowadays have an RS-232C DB-25 connector or a dedicated I/O port built right into them. They also support their own version of a cassette interface or monitor, and unless you expect the modem to function on its own, extra interfacing is of little use.

Along more practical lines, you find modems with automatic answering. Although this feature is built right into the modem chip, it requires external circuitry for you to be able to use it. Extra circuits mean extra money . . . and a higher price tag.

Often the number of times the phone rings before the modem answers it can be programmed into the unit. This also increases price.

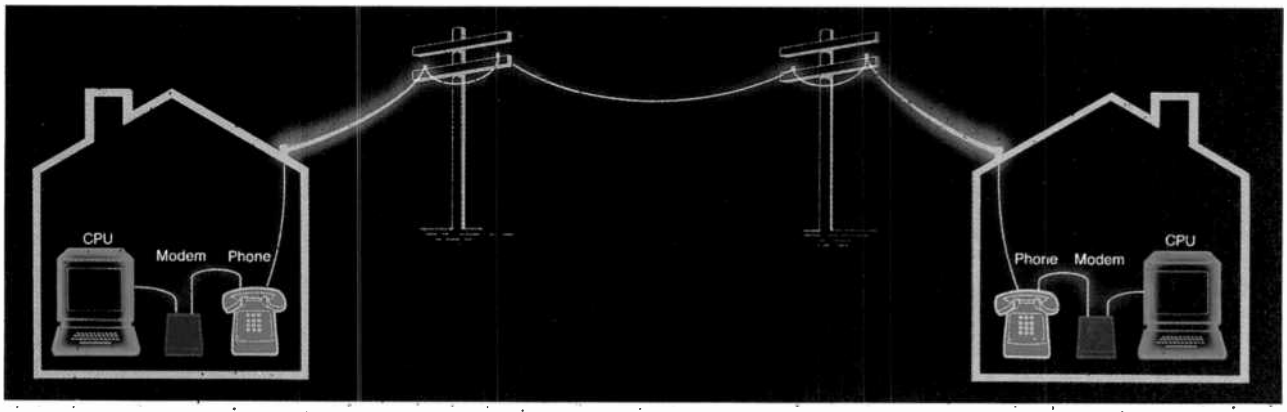

Fig. 1. Typical components of a computer-to-computer phone link.

On the opposite side of the coin are modems that can originate their own calls. They can even remember phone numbers and re-dial them if the line is busy.

Such a feature can be a definite time saver if you make several calls a day. Just think of all the labor saved by having the computer dial up and query the receiver with no user intervention. Then again, think of the price.

Budget Modems

As you may have gathered, budget modems have none of these frills. They are basically manually operated devices.

In almost all cases, the originate and answer modes are selected not by an automatic controller, but by a switch operated by you. If you're placing a call, you flip the switch to the originate position. When receiving a message, you turn it to answer.

Budget modems also require you to dial the telephone number of the intended receiver and to answer the phone yourself when it rings. That's not too much to ask for $100 or less, is it?

(Continued on page 93)

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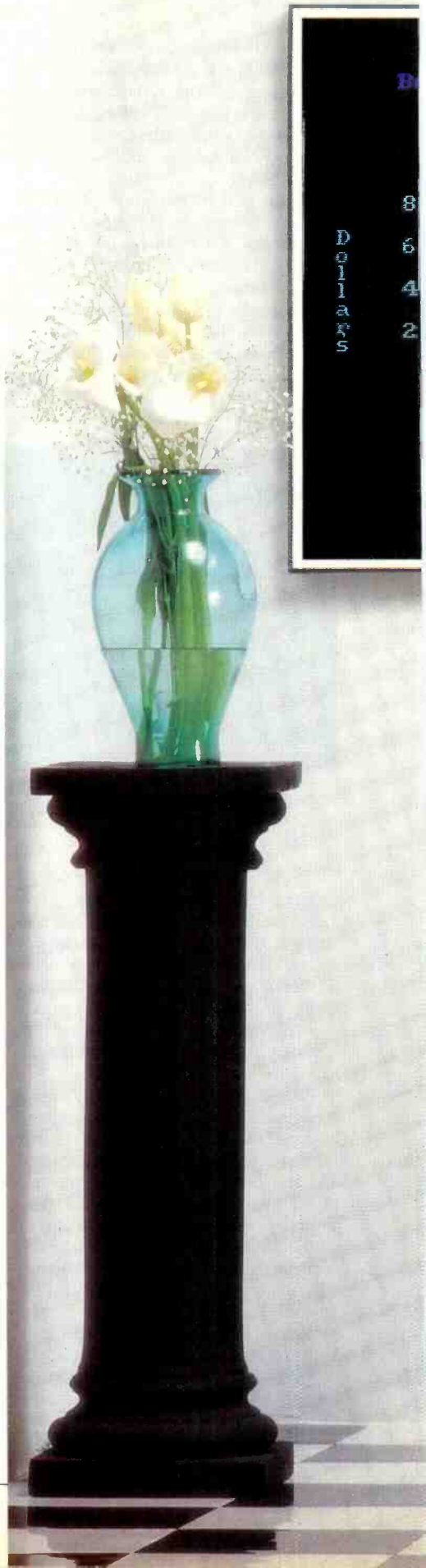
PAINTING A GOOD BUSINESS PICTURE

The best of the available hardware and software for building a top-notch business graphics system

BY JACK BISHOP



IN the business community, the ability to communicate information and data to an audience in the least-complicated and easiest-to-grasp manner is of paramount importance. Since much of the business information communicated consists of numeric data, the best communication medium is pictures in the form of graphs and charts. It is usually easier and more acceptable to present dry numerical data in picture format than to tabulate it in columns.

Today's sophisticated and powerful microcomputers and software packages make it possible for nonprogrammers to construct dazzling, informative graphs and charts that save the person presenting the information a great deal of explanation time. Color gives modern business graphics visual appeal and makes it possible for graphs and charts to contain multiple levels of related information without undue complication. Assigning a different color to each division, for example, permits a graph of income data for several divisions over time without the need for possibly confusing solid, broken, and dotted lines or different gradations of shading.

Dr. Jack Bishop's consulting firm, Bishop Associates, specializes in corporate planning and operations analysis.

Business Graphics Users

The term "business graphics" is a catch-all. It includes everything from line, bar and pie charts to sales territory maps to engineering drawings to pictorial representations of products to block (and other types of) diagrams that depict corporate structure trees or procedures to be performed. In fact, any pictorial representation can be constructed with and presented by a desktop computer. Sometimes, however, the computer must reach out beyond its own realm, to a larger mainframe or minicomputer, to obtain the data needed to construct a graphics image. However, since the focus here is on business graphics, our discussion will be limited to the charting and graphing options available. [For a discussion of getting corporate data to your micro, see "Getting Mainframe Data to Micros" elsewhere in this issue. Ed.]

Users of business graphics range from top executives in large companies to salesmen in the field to managers and analysts in accounting, stock, engineering, and any other departments in which pic-

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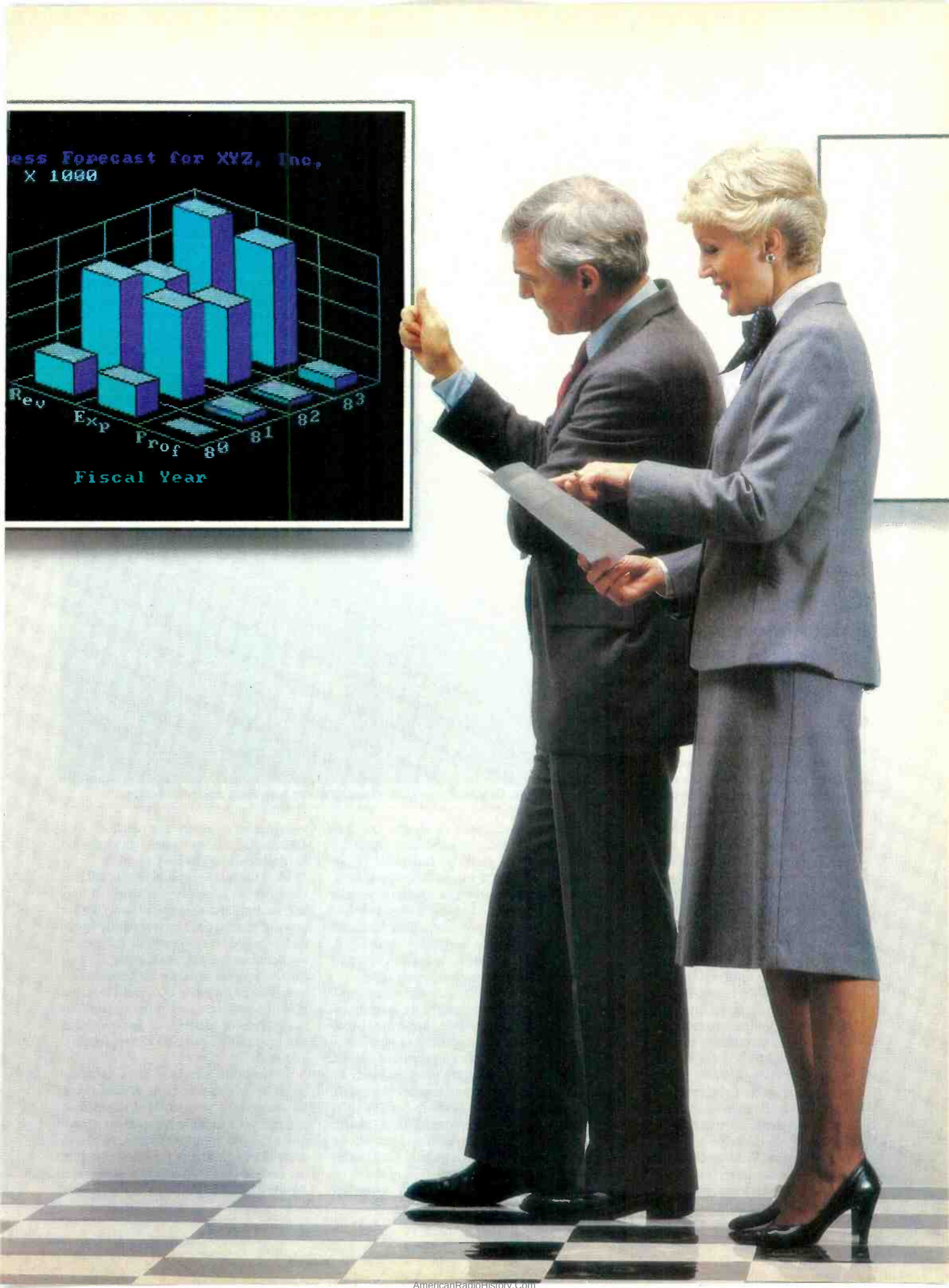

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torial images will be beneficial. Considering that numerical data is the common denominator at all levels, there is no limit to who can use business graphics in the professional community.

When we discuss business graphics, our frame of reference is on the "state of the art," since it is the standard by which a top-quality microcomputer business graphics system must be judged.

Toward the Ideal

It is almost impossible to avoid mentioning "state of the art" in any discussion of computers. Actually, the state of the art in business graphics at the microcomputer level is far from the ideal most users would like it to be. Available systems are too limited in their capabilities, too complicated to operate by the casual user, or both.

To be considered state of the art, a microcomputer-based system must support the charting needs of the business professional, though not necessarily by itself.

You must first decide on the types of charts needed for the intended audience

To achieve the desired level of performance, hardware and software must be viewed as an integrated "system." The system chosen must be able to support *all* the charting needs for analysis and presentation both now and in the foreseeable future. In the business environment, however, one should think of state of the art in terms of simplicity and clarity, not complexity and dazzle.

Opinions differ about what constitutes state of the art in business graphics, depending on the user, the intended audience, and the information to be communicated. The three-dimensional graphics of the engineering department just now beginning to reach the boardroom in a few companies may indeed be state of the art by one definition but may be inappropriate to a user who does not require this level of sophistication. Very powerful and flexible systems are almost always unwieldy to use and require of the user a considerable amount of technical expertise. For the more casual user, such as the inventory manager, budget analyzer, or salesman, a high degree of technical sophistication bought at the price of complex operator requirements prevents the system from being considered to be the state of the art.

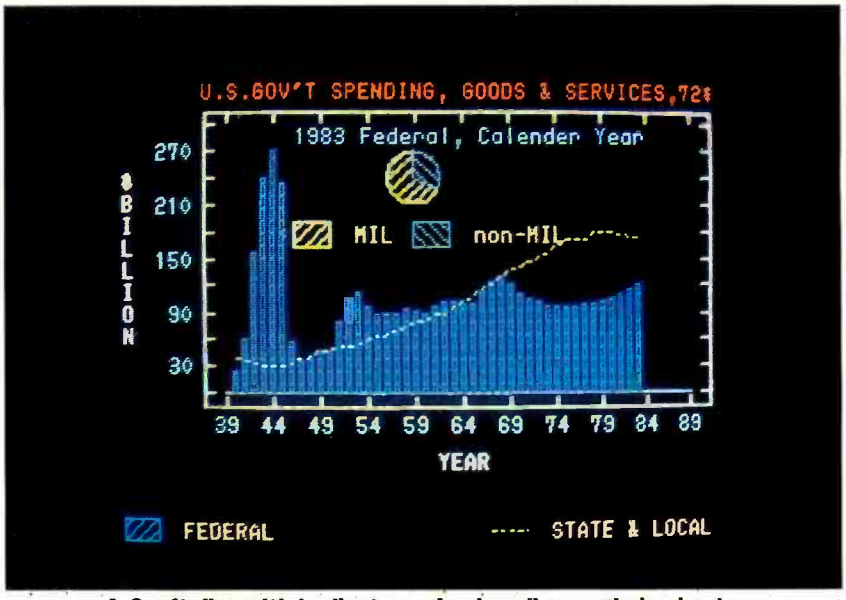
State-of-the-art software must be able to produce text and pictures, in addition to line, bar, scatter, and area (pie) charts. Ideally, the system should be able to develop maps of sales territories, plant and office layouts, process flows, and equipment placement. Additionally, the system should be able to develop a third dimension to permit evaluation of graphics from alternative perspectives. The software should also be flexible enough to permit the user to construct his own custom charts and graphs.

Most modern software can generate the four basic types of charts, but few packages are able to produce *all* types of charts easily, flexibly, and well. To be truly flexible, a state-of-the-art system must produce all types of charts simply and easily and have the ability to fetch data from other programs, data files, and databases. At the very least, such a system should be easy to operate in order to accommodate even infrequent users.

Regardless of type, any chart produced for business graphics applications falls into either of two categories. Most are standard charts produced on a regular basis. The other category consists of special charts that are produced only as the demand arises and that are almost always unique. The flexibility of the software required to produce special charts should not require repetitious operations to produce standard charts. Obviously, the hardware/software system must be able to accommodate both types of charts with ease.

Charts

The first step in putting together a business graphics system is to decide on what types of charts will be needed, based on the type of audience(s) for which they are to be designed. Different audiences require different things. For example, for a presentation to a drafting and engineering audience to be effective, sophisticated three-dimensional plotting capabilities might be required. For graphics artists, considerably higher resolution would be required than for, say, a sales department. If you have the responsibility for putting together a business graphics system, the needs of your audience(s) will obviously dictate what hardware and software you select.



A Graftalk multiple display using bar, line, and pie charts.

Most business graphics charts fall into the basic-set category consisting of line, bar, scatter, and area (pie) charts. Other types of charts, such as star (spider-web) and triangle, may be useful for special applications but are usually too difficult for the general business audience to interpret. The majority of current business graphics software can produce the four basic types of charts; but few packages can produce all varieties easily, flexibly, and well.

Software to produce sales territory maps, in which results or potential can be added as a pseudo-third dimension, are not yet available for current standalone microcomputer systems. A survey of available products for microcomputers reveals that software can be a major limiting factor in putting together a business graphics system. However, a

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modem link to a mainframe computer can give access to software that *can* be used, with a microcomputer to produce almost any type of chart or graph.

Hardware

The hardware side of a business graphics system consists of a basic microcomputer with high-resolution color graphics monitor; a means to generate hard copy of the charts on paper and/or transparent film; and means to connect to the outside world. The external connection, obtained with a modem, provides the system with the ability to use powerful mainframe software packages when the capability of the simple micro-based system is overtaxed. Using a modem to access a mainframe computer provides other capabilities as well, such as the ability to get information (marketing, financial, cost, etc.) from centralized data banks to use in constructing charts and graphs.

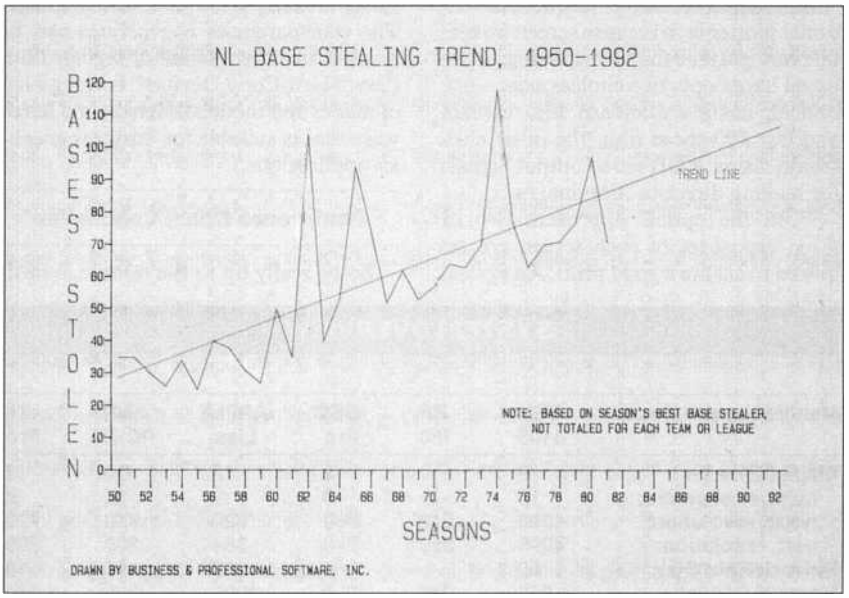
Though the ideal system does not yet exist in the microcomputer world, some of the currently available machines come close to the mark. In terms of user-friendliness, the Apple Macintosh and Lisa and the Hewlett-Packard HP 150 are among the best. Though not available in color yet, they offer excellent graphics capabilities. If color is a necessity, the Texas Instruments Professional Computer (see "System Overview" box) provides an excellent choice, though at a slight sacrifice in resolution. The standard IBM PC is a distant second to the Apple, HP, and TI machines but is worthy of consideration because a great deal of third-party hardware and software is available or under development for it. (Note: The ranking of these computers is based on manufacturer-configured systems. In some cases, particularly with the IBM PC and PC-XT machines, basic system performance can be considerably enhanced by adding third-party hardware.)

Spending more money on the basic system yields greater performance capability. The $10,000 to $13,000 (fully loaded) DEC Professional 350 computer, for example, offers excellent color graphics capabilities. Going higher in price, to the $15,000 and up range, we reach the top of the graphics line with Tektronix and Hewlett-Packard machines. These long-standing favorites of the professional provide resolution that can be described as superb.

A fair amount of storage capacity is required to plot many points and for ease of use in handling many charts. Memory capacity in this context does not refer to available user RAM inside the computer so much as to the system's disk storage capacity. Though a good graphics system can be built around a computer with as little as 256K of user RAM, it would be a wise move to have as much RAM as possible to avoid needless system processing limitations.

Memory capacity is of paramount importance in being able to store very large programs, many of which may not fit on single floppy disks. This requirement is best filled by a hard-disk (also known as "Winchester") system with at least a 10M-byte capacity.

The system's video display monitor should be a color model, both to provide visual impact and to be able to display the various colors that will be used for combination charts and graphs. To assure maximum resolution and color rendition, with a minimum of interference, the monitor must have an RGB (red, green, blue) signal input. (See "Color Monitors" box.)



Business Graphics from BPS permits annotation in charts.

Printers and Plotters

Virtually all users of business graphics systems want the images constructed on a computer to be converted into hard copy. To meet this demand, a number of devices can be used to obtain images on paper, transparencies, and slides, in monochrome (black and white) or in full color.

In keeping with the low cost philosophy of microcomputers, the devices most likely to be chosen will require only a moderate investment. At this level (actually, at any level) of the cost spectrum, no single device will provide a "perfect" solution, though a number can come very close.

Among the hard-copy devices available are dot-matrix impact printers, x/y plotters, and RGB-to-slide duplicators. The dot-matrix printer is not the best choice here, since it is primarily a text generator and only secondarily a graphics device. Graphics images produced by the dot-matrix printer generally lack the fine detail and color quality available with other hard-copy devices. The quality of even the latest color-ribbon dot-matrix printers cannot be considered to be state of the art, though for less stringent needs, these printers may suffice. In a well-rounded business graphics system, however, a good dot-matrix printer offers an inexpensive means of obtaining rough copies of charts to be used for reference purposes.

A color pen plotter is a much better choice for generating hard copies of business graphics. Prices for plotters cover a wide range, with quality varying accordingly. There are, however, several brand names that instill confidence in the graphics arena. Among the most respected is Hewlett-Packard, which makes a series of color plotters that have achieved a deservedly good reputation. Plotters made by HP are the most widely used in the graphics community, both because of product quality and the fact that they are supported by a number of software packages and require no modifications or complicated hookup to the computer.

Though the Tektronix Model 4662 pen plotter has been around for more

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than five years, it is still an excellent device for generating business graphics in hard copy. This top-of-the-line model, which sells for about $6000, can digitize drawings into the computer, a handy feature to have for some special applications.

Ink-jet printers offer an attractive alternative to the pen plotter. The $1600 Tektronix Model 4695 uses four ink cartridges to produce an 8″ × 10″ copy of the screen in three to four minutes at a cost of about 10¢ per copy. Time, price, and performance all recommend that this piece of equipment be seriously considered for inclusion as part of a business graphics system.

Another alternative to the conventional plotter is to capture screen images on photographic film. For photography-based hard copy, two choices exist—one optical, using a standard film camera and fast 400-speed film, the other electronic, using RGB video output signals for making direct-to-film images.

With the optical approach, two or three exposures of each screen are required to ensure a good print. An optical system requires a special lens housing and associated camera to avoid parallax from the curved screen, particularly at tight angles. Using a camera mounted on a tripod may be adequate for the budget-conscious, but it leaves much to be desired with regard to quality.

The electronic approach can be used with any computer that has an RS-232 serial output port. An electronic system, driven by a computer, can provide hard copy in color by bypassing the optical system altogether. Prices for such systems range from about $2500 to $15,000. The $3000 Polaroid VideoPrinter is an example of such a system. It has the ability to make 8″ × 10″ prints and/or transparencies from the screen image. The transparencies it generates can be made with either instant or regular film. (See "Hard-Copy Devices" box for a list of makes and models of hard-copy hardware that is suitable for business graphics applications.)

Conference Room Connection

To be really up to the minute, a business graphics system should also have a projection-TV hookup to bring the graphics from the screen of the computer to the screen of the boardroom. For less than $5000, for example, an Electrohome projection-TV system can be interfaced with the computer to present a graphics slide show produced and controlled by the computer.

Finally, there exist dial-up services that can produce a hard-copy version of a chart as 35-mm transparency for less than $10. One such service is "Target" from Comshare, 1935 Cliff Valley Rd., Atlanta, GA 30329 (404-634-9535). Some services offer aid with chart making as well. Truly professional chart-making requires a specialized minicomputer with proprietary software and is available in large cities.

Reconfiguring a System

One way to obtain near-state-of-the-art performance from a basic microcomputer system that ordinarily does not provide such a high level of performance is to reconfigure it. Most computers have expansion slots or facilities for using expansion chassis to accommodate hardware add-ins or add-ons. This feature can be used to upgrade a computer so that it has the desired capabilities.

By reconfiguring a system, the user who wants near-state-of-the-art performance can preserve his original investment in computer hardware. This may not be the best route to take in all circumstances, however. Reconfiguring an existing system usually requires the services of an expert who has considerable experience with computer hardware and software to devise a working system. When such expertise is available, this can certainly be a viable approach.

Some computers are more easily reconfigured than others. These machines have available to them performance-enhancement add-ins and/or add-ons from the computer manufacturer and other sources. Among the two most popular series of microcomputers with good expansion capability are the Apple II series and the IBM PC and PC-XT. The popularity of the Apple II series often has been attributed to the ease with which these machines can accommodate a wide variety of circuit cards that plug directly into the expansion slots. By plugging in a couple of cards, a lowly games-playing Apple II can be transformed into an advanced 16-bit computer with 256K of RAM to upgrade performance to the near-state-of-the-art level required for top-quality

(Continued on page 108)

SYSTEM OVERVIEW

Manufacturer*/Model	TEK 4105	HP 150	DEC Pro	APPLE Lisa	IBM PC-XT	TI Pro
Display Size (in.):	19		12	12	14	13
number of colors:	16	1	8	1	16	8
horiz. resolution:	4096	512	960	720	320	720
vert. resolution:	4096	390	240	364	200	300
Refresh Rate (Hz):	60		60	60	15	19
Memory (bytes):	256	256	256	1000	256	256

*Manufacturer abbreviations are as follows: TEK = Tektronix; HP = Hewlett-Packard; DEC = Digital Equipment Corp.; TI = Texas Instruments Inc.

COLOR MONITORS

The following is a representative listing of RGB-input color video monitors available in the marketplace.

Manufacturer	Model and Details
NEC Home Electronics	Model JC 1216: 12″ RGB; 8 × 8-dot matrix; 10-MHz bandwidth; 640 × 240-pixel graphics resolution
Princeton Graphic Systems	Model SR-12: 12″ RGB; 0.31-mm dot pitch; 31.5-kHz scan rate; 690 × 480-pixel graphics resolution
Amdek	Model Color IV: 13″ RGB; 15.75-kHz scan rate; 720 × 420-pixel graphics resolution
TSK Electronics Corporation	Taxan RGBvision III: 12″ RGB; 15.75-kHz scan rate
Wyse Technology	Model WY300: 8 colors

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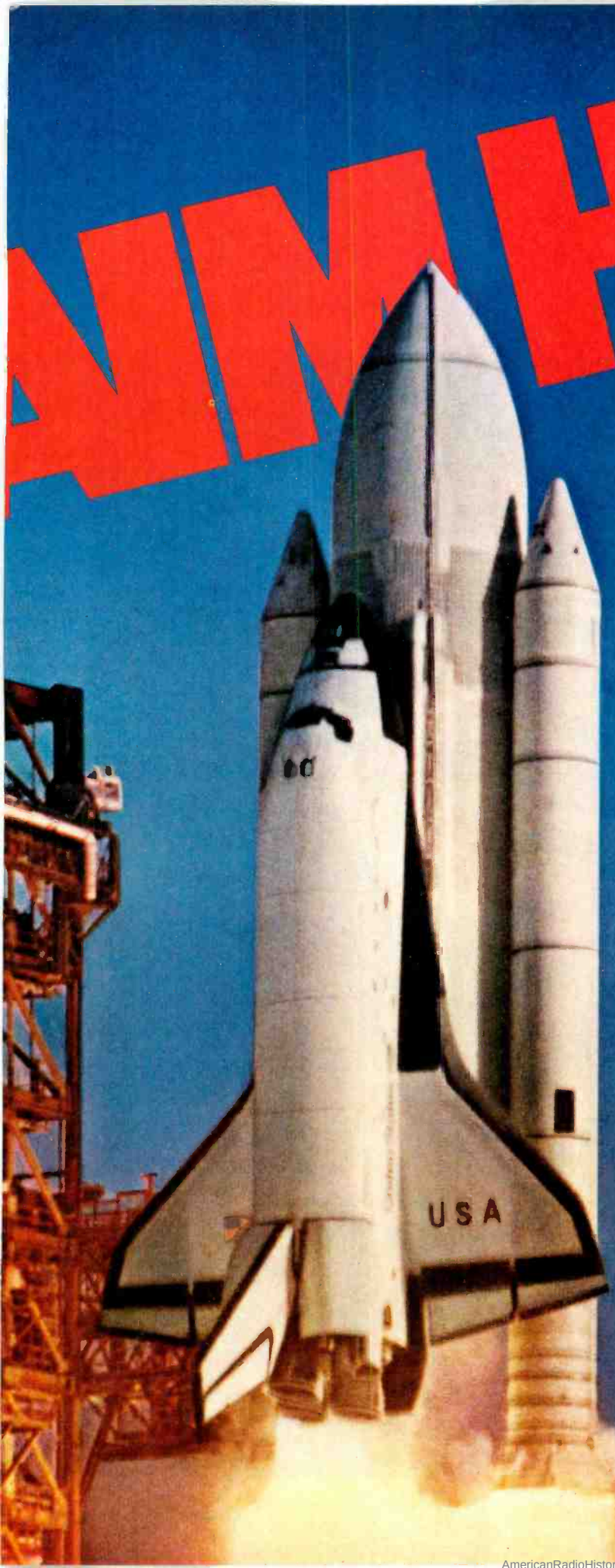

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NASA's space shuttle. For Air Force officers working as electrical or aerospace engineers, the challenge is just beginning. In fact, from laboratories to lasers to launch pads, we have exciting projects and management opportunities very few employers can offer.

For example, we are developing experiments that will be an important part of the space shuttle's cargo in the years to come. Experienced Air Force engineers will work as shuttle mission planners and as astronaut flight controllers.

If you have an electrical or aerospace engineering degree, or soon will have, we may have a challenging future for you as an Air Force officer. It's a future that demands the vision and commitment of people like you. And it's vital to our country.

For more information about Air Force engineering opportunities, mail the card. Or call toll-free 1-800-423-USAF (in California 1-800-232-USAF). Better yet, send your resume to HRS/RSAANE, Randolph AFB, TX 78150. There's no obligation.

AIR FORCE

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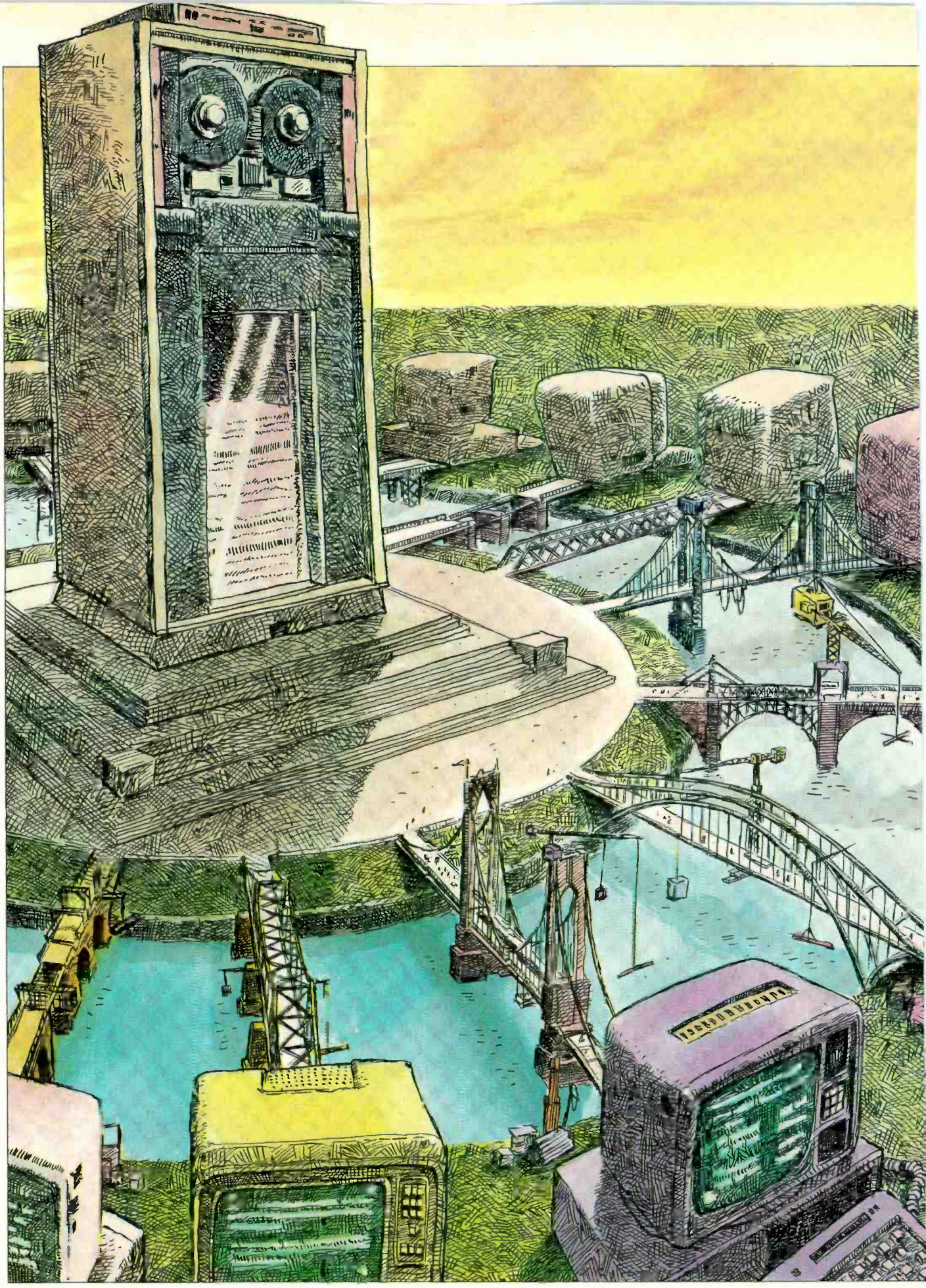

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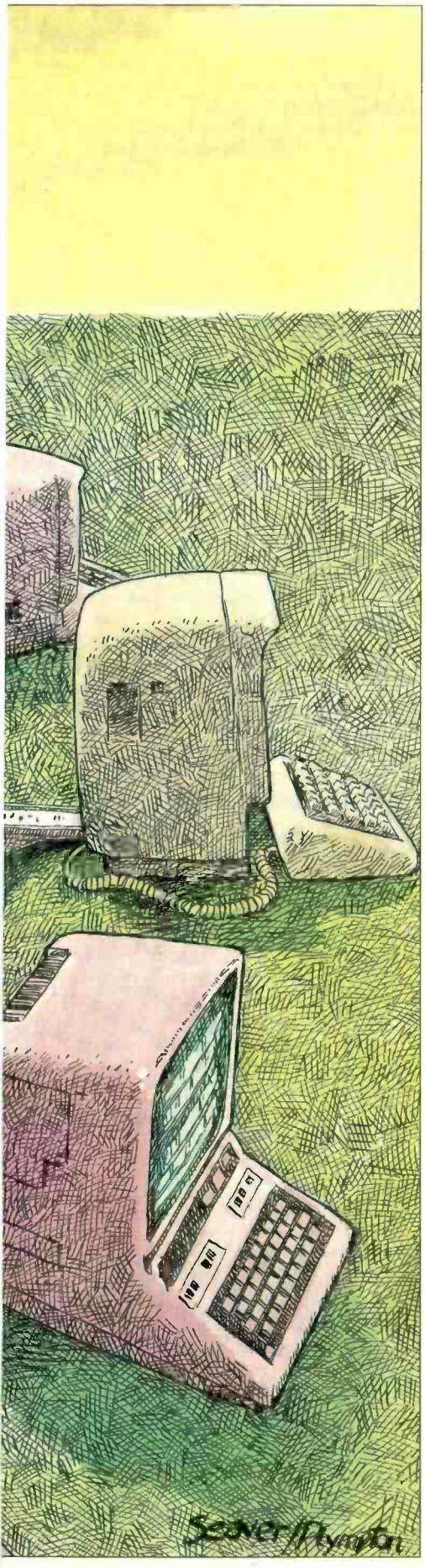

GETTING MAINFRAME DATA TO MICROS

Making corporate databases available to micro users isn't as easy as it sounds

BY JAN A. GUGLIOTTI AND ELLIOT B. WEITZ

With the rapid proliferation of personal computers and inexpensive software in the workplace, there has been reason to celebrate. Applications software such as spreadsheets, database managers and word-processing packages is helping users of personal computers produce higher quality work more easily and rapidly.

Their enthusiasm, however, can quickly come to a halt when they attempt to tap directly into their organization's big mainframe computer. Having developed a hunger for more fact and more analysis, users naturally begin to wonder why they have to wade through reams of paper to get at the information they need. Wouldn't it be simpler just to siphon off information from the corporate mainframe into a micro spreadsheet? Why not just bypass the mainframe entirely, and develop all new applications on personal computers?

Those who'd like to pursue this course of action typically run up against seemingly contradictory information. Their data-processing department, using extremely technical and rather obtuse language, says that the micro-to-mainframe connection can't be made—it costs too much money, takes months to implement, and won't produce the desired result (ready access to fresh data).

Yet, the packaged solutions advertised so widely seem to promise instant access to mainframe data at a reasonable cost. Who's telling the truth?

The fact is, both arguments contain an element of truth. The packages advertised can solve some of the problems of attaching a micro to a mainframe for purposes of data sharing. But the data-processing people are also correct—those packages solve only some of the problems.

The purpose of this article is to provide some explanation of the issues, definitions of technical jargon, and examples of products, so the personal computer user can have a more informed discussion with both vendors and data processing. But because the past months have literally opened the floodgates to new mainframe-to-PC software, the commercial products we reference have been limited to (a) those that provide a physical link between an IBM mainframe and an IBM PC, and (b) representative IBM-to-PC software packages. Apologies to those who have been omitted in the interest of space.

The Issues

Knowing the meaning of the technical terms you will encounter in your search for the micro-to-mainframe connection (see the sidebar) isn't enough. You need to understand the problems that exist and how they place a barrier between the personal computer and the company mainframe.

There are two technical issues that must be addressed to make the micro-mainframe link feasible. The first is

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ILLUSTRATION BY BILL PLYMPTON

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making the physical connection—how to introduce your personal computer to the company mainframe without spending a quarter of a million dollars for new hardware and software. The second, *making the data connection*, is how to get the data you want without the resources of a squad of black belt programmers.

The Physical Connection

Connecting your personal computer to your company's big one requires playing by the mainframe's rules. Before you run out to the corner computer store and spend money on hardware or software to make the link, spend time with your information systems and communications departments to define exactly what your mainframe requires or is able to provide to support communications with a personal computer.

If the mainframe already supports remote timesharing, and if the number of personal-computer users who want to access the mainframe is small (and likely to remain so), you're in luck. You can use simple one-to-one links with your mainframe, and one of the asynchronous communications protocols that are widely supported by personal computer equipment and software vendors. These links are relatively inexpensive, and have been around for a long time. The investment required at the micro end is an ordinary personal-computer modem (e.g., Hayes, Novation, Rixon, etc.) and communications software (e.g., Crosstalk, Mite, or even a public domain program like MODEM 712).

Before you run out and spend money, define your requirements

If your mainframe does not support remote timesharing, however, you will be forced to explore and become familiar with the world of synchronous protocols, cluster communications, and IBM 3270 terminal emulation. As a general rule, personal computer links to this environment are more expensive and have undergone less of a technical shakeout period. Examples of products that forge the physical link alone from the personal-computer end, in a synchronous, cluster-controlled environment, are the IRMA board (TAC, Atlanta, GA), various hardware/software connections from AST Research (Irvine, CA), and the 3270 PC made by IBM, which has the added advantage of allowing four separate programs running simultaneously on the mainframe to be piped into "windows" on the PC screen.

Most other vendors whose products primarily support the data-grabbing function (see The Data Connection, below) have integrated the physical connection into their "tool kits" of mainframe-to-PC software. A good example is the IT series of micro-to-mainframe connections, from Martin Marietta Data System of Princeton, NJ. The IT series includes a physical link for asynchronous communication (Link-IT), and for synchronous communication (Pass-IT), as well as data management software described below. Omnilink and Omnimicro (On-Line Software International, Fort Lee, NJ) is another powerful family of tools that support a variety of mainframe asynchronous, synchronous and networked physical links, in tandem with a query facility to grab data out of a

A GLOSSARY OF TERMS

A PHYSICAL link consists of the hardware, the media, and the actual physical configuration used to link one computer to another.

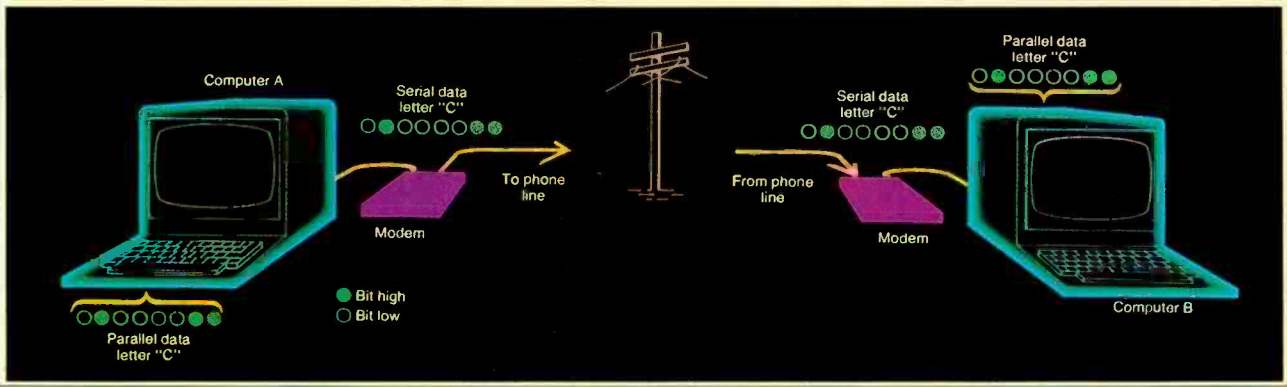
The link starts (and ends) with a serial port for the computer and a modem (*mo*dulator/*dem*odulator). The easiest way to understand the role of these components is to follow a single character as it is transmitted from one computer to another.

The character, represented by seven or eight bits (*b*inary dig*its;* logic 1s and 0s) in parallel—side-by-side—within computer A, is transferred from the computer's keyboard or memory to the circuitry of its serial port as pulses of electricity. There the bits are rearranged so they can be sent serially—one bit after the other—as dc voltages to the physical termination of that port, the connector to which a modem can be attached. Each bit's presence or absence is represented by a high (about 12 V) or low (close to 0 V) pulse whose duration depends on the transmission speed being used. The higher the speed, the shorter the length of the pulse.

From the (physical) serial port of computer A, the bits representing the character can be sent to the serial port of computer B, where the serial-to-parallel process is reversed and the character is displayed on the computer's screen, printed out, or entered into its memory (see figure below). The character can get

(Continued on page 104)

Modem transmission of signals from one computer to another.



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variety of "live" data files on the mainframe. Other software families with similar physical link additions to their data-grabbing bridge capabilities include System W (from Comshare, Ann Arbor, MI) and ADR/PC (Applied Data Research, Princeton, NJ).

However, the real investment that may be required to support personal computer access shows up at the mainframe end—a cluster controller, new cabling, networking software, and additional front-end communications gear. It is easy to spend a quarter of a million dollars on hardware and software enhancements for the mainframe to enable dialogue with an office full of $2000 micros.

The Data Connection

Four types of generic software offerings to bridge the gap between mainframe data storage and personal computer applications packages (usually spreadsheets) began to appear late in 1983.

The first type provides a bridge from a mainframe fourth-generation language (one that permits nonprogrammers to quickly produce reports from mainframe data files) to a micro version of the language or to a spreadsheet. The bridge makes it easier for nonprogrammers who have spent time learning the fourth-generation language to find, extract, reformat and download data that already reside in the mainframe version of that language's data files.

The following things typically must happen in a fourth-generation language link:

- Data of interest to many users are taken from a variety of sources (e.g. accounting programs, production programs, "bought" data such as market share reports) and stored in a file accessible by the mainframe fourth-generation language. An experienced programmer is almost always required to write this "data read/write" program. Each time the original source of data is updated (for example, each time new production statistics are reported) the "data read/write" program must be re-run.
- An individual user decides what kind of information he or she needs from the mainframe, fourth-generation file. Someone writes a program in the fourth-generation language, usually off-line on the micro, to find, aggregate and possibly reformat the data into a set that serves the micro user's purposes. Dedicated nonprogrammers can often write this "data fetch" program with a little outside help.

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PROTOCOLS

By Charles Daney

PERSONAL computer owners who use their equipment to communicate with mainframes or other personal computers are generally aware that they must use "asynchronous terminal" emulation software to do this. Just what is an asynchronous terminal, and what makes it different from other types of terminals?

The chief respect in which terminals differ—as far as communications is concerned—is in the communications protocol employed. A dictionary definition of "protocol" might read: "A formal standard of speech or behavior governing interactions between individuals." The purpose of such a protocol is to establish who should speak at what time, and how his words should be interpreted.

Although computers communicate using bits rather than the spoken word, the problems to be solved are much the same. Whose turn is it to transmit data? How fast can the data be transmitted? Are special signals required to get the other side's attention? Are there special signals to use to indicate that an error has occurred?

Protocols determine how data flow is controlled and how potential errors can be corrected

Strictly speaking, asynchronous communications really implies the absence of a protocol, since either side can talk at any time. The two ends do not need to be in sync with each other. In practice, of course, it is not feasible to communicate without some further conventions. Therefore, many asynchronous terminals and communications programs can be configured to use a specific baud rate, parity, number of data bits, number of stop bits, etc. But these parameters are arbitrary. They are not truly a part of asynchronous protocol.

While the format in which data is transmitted is important, it is not "protocol." Protocol determines how the flow of data is controlled, and how potential errors in transmission (or reception) are detected and corrected.

For asynchronous terminals, a number of *ad hoc* methods have been devised for dealing with such matters. For example, the use of the parity bit permits the terminal or host computer to detect whether the number of bits in a byte is incorrect. The XON/XOFF characters (CONTROL-S, CONTROL-Q) can be used as signals for one side to stop sending momentarily while the other catches its breath. But every such device tends to introduce other problems. For example, if the parity bit is in use, arbitrary 8-bit bytes (binary data) cannot easily be sent, so special methods of character encoding must be provided.

To handle such problems in a satisfactory and uniform manner, genuine protocols have been defined with the intention that both terminals and host computers will employ them "transparently" to the user or application program. One of the earliest of these, developed by IBM in the 1960s, is called **binary-synchronous communication,** or **bisync** for short.

As the name "bisync" implies, both ends of the communications link attempt to remain in sync with each other. This is done using a special character (i.e., a bit pattern) called SYN. Bisync is a **half duplex** protocol, in that only one side can be transmitting at any given time. Another special character called ENQ (for "enquiry") is therefore used to gain control of the communications line, which must subsequently be relinquished with an EOT (for "end of transmission") character. This mechanism handles the flow control problem to prevent data from being sent faster than the recipient can handle it.

Instead of using a parity bit for error checking, bisync employs a **checksum,** which is just a number computed from the actual data to be sent. The sender computes the number and forwards it along with the data. The recipient recomputes it. If the checksums match, the recipient assumes the data is correct (although there is still a low probability that it isn't!), and replies with an ACK (for "acknowledge") character. Otherwise the data is assumed to be in error and a NAK (for "negative acknowledgement") is sent. The originator then retransmits the data.

Note that ENQ, SYN, ACK, NAK, etc. are just ordinary control characters, so they could be present in normal (binary) data. To prevent confusion, yet another

(Continued on page 103)

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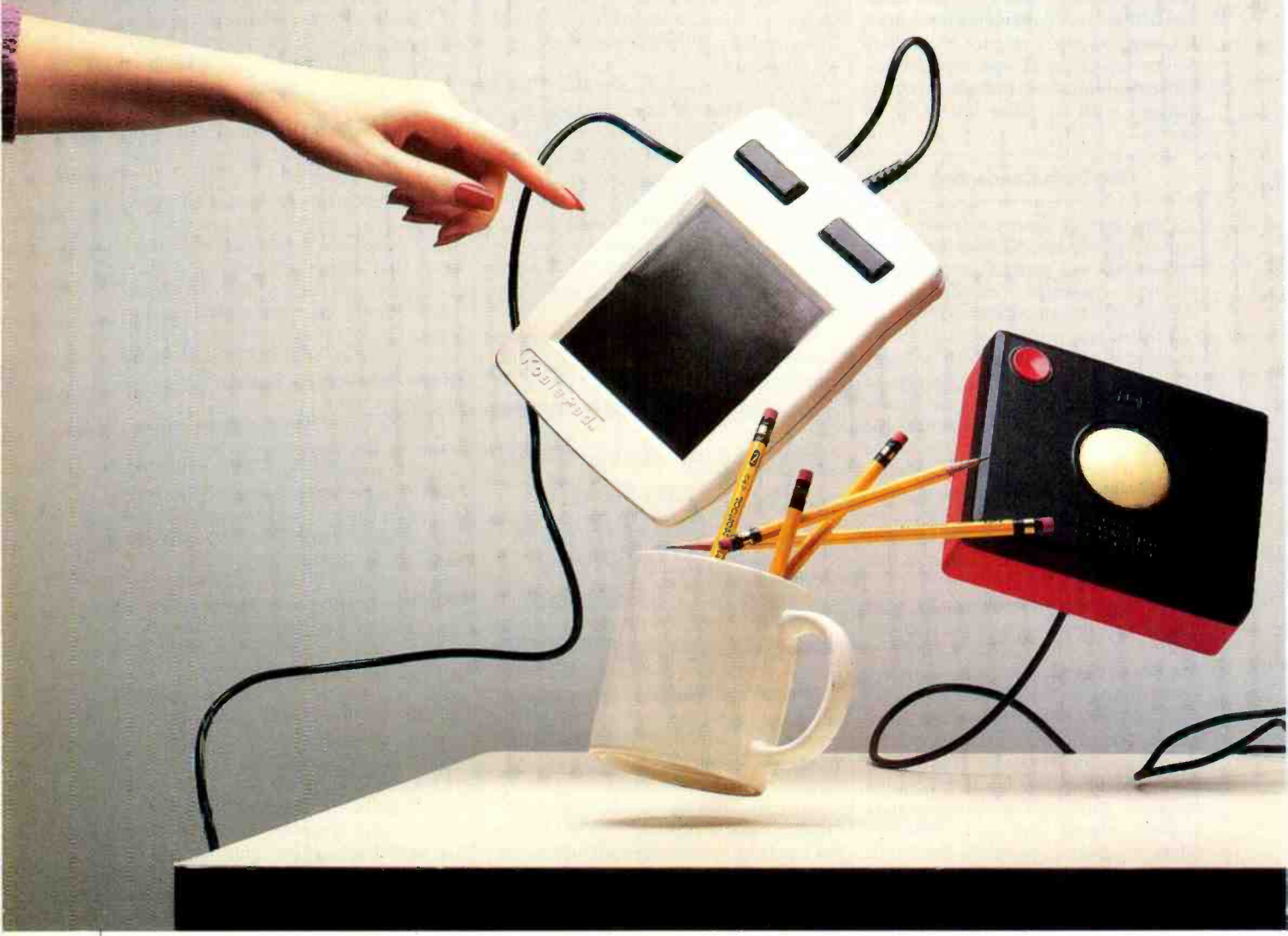
A Few Quick Pointers

Mouses, touch screens, touch pads, light pens, and the like can make you system easier to use

BY FORREST M. MIMS III



PHOTOGRAPH BY STEVE BRONSTEIN

AMONG the most powerful peripherals for personal computers are those that enable the user to move a cursor and enter commands and data *without* resorting to the keyboard. Collectively known as *pointing devices*, they include various kinds of joysticks, digitizing tablets, touch screens, light pens, and mice.

Forrest M. Mims, III is a contributing editor to C&E.

Many of these pointing devices have long been available to users of sophisticated scientific and engineering computers. However, with the exception of some joysticks and light pens, their price was far beyond the means of the typical personal computer owner.

Fortunately, the rapid growth of the personal computer industry has made a major impact on the availability of reasonably priced pointing devices. Today a wide variety of such devices, along with quality driver software, is available.

Many computer users have had little or no experience in the use of pointing devices and therefore are unsure which is best suited for their needs. If you fall in this category, you're not alone. Even experienced users of pointing devices continue to debate the merits of the various kinds by citing research studies and scholarly papers that claim *their* favorite pointing device is indeed the best.

Notwithstanding the ongoing contro-

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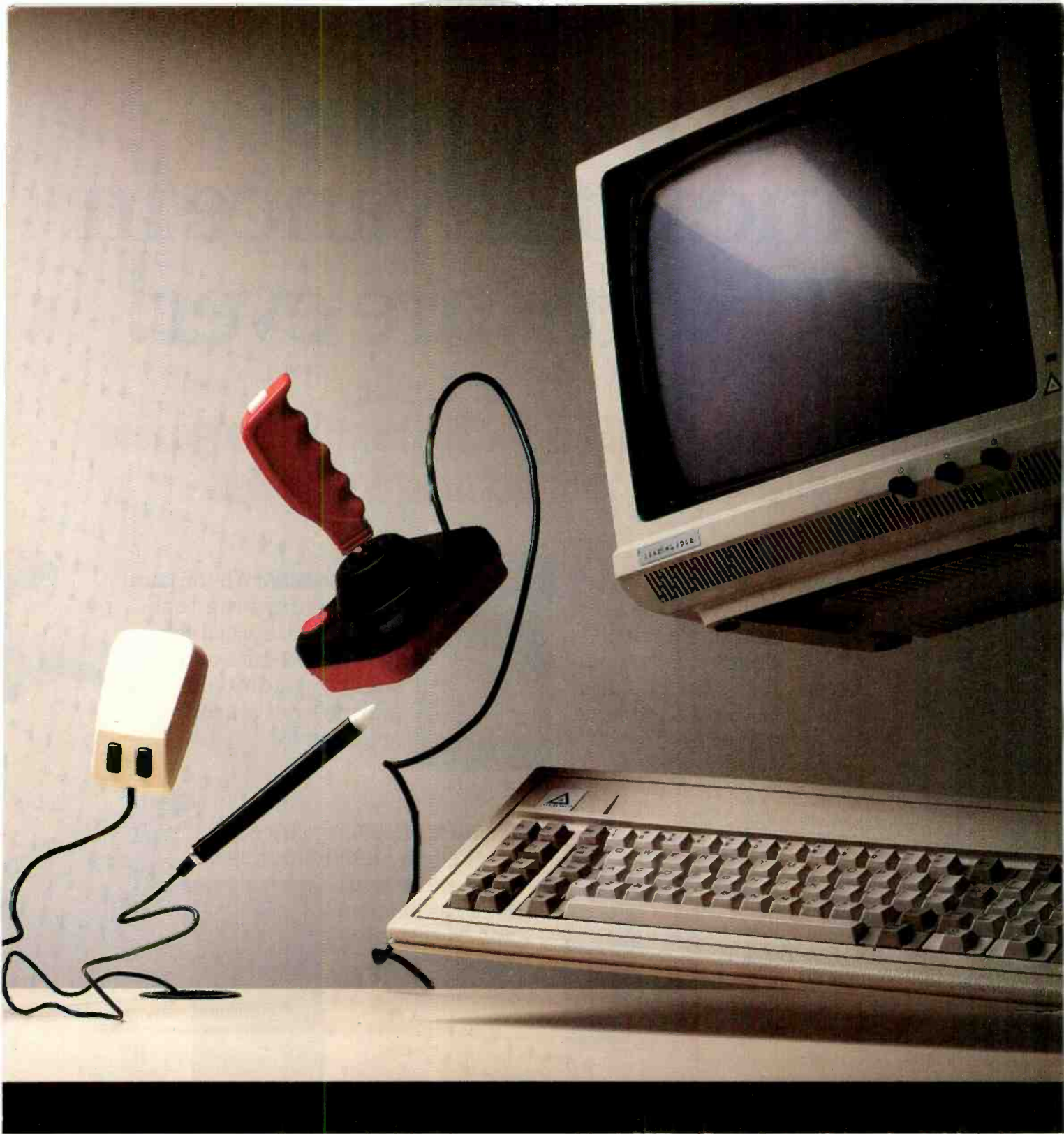

versy it *is* possible for even a novice user to decide which pointing device is superior for a particular application. All that's required is a comparison of the features of the various kinds, followed by a "hands-on" session with those that seem best. The review that follows will help you get started.

Joysticks

Thanks to the video game industry, joysticks and game paddles are the most pervasive of pointing devices. Virtually every low-cost computer system sold today includes a pair of joystick input ports.

The two major kinds of joysticks, *analog* and *digital,* use entirely different operating principles. The analog joystick is a proportional device. Long a favorite control interface for radio control airplane enthusiasts, the most common kind of analog joystick consists of two potentiometers whose rotors are mechanically linked by a two-axis coupler and shaft assembly. Movement of the shaft (the "stick") along either the x or y axis moves the rotor of the respective potentiometer. Off-axis movements of the stick move *both* rotors, each in direct proportion to the direction and displacement of the stick.

In a typical analog joystick, a dc voltage is connected across each potentiometer. A variable voltage appears at the ro-

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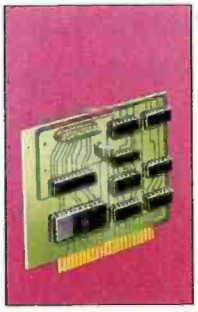

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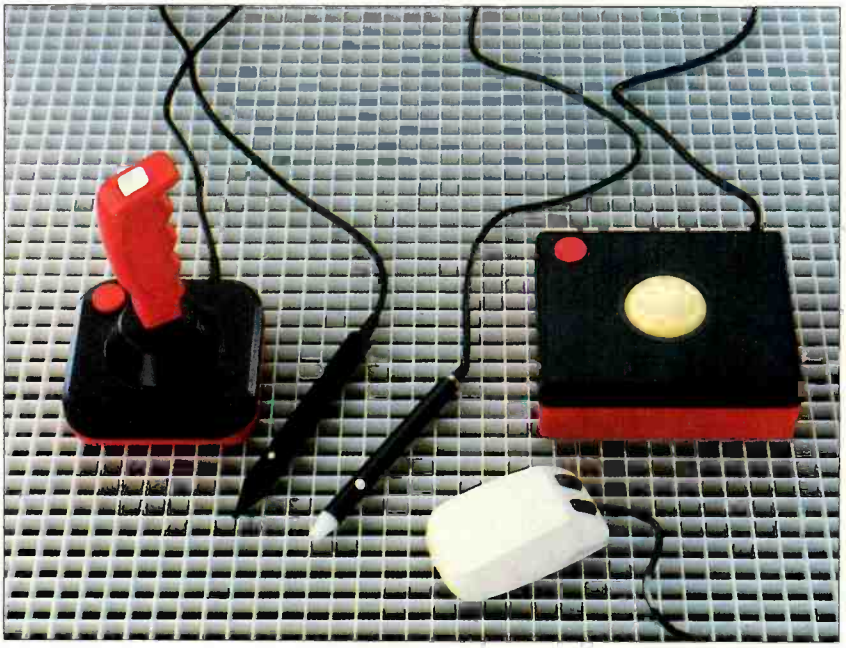


Joysticks, light pens, trackballs and mouses are all pointers.

tor terminals. Thus, as the stick is moved, analog-to-digital conversion circuitry in the computer transforms the variable voltage into digital bytes that can be processed as data entries or used to move a cursor.

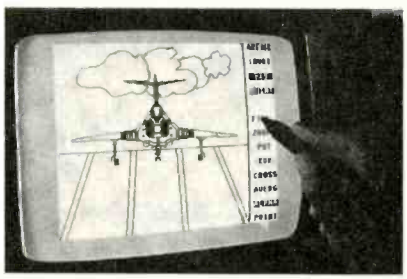
Some analog joysticks have a "floating" stick that remains where it is moved. Others are equipped with springs that return the stick to its center position when it is released. Some center-return joysticks can also be operated in the floating mode.

The digital joystick, commonly used with many low-cost home computers, is much simpler in design. It generates an output byte when its shaft is moved in each of eight directions. A typical digital joystick contains only four switches. The additional four output bytes are generated when *two* of the switches are simultaneously closed.

Analog joysticks are usually operated in an *absolute* mode in which the cursor follows the position of the stick. Digital joysticks are *rate* devices. The cursor moves in the direction the stick is moved. When the stick is returned to its center position, however, the cursor simply stops moving. The next time the stick is moved, the cursor follows in the same direction. Some rate joysticks increase the speed of the cursor as the stick is moved farther from its center position.

Recently the features of absolute and rate joysticks have been combined in a hybrid device called the *absolute/rate* joystick. One such device normally functions as a rate joystick. When a small switch on the stick is pressed, the joystick functions in the absolute mode. The absolute mode permits very quick movements of the cursor to a general area of interest, while the rate mode allows the cursor to be precisely located.

Quality joysticks for use with personal computers cost under $50, a good buy considering the ruggedness of most



Inkwell Systems' Flexidraw.

units. Specialized joysticks for flight control systems, radar operators, and outdoor use can cost considerably more.

For instance, miniature, finger-operated joysticks made by Measurement Systems, Inc. cost from $444 to $1126. Tiny silicon piezoresistive elements within these hermetically sealed joysticks generate a small voltage as pressure is applied to the stick.

Trackballs

The trackball permits very rapid cursor movements. It consists of an enclosed assembly containing a plastic ball that can be freely rotated in any direction. As the ball rotates, it turns one or both of two small rubber wheels, each of which is attached to a shaft that is free to rotate.

The shafts of the analog trackball are mechanically linked to the rotors of potentiometers. Other trackballs include encoding devices such as slotted pick-off wheels. A light emitting diode and phototransistor on opposite sides of the pick-off wheel cause a series of pulses to be generated as the trackball is moved.

The trackball is well suited for very rapid movements of a cursor across a display and for causing a cursor to follow an on-screen outline. Simply by varying the speed at which the ball is rotated, the motion of the cursor can be varied from a slow crawl to a rapid clip. This is why the trackball is superior to the joystick for some kinds of video games. On the other hand, an analog joystick is generally a better choice for continuous tracking of moving on-screen objects.

Trackballs are more complicated, hence more expensive, than most joysticks. Precision units designed for military and flight control applications can cost more than $2000. Trackballs for home computers and video games can be purchased for as little as $30.

The Mouse

The mouse is a movable pointing device. About the size of a bar of soap, most resemble an up-side down trackball designed to be rolled across the surface of a desk. Others incorporate optical sensors that generate pulses as the mouse is moved across the surface of a specially marked grid.

Developed more than fifteen years ago at Stanford Research Institute, the mouse has only recently come into widespread use. It's biggest proponent, Apple Computer, has staked its future on the viability of the mouse as an efficient, effective pointing device. Both Lisa and Macintosh replace function keys and complicated sequences of keyboard commands with on-screen options and icons that can be quickly selected by moving a small mouse-driven, on-screen pointer over them. The selection is then implemented by pressing a button on the mouse.

It's important to understand the differences between mechanical and optical mice. A mechanical mouse detects movements of its rotating ball using the same methods applied to trackballs. Some mechanical mice create noise when they are moved. And the ball can transfer eraser particles and other debris

COLOR PHOTOGRAPHS BY MICHAEL CARDACINO

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from the desktop to the inside of the mouse's housing.

Optical mice have no moving parts. But the grid-marked pad they require occupies valuable desk space.

An ongoing debate among mouse manufacturers concerns the number of switch buttons on the device. Apple claims the best approach is a single switch that can be operated in three modes. For example, one press might select an option, two presses might implement an operation and continuous pressure might draw a line.

Others claim that multiple buttons are best. They note, for example, that several buttons allow lines to be drawn without the nuisance of having to press continuously on a switch.

How effective is the mouse? A 1978 project known as the Xerox study compared the relative effectiveness of the mouse, joystick and cursor and text keys for text selection and editing purposes. The mouse was " . . . found to be the fastest on all counts and also to have the lowest error rates." (Stuart K. Card, William K. English and Betty J. Burr in *Ergonomics*, Vol. 21, No. 8, pp. 601-613.)

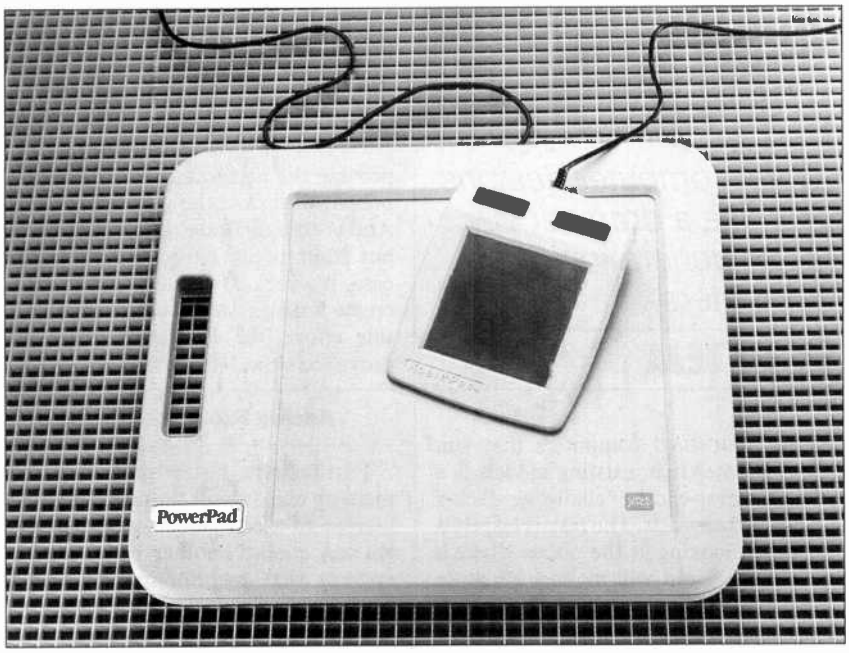
These advantages, however, must be viewed in light of the mouse's drawbacks. These include the fact that it requires space and is totally unsuited for use with lapsize and other portable computers. Furthermore, long-term operation of a mouse is more fatiguing than a joystick. Finally, the mouse is more expensive and more fragile than most joysticks.

The Light Pen

There's something magical about a pen that leaves behind a trail of color as it is moved across the face of a computer screen like an electronic paintbrush. And since the light pen is held and used like a pencil, it's operation is much more natural and familiar than most other pointing devices.

The operation of a light pen is less mysterious than it appears. The screen of a cathode-ray tube used as a computer display is repeatedly scanned by a tightly focused electron beam. Therefore, because of the slow response of the human eye, the entire screen appears to glow. Actually the glow is caused by a fast moving dot of light that can be easily sensed by a phototransistor or photodiode in a light pen.

The light pen generates a pulse when it detects the sweeping dot. Since the position of the dot at any time can be easily determined, the computer "knows" exactly where the light pen is pointed. Depending upon the software, it can then light (or extinguish) a pixel or select a menu option.



The Koalapad and PowerPad are two types of digitizing tablets.

Recently several light pens specifically designed for home computers have been developed. Some cost as little as $25. Much more sophisticated versions can cost more than $100 and are sold with surprisingly complete software packages.

Hewlett-Packard's touch screen.

A particularly impressive light pen-software combination is Inkwell Systems, light pen and Flexidraw™ software. Designed specifically for the Commodore 64, Flexidraw's on-screen menu includes such functions as Box, Circle, Line, Draw, Point-to-Point, Grid, Fill, Zoom, Rubber Band and Shade.

Flexidraw can be used to make on-screen drawings such as circuit diagrams, graphs, musical scores and floorplans. The completed drawing can then be printed on paper by a dot-matrix printer.

Though in principle the light pen is more natural to use than most other pointing devices, it lacks high resolution. Worse, it's both tiring and unnatural to draw with a light pen on a typical computer monitor screen for extended periods. These drawbacks may not be significant when the light pen is used for relatively short sessions. And they can be eliminated entirely if the display screen is mounted in a *horizontal* position. The screen then becomes a properly positioned sketchpad on your desk or tabletop for the light pen.

Touch Sensitive Screens

Touch sensitive computer monitor screens permit an index finger or, perhaps, a stylus, to function much like a light pen. They provide a very simple and totally natural interface between a computer and its operator.

Because of the relatively large size of even the smallest finger tip, however, touch sensitive screens have low resolution. While they are fine for selecting menu options, they cannot be used to point to a single character or digit.

Some shopping malls have replaced their directory signs with a computerized touch screen system. Shoppers can find directions to any store in the mall simply by touching the appropriate category in the listing on the screen and, when it appears on the screen, the store's name. Instructions for finding the store then appear on the display.

Several sensing methods for touch screens are in use. The simplest incorporates two clear plastic sheets, each coat-

(Continued on page 114)

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New Architectures

Novel computer designs promise a dramatically faster generation of computers

BY ED TEJA

DESIGNING computers that run faster than existing models is a never-ending challenge facing computer scientists. The task is largely a matter of looking at the places where a little more speed will make a lot more difference in the overall system performance.

A block diagram of conventional computer architecture is shown in Fig. 1. What can be done to speed it up? Without changing the architecture, about all a designer can do is choose newer and faster microprocessor chips. Since the processor does the bulk of the work in this design, faster processors usually mean faster computers. As a result, a great deal of research effort has been dedicated to finding new manufacturing processes and materials that will provide us with faster processors.

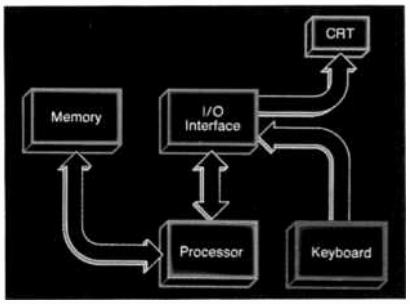

Fig. 1. Basic computer architecture.

But the newest processors are always the most expensive. This is one strike against relying on state-of-the-art components, but not the most important one. Using a fast new processor also demands comparable improvements from other system components. This might mean faster memory chips as well as disk subsystems that transfer data at higher rates (and this is a major bottleneck in many small systems) just to keep up with the processor's new-found speed. Improving the performance of these components will raise the system's cost, too. And you might find that even the system bus itself needs improvement. In this case, it's back to the drawing board to create a new system bus. Even after all this effort, the computer might still prove too slow. What then?

Ed Teja writes frequently for C&E on computer electronics.

Adding Processor Power

Fortunately, faster processors and memory chips aren't the only solution to increasing a computer's speed. Designers can choose another tack—creating systems that use multiple processors. Each processor you add to the system has the potential of adding to its overall performance.

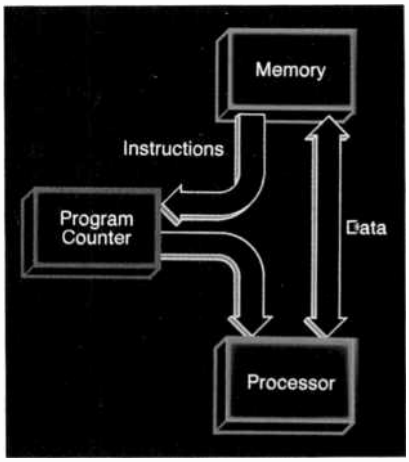

Fig. 2. The Von Neumann design.

The basic idea behind using extra processors to gain speed isn't a new one at all. In fact, it comes from one of the oldest adages applied to any problem solving task—divide and conquer. Whether you are talking about armies or mathematics problems, breaking a big problem up into a bunch of easily solved smaller ones makes a great deal of sense. And your computer already does that much. When you program it to compute:

$$x=(34*4)+(2*6)$$

the computer doesn't try to handle it as one large problem, rather it breaks the problem into three smaller ones. Properly divided, the problem is now to:

(1) solve: 34*4
(2) solve: 2*6
(3) add result of (1) to result of (2).

The point here is that steps one and two can be executed in any order, or, and this is important, they can be executed at the *same time* without adversely affecting the result. So instead of the system waiting the time it takes to perform two multiplications sequentially, the system could assign both at the same time. In an 8086 processor, the simplest possible addition, a register-to-register immediate, takes three clock cycles. Doing all three steps in sequence would require three complete clock cycles for each addition.

Performing the two multiplications simultaneously would mean that both could take place during the same clock cycles. If you are in a hurry for the result (in a real-time industrial control situation, perhaps), saving clock cycles can be significant.

Adding Specialized Processors

But this describes the solution—what does the hardware look like? To put several processors to work in a single system requires a new architecture. The simplest approach is to extend the basic architecture somewhat, using one or more specialized processors that are optimized to repetitively perform a specialized task. Take, for example, the math coprocessor. No one, even computers it seems, likes to do arithmetic. Math is the processor's most difficult task. Therefore, nearly every one of the popular 16-bit microprocessors has a math chip available to work with it. This chip, the coprocessor, sits on the bus along with the microprocessor and handles all math processing—at much higher speeds than the processor could handle them.

Using the math coprocessor to save system time is fantastic if the application is sure to encounter certain types of math problems over and over again. But while the math processor is working, the main processor takes a vacation. It will pass the math problem to the math processor and wait for the answer; it won't do part of the math itself. So you still wind up doing all three steps of our problem in sequence. It is more of a divide-and-send-the-parts-to-a-specialist approach than it is divide-and-conquer.

We are stuck with what is termed a control-flow or control-driven computer architecture; a design developed in 1945 by John Von Neumann. The diagram shown in Fig. 2 describes the flow of data

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Columbia University's research facility, where the Non-Von 1 is being developed.

and instructions that defines the basic Von Neumann computer architecture.

The program counter (PC) plays an important role in Von Neumann's design—it controls the passage of instructions from memory to the processor. The PC tells the processor the next activity that should take place. The processor itself decodes and executes each instruction. The instruction will contain the coded address of the data. Before the processor can execute the instruction, therefore, it must first fetch the data from memory. Another part of the instruction tells the processor where to store the results when it is through executing the instruction.

Adding a coprocessor doesn't really change the computer's design—it extends it. We have modified the flow of data and instructions a bit so that the path appears as shown in Fig. 3. When the PC indicates that an instruction must be executed, the processor must still decode the instruction, but the math processor can access the data directly.

Extending Control-Driven Computers

You can gain a great deal more speed by extending the control-driven architecture until it resembles a tree, with a central processor passing tasks off to independent processing elements running concurrently (Fig. 4.). Each processor has access to the data directly, allowing it to run independently of the other processors. In the case of one such machine, the Non-Von 1 currently under development by a group headed by Dr. David Shaw at Columbia University in New York, each processor has its own path to memory via an intelligent head unit—a disk head that will read just the data needed by the processing element that it serves. (For more information on this project, see the accompanying sidebar.)

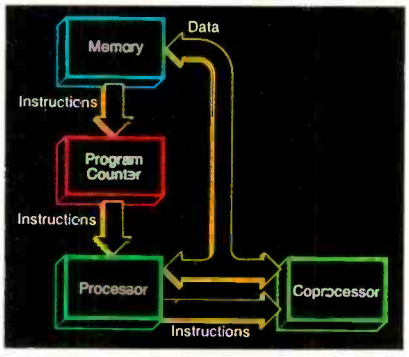

Fig. 3. Adding a coprocessor.

All control-driven machines suffer from one weakness—the programmer must decide, and then specify, how each problem will be divided among the processors. The central processor has no inherent way of knowing which pieces of the job can be performed concurrently. The programmer must subdivide the work; the central processor will assign it. Programming, therefore, becomes more of a chore with the enhanced architecture than it was on simpler machines.

Data-Driven Machines

But extending the existing architecture isn't the only way to improve performance. A new generation of designs might manage to gain speed and avoid the problems and limitations of control-driven machines by abandoning the Von Neumann approach altogether. Unlike the coprocessor approach, they will configure the processors as equal general-processing units that operate concurrently. And unlike the Non-Von-1, these machines will automatically uncover the concurrency within a problem.

Instead of using a program counter to control the flow of data and instructions, these machines will be either data- or demand-driven architectures. Let's see what that means.

Data-driven machines quite simply call for a processor to execute an instruc-

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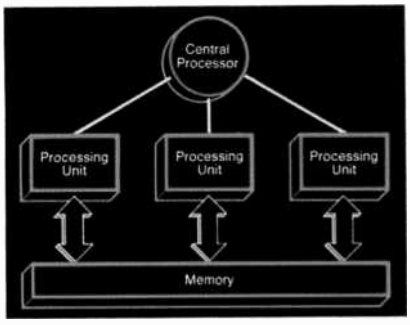

Fig. 4. Extended design.

tion whenever the data which that instruction needs becomes available. To implement this, data is packaged with its destination and information about how it is to be processed, into units termed tokens.

A network of input/output switches (Fig. 5) distributes the tokens to independent processors. Within each processing unit, the token flows through a circle where it is processed and then returned, via the network, to the system. If

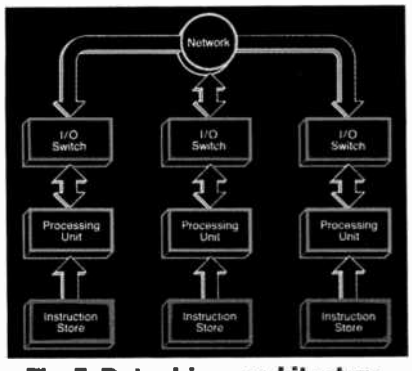

Fig. 5. Data-driven architecture.

the information in the token indicates that other data is needed, the processor will monitor the network for data addressed to the same location as the current data. If no other data is needed, the processor will fetch the appropriate instruction and execute it. The processing unit then transmits the results via the network, to the destination required by the tokens.

The University of Manchester has developed a version of the data-driven machine that uses 12 processors. It executes 1.7 million machine instructions per second (MIPS).

Demand-Driven Machines

The last technique being used to make a computer's operations run in parallel is the demand-driven machine. Here, a task isn't executed until the results of that process are needed. Effectively, this prioritizes the parts of the problem.

Known as symbolic reduction machines to artificial intelligence researchers, the demand-driven engines automatically reduce a complex symbol to a simpler one, repeating this task until it can reduce it no further. In semantic terms, the machine evaluates symbols until it reduces them to actual values. The expression 3+4, for example, would become 7. The expression 2(3+4) would first reduce to 2(7), then 14.

The tree diagram shown in Fig. 6 illustrates how a demand-driven machine might execute the simple math problem we used earlier. The more complex a problem is, within limits, the more time the demand-driven engine saves when compared to Von Neumann machines.

Apparently then, systems using parallel architectures resemble networks of computers more than conventional computer architectures. Each processor does its job independently of the others the same way that each user on a network does his or her job, while sharing valuable system resources, such as a hard disk. Each user has access to the same data, the same programs, the same system capabilities. The success of the overall operation depends on how well management has divided up the problem parts and assigned them to the users.

State of the Art

Perhaps nowhere more than in artificial intelligence applications, where the computer is called upon to do large quantities of calculations quickly, is parallel processing awaited so excitedly. And the future is already beginning to appear. Architectures become more like networks and less like conventional configurations all the time. In other words, they become more parallel. The Lambda machine, for example, from LISP Machines, Inc. (Culver City, CA) uses a 10-MHz 68000 microprocessor and a 4-board 32-bit LISP processor that runs at 20 MHz. Each processor has its own memory and its own bus. The LISP processor uses the NuBus with its 40M-byte/s peak transfer rate while the 68000

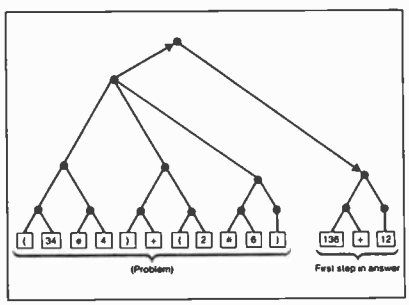

Fig. 6. Reduction machine.

plugs into a conventional Multibus.

The two processors are loosely coupled; the design is more parallel than many, but serves more as a practical example of the trend toward parallelism than as the first article of any particular architecture. The processors are nearly independent, but networked together.

The dual-processor environment uses the 68000 (running Unix) to handle normal system tasks; the faster LISP machine runs the AI algorithms—directly executing instructions written in the LISP programming language.

Speaking in Tongues

Part of the process of dividing problems and assigning tasks will reside in the system software. At least some of the success of parallel computers will depend on the ability of system software designers to develop high-level languages that take adequate advantage of the hardware. And this is no mean feat by any estimation.

At the University of Illinois in Champaign-Urbana, for example, researchers have spent 10 years working on making versions of the FORTRAN programming language that will support parallel, pipelined and multiprocessor systems. It's important that FORTRAN run on the next generation of machines, because it is the most popular language for large-scale scientific programming. Programmers want to be able to use the vast numbers of programs already written in FORTRAN. There's no pain like that of starting completely over. And most institutions won't be willing to do it.

But new languages are also being developed; languages that uniquely allow a programmer to get the most from a highly parallel structure. Many of the algorithms used in artificial intelligence have been contorted to fit the demands of conventional programming languages. Perhaps languages based on those algorithms would help break new ground in artificial intelligence.

Getting There from Here

Currently research and development projects to create what is called the "Fifth-Generation Computer" are underway in the United States, Japan and Europe. The Japanese goal, in fact, is to have a commercial model available by the 1990s. This drive to build a non-Von Neumann, parallel processing computer should not only give new meaning to the word "fast," but should also create a computer the likes of which we've never seen before. ◇

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WORKING FASTER TOGETHER

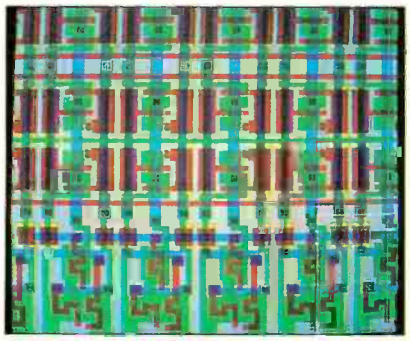
C&E talks with Dr. David Shaw about his efforts to build a new kind of computer

By Joe Desposito

Dr. Shaw is a pioneer in parallel processing design.

THERE are various ways to squeeze more speed out of a computer, as discussed in the accompanying article. One of them is being tried by Dr. David Shaw, whom we spoke with at Columbia University in New York City. Shaw has designed a machine, called the Non-Von computer which uses massive parallelism as its underlying architecture. He contrasts his approach with other parallel processing designs, saying, "There are certainly various interesting relationships between it (Non-Von) and other architectures, but I think that most people in the field will agree—especially my critics—that it has very little to do with other approaches to parallelism.

"For one thing, many people today are trying to design parallel machines with one hundred, one thousand or at most a few thousand processing elements. Our machine, on the other hand, is really designed to ultimately use a million processors or something on that order. And you have to use those processors in completely different ways. Some of the influences on this architecture were, first of all, thinking about humans and how they work, and the associational nature of human memory. We seem to come up fairly rapidly with many associations to a single concept. Also, there's the notion of massive parallelism. We know that the brain is made up of a tremendous number of neurons, and that there are a tremendous number of interconnections between them. Even though the neurons work quite slowly—in comparison to a computer a brain works extremely slowly, or at least an individual neuron does—when you put them all together, the net processing power of the brain seems to be sufficient to do all the things that we do. It's not that Non-Von is an attempt to be a brain by any means. And it's not that I believe that the brain is organized that way. But those are some of the subtle influences that pushed me in that direction."



CAD terminal display.

Dr. Shaw's knowledge of the brain's structure doesn't come from casual reading about the subject. He studied experimental cognitive psychology at the University of California at San Diego (UCSD). His advisor there was very interested in using the computer to model how people think and remember things, what attention is all about, and so forth. That's what first got Shaw interested in making computers do things that seem to require intelligence. He went on to do graduate work at Stanford University, one of the two important research centers for that type of research at the time.

Shaw studied at the artificial intelligence laboratory there, trying to make computers do things that we consider intelligent. Near the end of his graduate career he realized that, even if he and his colleagues could figure out what thought is about and how you might trick a computer into imitating it, available computer power would be a limiting factor. That is, even if they were able to figure out how to get a computer to understand people speaking English and figure out what they were talking about—and there were still a lot of problems as to how they would go about achieving this—it would take existing computers hours to do things that ought to happen in seconds. That led Shaw to look at radically different ways of organizing computers to enable them to do work much faster. Most of his research over the last

PHOTOGRAPH BY BRITAIN HILL

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five years has focused on this problem. He has also done work on artificial intelligence, database management, and other applications of computers. But his main concern is how these tasks can be done dramatically faster using completely different types of computers.

Dr. Shaw's perspective is not only theoretical; it's practical, too. Before he got his PhD at Stanford, he took out some time to start his own corporation and he ran it for three years. This gave him a slightly more practical perspective on the question of computation. It was really the first time that he stopped thinking about how "thought" could be accomplished on a computer and started to consider questions like efficiency and what computers really are and how they are organized.

What's the current status of the project? Dr. Shaw says, "There have been two significant milestones to date. One was having a chip that was 100% functional. The chip had a single processor on it, not the eight it will ultimately have, but it executed all of the instructions perfectly. That was just recently accomplished. The next big milestone will be producing our first prototype, a very small one. What we'll be doing is hooking up 64 of these single-processor chips in the same way that they will be hooked up in the final machine. So it will be a real Non-Von machine, but it will only have 64 processing elements. It won't be enough to demonstrate anything useful in terms of speed, but it will demonstrate that the approach works and give us the signal that our further work will be likely to produce a machine that could do something—funding permitted. The time that we're shooting for is the end of this year. At that time we should also have software to run on the machine. It won't be very extensive—just some toy programs—but we would be able to demonstrate a working machine.

As director of the project, Shaw oversees both the hardware and software development of the machine. However, the key person involved with the hardware effort is research engineer Ted Sabety, who has three other full-time engineers on his staff. In addition, he has a fairly large number of students working either for him or one of the other engineers. Although they aren't full-time staff members, per se, many of them spend huge amounts of their spare time on the project. "Because it's an exciting project for them," says Dr. Shaw. On the software side, most of the work has been done by PhD students doing theses, who report directly to Shaw. "We have had at least 60 people thus far writing software for Non-Von, or rather simulating it," says Shaw, "since we don't have a computer actually working."

Creating a new computer means using existing software and hardware as your primary tools. Dr. Shaw's group first defined what they wanted their computer to be and then went to great lengths to simulate it at various levels of detail. In fact, they have five levels of simulation for the machine. The first is to see whether or not programs can be run on it. Then there is a more detailed level to find out if the data is transferred between the registers the right way. The levels go all the way down to testing the primitive physics properties (device physics) that described the behavior of the transistors. Much of the work was done using ordinary computers, mostly from Digital Equipment Corporation (DEC). Software simulation is one part of the project and it is proceeding for designing later versions of the computer and for writing new programs for the one being implemented now.

The big prize in the field will be a successor to the Von Neumann

The other part is the actual hardware design, which involves design of the chip. For that they use color graphics displays connected to DEC VAX computers. They also use a whole set of design tools imported from places such as Berkley and MIT and software that they wrote themselves. The final part of the process is submitting integrated circuit chips to a manufacturer, first with various components of the processor, then with larger and larger pieces until a complete processing element is built. With this final step of processor design already completed, they have begun ordering all the components for the first prototype, Non-Von 1. They now have to put the whole system together. "And find out why it doesn't work the first time, because it never does," commented a smiling Shaw. "At that point we'll be able to perform some really interesting experiments with it."

Where does the broad range of abilities needed to build Non-Von 1 from scratch come from? "No one person on my staff has all those abilities," says Dr. Shaw. "For example, Ted Sabety came to us from Hewlett-Packard's integrated circuit labs where he was involved with several things. He was himself an IC designer, but also a consultant within the company, telling other people various things about how IC design works. This is, in fact, one of our advantages over many universities—most of them don't have a Ted Sabety. They have mostly university people who have learned about the process of IC design through a very effective system of teaching it, which has been spread through the country during the past three years. But the system doesn't help you get out of serious unexpected binds that come up when you're building a production chip. And then we have people with different sorts of experience in other technologies.

"We also go outside for help—often to our competitors. For example, Chuck Seitz of Cal Tech, who I think is one of the most gifted researchers in this field, is building some very interesting machines that are organized according to completely different principles. He doesn't really agree with our basic architectural principles, but we enjoy talking to each other, and he has helped us tremendously in thinking out how we were going to do our timing and solve other system problems."

Does Dr. Shaw see commercial viability down the line? "I'm not sure about that," he says. "There seems to be some evidence in selected areas to indicate that it ought to be commercially viable. But we won't know until we actually build one. But I guess I should say that we wouldn't be doing any of this unless we thought it had the that kind of potential. Not that *we* want to do it here, but we're really interested in producing a machine that will have a substantial economic impact. It's just a long process of research and trying it out on various applications until one knows that it's possible."

When asked whether he thinks his approach to parallelism is the best one, Shaw responded, "Again, it's hard to say. I think it's premature to say whether Non-Von or any of the other machines is using the strongest approach. Most of my serious colleagues have some ingenious ideas, and we aren't yet able to compare them. We really won't know until we see a completed machine, find out how much it costs, and see if it's maintainable, produceable, and so forth. Then we can actually run some applications programs generated by real users, instead of generated just as test programs.

(Continued on page 111)

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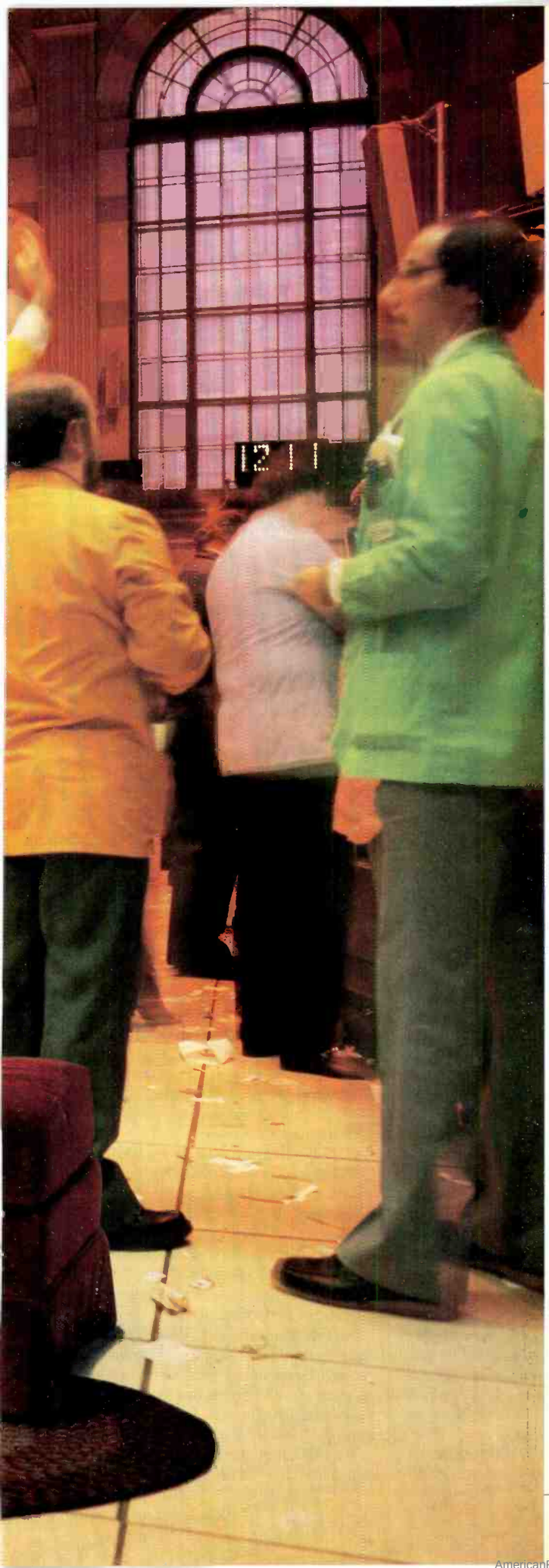

STOCKS, BONDS & PERSONAL COMPUTERS

Brokerage firms, beginning with EF Hutton, are providing on-line access to customers' account information

BY BARBARA E. McMULLEN & JOHN F. McMULLEN

On December 13, 1983, after 5 years of planning and development, EF Hutton & Company introduced an electronic information service called Huttonline. With this step, Hutton became the first securities firm to provide such a service to its clients. It also became one of the few companies with foresight enough to design a system *before* it became economically feasible to market it. While we expect that EF Hutton will soon have competition, the story of this unique product warrants our attention.

What is Huttonline and why is it important? It is a system that enables Hutton's clients to use a personal computer or terminal to access Hutton's computer files containing its Research and Investment Briefs as well as the client's own accounting records. It also allows the client to send messages to his Hutton account executive (AE) through the system and receive investment reports and messages from his or her AE. The system is menu-driven, and we expect that Hutton's clients will find it easy to use. The service is available to them for an initial charge of $25 and a monthly fee ($17 for the first 2 hours of use and $7.50 per hour thereafter).

The importance of the system is hard to overestimate. In announcing the service, Norman Epstein, Executive Vice President and Managing Director of Operations at EF Hutton, said, "We are bringing our computing and communications resources even closer to the client. The home is the last frontier." We agree with Mr. Epstein and think it is obvious that Hutton has far outpaced its competitors in this area.

A service like Huttonline brings its users immense benefits that reach far beyond those directly related to investment. A significant portion of subscriptions (33% to date) come from individ-

Barbara and John McMullen each have nearly 20 years experience in data processing for the securities industry.

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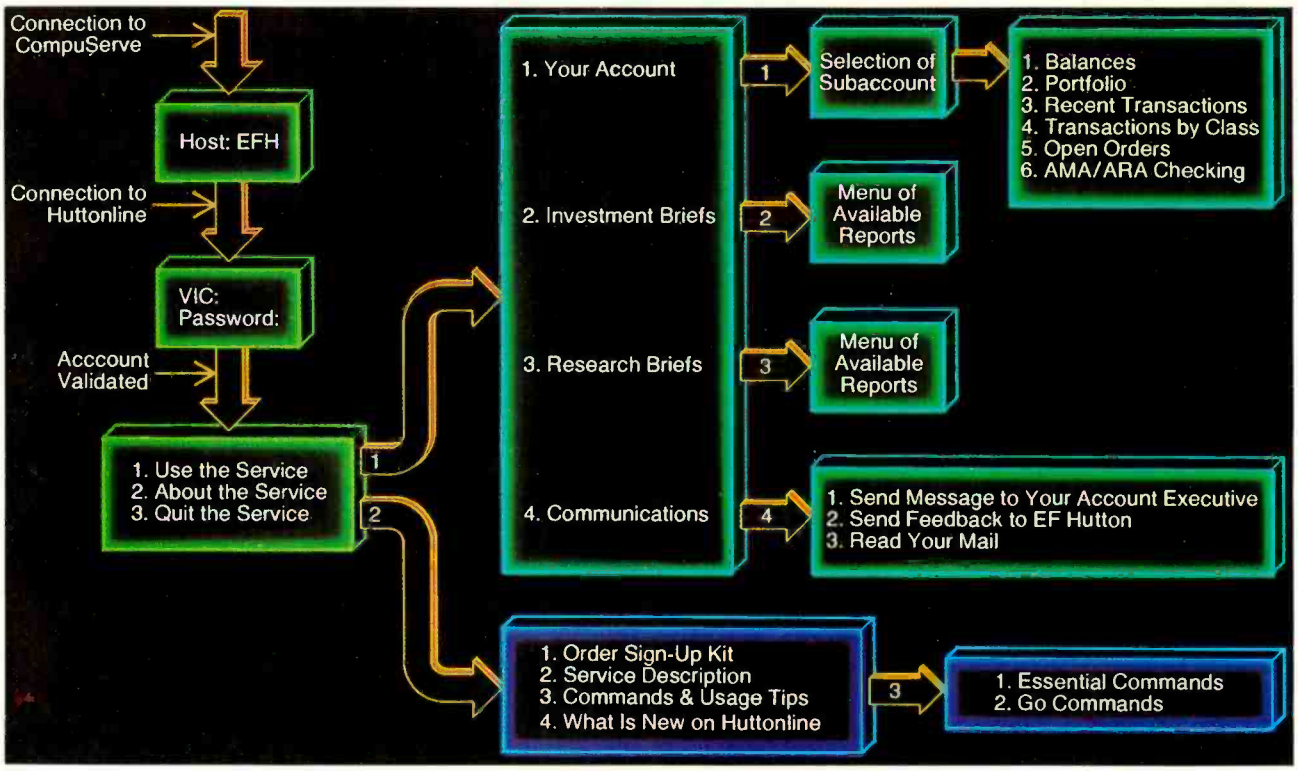

Fig. 1. Menu tree for the Huttonline service.

uals who have never before had up-close experience with computers or terminals. Using this system is bringing computer literacy to the novice; and, for many, it will be but the first step toward the use of other information services such as CompuServe, The Source, and Dialog, and programs for word processing, spreadsheet analysis, and database management.

Another long-range benefit will accrue to users of Huttonline and any similar services that may arise. They will take part in a democratization of the investment decision-making process. As most insiders in the investment community know, institutions and professional investors have access to much more timely and comprehensive information and research opinion than the average individual investor. The reason for this advantage is not insidious; it relates, rather, to the cost of disseminating masses of information.

Institutions have both the capital to obtain costly services and a method of receiving such services with little or no out-of-pocket expense. As such wherewithal has normally not been available to the individual investor, there has been a decided difference between the quantity and quality of investment information available to individuals and that to financial institutions. Now, the gulf has been made smaller. Already available from Dow Jones are public disclosure information (including SEC form 10K), earnings estimates, fundamental information (from Media General), and automatic searches of the *Wall Street Journal, Barrons,* and the Dow Newswire. Now, research opinion and specific customer information is dispensed through Huttonline.

While the above points may be interesting from a social science viewpoint, Huttonline would have little impact if it were not an attractive product offered at a reasonable price—which it is. Furthermore, it would not be considered for discussion in this magazine if it were not an innovative system that made use of state-of-the-art electronic technology—which it does.

Background

Over 5 years ago, the management of EF Hutton recognized that eventually there would be the capability to deliver information directly to individual homes. They set up an organizational entity to study this rapidly developing world of microcomputers, videotex devices, and information services, hoping to determine what impact such developments might have on their own business. Chosen to head this study was Vincent T. Pica II, a staff assistant to Norman Epstein.

Pica had joined Hutton immediately following his graduation from Iona College in 1975. In the 3 years of his employment at Hutton that preceded this assignment, he had come to appreciate how well the company had responded in the past to technological opportunity in supporting its securities business. In 1904, the year the firm was founded, Edward F. Hutton helped finance the first private, direct coast-to-coast communications wire. (Hutton still holds Western Union's contract No. 1.) Since the time when Epstein was responsible for its data processing and communications resources, the firm pioneered the following applications:

1966—Use of a third-generation, general-purpose computer (IBM System 360) for message switching and order entry.

1973—Branch-office retrieval from a central database.

1975—Installation of a comprehensive, high-speed telecommunications network.

1976—Integration of its market data system (Bunker Ramo System 7) into its private communications network.

In this environment, Pica felt confident in taking on this assignment even though it appeared that such in-home service would not be practical or economically feasible to anyone concerned until the 1990s.

By 1980, it became obvious to Epstein and Pica that technology was moving

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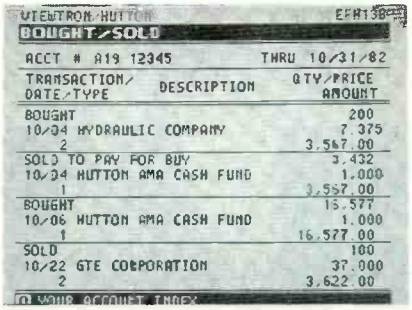
much more rapidly than they or anyone else had expected. To better enable Hutton to take advantage of the burgeoning technology, a new organization—MIS Operations—was set up under Pica; and his charter was expanded to include the support of microcomputers throughout Hutton's internal organization. Pica was presented with staffing and budget authorization and instructed to develop a formal plan for carrying out these responsibilities.

As a first step in the support area, Pica began planning an internal newsletter that would provide general information about personal computers, product reviews, and recommendations. To put this newsletter into operation, and to assist him generally, Pica added Lee R. Greenhouse to his staff. Shortly thereafter, *EF Hutton Personal Computing Newsletter* came into being.

At the same time, Pica and Greenhouse were planning the overall duties of MIS Operations. It was then, also, that Huttonline was conceived and integrated into the overall plan. The concept of Huttonline was dynamic for Pica and Greenhouse because expanding technology continually made new things feasible. Also, the planner's view of Huttonline's place in the overall scheme of Hutton operations changed dramatically. It was originally conceived as a supplementary service to benefit Hutton by increasing the number of accounts and improving the productivity of account executives through reduction of time-consuming customer inquiries. Soon, however, it came to be viewed as a significant product with a marketability of its own.

Pica and Greenhouse also foresaw that this service would attract clients who did not have either microcomputers or terminals of their own and that many of them would need guidance in selecting and installing a computer to use the Huttonline. They realized that it would be both a service to such clients and a source of revenue to sell the necessary equipment directly to clients requiring it. With the approval of management, they began to negotiate with the appropriate vendors to become what is known in IBM parlance as a VAR (Value Added Reseller).

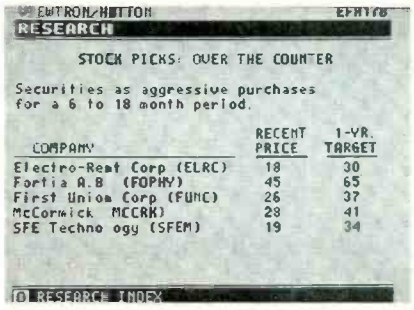
By June 1983, it was decided that Huttonline was to be viewed as a profit-making entity. Agreements were reached with Convergent Technologies, IBM, Wang Laboratories, and Quazon, allowing Hutton to act as a vendor for their equipment. Huttonline was publicly announced and launched on December 13, 1983.



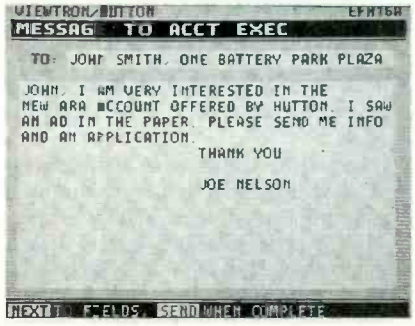
Personal accounting service.

Investment briefs menu.

Account menu.



Research brief.



Electronic mail.

Design Considerations

There were two main goals in designing the system. The first was to provide the client with as much information as possible in the most efficient manner. The second was to insure that the system served only as a supplement to the services performed by the Hutton account executives. It was very important that Huttonline in no way reduce the responsibility of the AEs in managing the clients' accounts. The New York Stock Exchange and other agencies have "know-your-client" regulations that make AEs responsible for questioning any client trading activity that is inconsistent with either the client's stated or normal trading objectives. Nothing in the system design could be allowed to interfere with carrying out this responsibility. In short, there could be no inputting of orders directly by clients.

Another obvious design requirement was that the system be easy for the client to use. For many of them, this would be their first, and perhaps only, use of computers or terminals. Finally, the system had to be compatible with Hutton's overall high-speed communication network, Compass (an IBM TCAM communications system based on IBM 3033 and 3083 mainframes). Another new Hutton system, BIPS (Branch Information Processing System), is to be added to deliver electronic mail through Huttonline to the AE. BIPS is to be based on Data General MV/4000 superminicomputers in each of the 400 Hutton branch offices and will control over 8000 Data General Dasher and Bunker Ramo System 7/90 terminals. It will operate under Data General's CEO (Comprehensive Electronic Office) automation software.

System Configuration

In selecting equipment for both the client's use and the communications between Hutton and the client, Pica was concerned with imposing as few technical restrictions as possible on the client. He wanted any client anywhere to be able to access the system through public telephone lines (at local rates) using whatever terminal, personal computer, or communications device was available. This precluded terminals designed exclusively for use with Huttonline as well as the use of private communications lines connected directly to Hutton. According to Epstein, the aim was "to deliver services to clients through any ap-

(Continued on page 112)

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IN-CIRCUIT EMULATION

A diagnostic approach to fixing a microcomputer from the inside out

BY LES SOLOMON

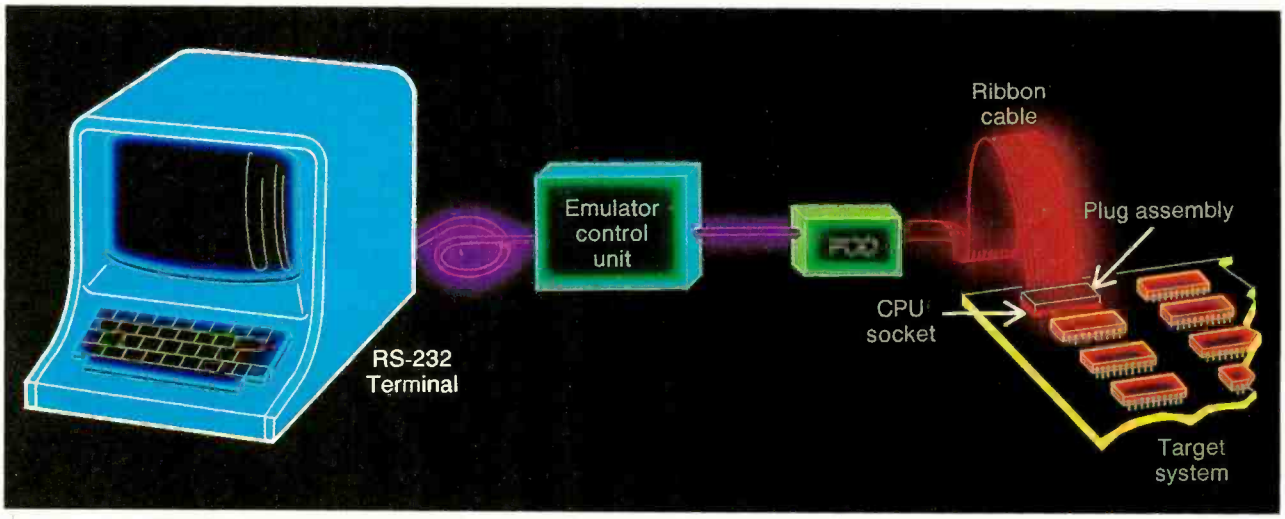

Fig. 1. The microprocessor in the faulty computer is replaced by the in-circuit emulator.

DESPITE preventive maintenance, any piece of digital equipment from a microprocessor-controlled washing machine to microcomputer can "go down" at any given instant. When this happens, what can you do?

Once the initial panic is over, the next thought is to find out what went wrong and repair or replace the faulty part. This article will focus on microcomputers although the same diagnostic approach can be used for any piece of digital equipment that uses a microprocessor as the controlling element.

The first thing most people would do is to reach for the diskette containing system diagnostic procedures, or call whatever form of diagnosis utility (if any) that is built into the operating system. Although these are both obvious choices, the chances are that they will not work.

Les Solomon is Technical Director of COMPUTERS & ELECTRONICS.

For a computer to run such a utility, the bulk of the system must be operating. This includes the microprocessor, RAM, ROM, I/O port, the disk controller, the disk drive, the diskette, and the bulk of the ICs in the system.

Then there is the question of disk-based CPU diagnostics. If the CPU is bad and requires the diagnostic, how do you run it?

To further compound the problem, it is always possible that the hardware is good, and the fault is in the software. Then what do you do?

There is an answer to this seemingly unanswerable paradox, and it is called "in circuit emulation," or I.C.E. for short.

To use this approach to digital servicing, in which every element in the faulty computer can be tested, all that the non-working system needs is system operating voltage (usually +5 volts) and "clock." That's all. The emulator doesn't need any of the target system's memory or I/O.

The operating voltage can be checked using a dc voltmeter, while almost any oscilloscope can show the presence of the clock signal at the pertinent CPU chip and bus pins.

An emulator can be used for debugging hardware and software, pinpointing potential problems before production, or for on-site repair calls to save the expense and bother of bringing complete systems into the shop for repair when only a plug-in board has a fault.

For the sake of this discussion, consider a hypothetical situation in which your computer's disk drive is acting up. Thus, even if you had the best diagnostic utility on the planet, there would be no way for you to load it.

How It Works

An emulator is a digital diagnostic device that permits complete control of the target microprocessor's function, including control of every device connected to the system bus. Although em-

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ulators are (or soon will be) available for almost every microprocessor, our attention here will be devoted to a low-cost emulator for Z80 systems from Nicolet Paratronics Corp. of Fremont, CA.

To get started, as shown in Fig. 1, the microprocessor in the faulty computer is removed from its socket, and replaced by a plug with similar pins that is connected to the emulator control unit via a lead-mating pod. The emulator contains a microprocessor indentical to that removed from the faulty system, and has its own dedicated operating system in ROM. Thus, in its most basic mode of operation, the emulator "tricks" the target system into "thinking" that nothing has changed. The emulator operating system is controlled by a conventional RS-232 terminal driven by circuits within the emulator.

However, as selected via the RS-232 terminal, the emulator firmware allows examination and modification of the microprocessor's internal registers, and provides the capability to alter and manipulate the system RAM, to implement and observe systen I/O operations, to control interrupts, to single-step the program to trace instructions, and to perform all the functions shown in Table I. Thus, almost all possible functions in the target system can be tested and checked.

In the following discussion, all emulator commands and the resulting CRT screen displays are specific to the Nicolet unit.

Basic Operation

Since emulation is at the CPU (machine language) level, it is very important that the user have a full understanding of the machine-language code of the program being run on the faulty target system.

When the target computer is turned on, it must first be reset. This is done automatically in many systems.

The reset command places the emulator in the GO mode which permits the target system to operate just as if its own microprocessor had never been removed. In this mode of operation, the emulator is said to be transparent to the target system.

The RS-232 terminal screen display will then produce a status message to indicate that the terminal, emulator, and the target system are all properly interacting. If by chance, the disk drive problem goes away, then the Z80 that was removed from the faulty system was the problem.

Unfortunately, things are rarely that easy and the disk drive will probably still give you trouble. At this time, the best approach is to halt CPU operation and examine the processor registers, particularly the program counter which will tell you whether or not the target system is even executing the program within the disk driver routine.

After the prompt is displayed (in the case of the Nicolet instrument, this is an OK followed by an arrow), the user types in the Q (uit) command. This act stops the Z80, inhibits interrupts and bus requests, and displays a listing of current Z80 registers and the SZHVNC system status flags on the CRT screen as shown at the top of Fig. 2. Note that the program counter (P register) is at address E701 which is where it should be when exercising the disk driver routine in this particular program.

The next terminal entry is the T (race) command which is used to follow a program through one or more instruction steps. After each instruction is executed, the monitor CRT displays all the CPU registers and flags.

When the T is used alone, only a single instruction is traced. When a T is followed by a number such as 4 (as shown in Fig. 2), that number of instructions will be traced and displayed.

Examining these particular instructions, and comparing them to what should be going on according to the program, shows that the disk driver routine is functioning as it should.

Up to this point, everything looks normal. So, the next thing is to test the target system memory. This is accomplished by entering MT (memory test) after the prompt, followed by the starting and ending addresses (E800 and E8FF in the example shown in Fig. 3) This particular memory test uses a "walking" 1s and 0s pattern. If an error is detected, the address of the failed bit is displayed, otherwise the OK prompt appears. It takes approximately 15 seconds to check each 1K block of memory.

If the target system passes the memo-

```
OK ====> Q

       A=60  BC=0000  DE=E758  HL=E831  S=E8FC  P=E701  M(P)=77
SZHVNC A'=7F  B'=7FFF  D'=FFFF  H'=FFFF  X=FBAB  Y=FBDF  I=00

OK ====> T

       A=60  BC=0000  DE=E758  HL=E831  S=E8FC  P=E702  M(P)=23
SZHVNC A'=7F  B'=7FFF  D'=FFFF  H'=FFFF  X=FBAB  Y=FBDF  I=00

OK ====> T 4

       A=60  BC=0000  DE=E758  HL=E832  S=E8FC  P=E703  M(P)=C6
SZHVNC A'=7F  B'=7FFF  D'=FFFF  H'=FFFF  X=FBAB  Y=FBDF  I=00

       A=70  BC=0000  DE=E758  HL=E832  S=E8FC  P=E705  M(P)=C2
SZHVNC A'=7F  B'=7FFF  D'=FFFF  H'=FFFF  X=FBAB  Y=FBDF  I=00

       A=70  BC=0000  DE=E758  HL=E832  S=E8FC  P=E6FE  M(P)=36
SZHVNC A'=7F  B'=7FFF  D'=FFFF  H'=FFFF  X=FBAB  Y=FBDF  I=00

       A=70  BC=0000  DE=E758  HL=E832  S=E8FC  P=E700  M(P)=23
SZHVNC A'=7F  B'=7FFF  D'=FFFF  H'=FFFF  X=FBAB  Y=FBDF  I=00

OK ====>
```

Fig. 2. Quit and trace commands.

```
OK ====> MT E800,E8FF

OK ====> E FF
 ---> 80

OK ====> O FE 81

OK ====> O FF,00,01,00;RL
```

Fig. 3. Memory test.

```
 MAIN      TRIG  006B  CALL  00C2H
           +001  006C    C2    OPERAND FETCH
 LOC: TRIG +002  006D    00    OPERAND FETCH
           +003  1FFC    00    STACK WRITE
 SIG:      +004  1FFB    6E    STACK WRITE
 145E A057 +005  00C2  RET
           +006  1FFB    6E    STACK READ
           +007  1FFC    00    STACK READ
           +008  0097  JMP   009AH
           +009  0098    9A    OPERAND FETCH
           +010  0099    00    OPERAND FETCH
           +011  009A  JM    009DH
           +012  009B    9D    OPERAND FETCH
           +013  009C    00    OPERAND FETCH
           +014  009D  JP    00A0H
           +015  009E    A0    OPERAND FETCH
```

Fig. 4. Assembly/disassembly.

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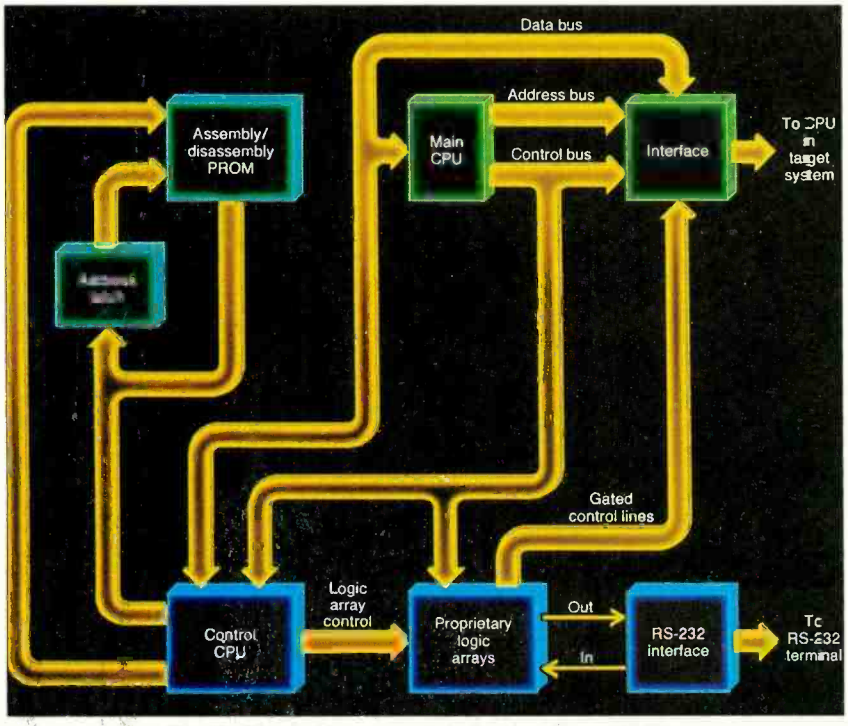

Fig. 5. Block diagram of an in-circuit emulator.

ry test, the next step is to check the status of the disk I/O port. This is done by entering the command E (xamine) after the prompt followed by the address of that port (FF in the example shown in Fig. 3). The emulator returns 80H from the port which, according to the program, indicates that the disk drive is ready.

The fourth line in Fig. 3 shows the use of an O (utput) command to send instructions to the disk head at port FE. The instruction 81H loads the disk head and sets the direction to "out."

The fifth line shows a simple routine that first sends a 0 to port FF, followed by a 1, a 0, and the command RL (Repeat Line). The effect of this alternating sequence is to skip the disk head from one track to the next in a continuous fashion so that the disk driver circuit can be checked with an oscilloscope if desired.

Thus, even with just a handful of the 48 powerful commands shown in Table I, you will note that an emulator permits some fairly in-depth tests.

Bells and Whistles

Most emulators display instructions and data from the target system in hexadecimal format. Some (including the Nicolet instrument) display this information as mnemonics—the English language equivalent abbreviation of the hex data which is far easier for the human operator to read and understand.

The process of translating a machine-language instruction into its mnemonic equivalent is called "disassembly". For example, the Z80 instruction for a jump in binary is 11000011, in hexadecimal it is C3, while the more understandable mnemonic is simply JP (JumP). An example of disassembled code for the Z80 is shown in Fig. 4.

An emulator permits complete control of the microprocessor's functions

The opposite of disassembly is called "assembly." In this mode the emulator accepts an English-language mnemonic and translates it to machine language for use by the processor. For example, if the programmer wants to jump to a particular item, he writes JP xxxx where the xxxx is the address to which the program should jump. The assembler converts this to the machine readable binary 11000011xxxx.

An emulator having assembly and disassembly capabilities and used with a computer (instead of just with a terminal) produces a Microprocessor Development System that can be used to develop, test, modify, and patch software in a target system.

Emulator Design

The block diagram of a typical in-circuit emulator is shown in Fig. 5.

To accomplish a low parts count (six ICs), Nicolet elected to use a 6-MHz Z80B as the main processor, a custom control microprocessor that incorporates the operating system within its internal ROM, two high-speed custom logic arrays, a PROM containing the assembly/disassembly routines, and an address latch for the PROM.

Some emulators multiplex a single CPU to perform the functions of both main and control CPUs. In the Nicolet instrument, the Z80B takes the place of the CPU removed from the faulty target system and acts like a Z80 and nothing more. The separate control CPU handles all aspects of the emulation including command execution and error reporting.

The high-speed logic arrays, under the control CPU, gate the Z80B's control lines as well as stopping the Z80B at particular states so that the control CPU can gain access to the Z80B's data bus.

The emulator's main CPU connects to the microprocessor socket in the target computer via an interface that connects all the required signals into their respective pins on the Z80 plug. Note that this particular emulator gets its operating power (+5 volts) and clock signal directly form the target CPU socket.

The RS-232 terminal connects to the emulator via a conventional DB-25 connector, with all signals passing through the proprietary logic arrays. An algorithm is provided within the emulator operating system to automatically set the communication rate between 150 baud and 19,200 baud by measuring the length of the first start bit transmitted from the terminal when a carriage return is entered.

Conclusion

You can now understand why in-circuit emulation is a very powerful diagnostic tool that can be used even with a "crashed" computer. When will such potentially useful instruments become readily available? Well, up to now, they cost several thousand dollars, but it is hoped that the introduction of the Nicolet emulator which is priced at under

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Leading Edge WP
(Continued from page 47)

what special attribute has been given to that text).

Other special attributes include superscripts and subscripts, bold, special fonts (italics or other possible type styles), overstrike (where one character is printed over another to create special, nonstandard symbols), and color (for display on the color monitor and eventual printing in color if you have the required peripherals).

Safety Features

Basic word processing packages just sit and take all the words a typist can throw at them. It's only when you go to save a document that anything is actually recorded on disk. The problem with this is that, if there is a power failure, or somebody removes your disk without typing "KD," or some other hallowed command, you lose your precious data. The Leading Edge Word Processing package, however, offers users the ability to automatically create backup versions whenever they load an old document. (The system tells you that it's doing this when you enter the program). I liked this feature, and you can turn it off if you are running short of disk space.

Another handy feature is that the program will occasionally save text to disk while you are actually typing. This can be a little disconcerting at first. In fact, since I once lost most of a 3000-word original article to a word processing program that had a similar feature, I am a little sensitive about such matters. In software design circles, it's a controversial issue whether or not programs should automatically carry out certain actions without the users' prior knowledge. I guess this kind of thing is just a question of personal taste.

As an experiment to test the program's ability to automatically save text and cope with a power failure, I created a small document and then switched the power off. On restarting the system, the program discovered that the document had been damaged in some way and announced that it was trying to repair it.

When the document was finally displayed, it was in just about the same condition as it was before I yanked the plug—only odd bits of garbled text had to be retyped.

The main documentation provided with the program is quite good, and should present the user with few problems (an "800" number is listed to call if troubles do occur). The documentation provided with the tutorial disk is another matter. While the tutorial lessons do show off the various features, they are a bit "over-the-top" and "gee whiz!" about it all.

While I'm not sure that the Leading Edge Word Processing package is "the most powerful word processing package created for the IBM Personal Computer," it has a lot to commend it to those users appalled by many of the other products on the market. ◇

OVERVIEW

Product: Leading Edge Word Processor
Manufacturer: Leading Edge Products, Inc.
325 Turnpike Street
Canton, MA 02021
Price: $295 ($350 with mergeprint option)
Operating System: MS-DOS, PC-DOS
Memory Required: 256K
Disk Requirements: Two drives recommended

The Leading Edge Word Processor is a powerful one, and quite well designed for its intended task. It should find particular favor among those who learned word processing on Wang equipment and want to use a similar system on their personal computers.

TWO DBASE II FRONT ENDS

By Robert Rioja

If you have ever needed to set up a specialized database on your computer, chances are you have done it with Ashton-Tate's dBase II. Although other database management programs may be easier to use, dBase has gained great popularity because of its inherent power. However, this power comes at a price: it requires you to learn dBase's unique language, which is often difficult to master. So you must spend time programming, testing, and debugging.

You can write a program using dBase's Modify command, which is actually a very simple and limited text editor. Otherwise, you can use a text editor or word processor like WordStar. But mastering the complexities of some of today's editors can be quite a chore. Thus, although the tools are there, using them can present problems.

To alleviate this difficulty, some clever people have come up with program generators—or "front ends"—that actually "write" dBase programs for you. These programs let you specify the characteristics of your database, and then generate a (presumably) bug-free program that can be run immediately by dBase. Of course, you can modify the program so generated at a later time to optimize it for your needs. Two such program generators are **Quickcode** and **Autocode 1**.

Quickcode

Quickcode, from Fox & Gellar, is a huge program that consists of one main module (33K) and some twenty program overlay modules. The total size of the files on the Quickcode distribution disk is 229K. (As compensation it should be noted that Quickcode can generate code without dBase being present.) It is fairly obvious that one should think twice before running Quickcode on a system with low-capacity disk drives. In fact, when you consider the space needed for dBase, Quickcode, and the resulting application program, a hard disk system might be a good idea. This is especially true if you really want to use all of Quickcode's fancy features. The Quickcode manual is commensurate in size with the program, but you can get away with reading only parts of it if you are just setting up a simple database.

When you start up Quickcode, a menu filling the entire screen appears. It lists every single command and serves as a fast guide to Quickcode's capabilities.

The first feature of Quickcode that you will probably want to use is its "Quickscreen" mode. This is a screen editor (Fox & Geller calls it an "electronic blackboard") that allows you to design data-entry forms with incredible ease. A data-entry form emulates on the screen a printed form, such as a driver's license application. It can contain instructions on how to fill out the form, descriptions of the data to be filled in, and blanks to write the data in.

To design such a form, you simply move the cursor of your terminal around on the screen and type in whatever descriptions, titles, prompts, etc., you wish to have. You also type in the names of each data item in the screen locations where you will be entering the data. If you want a simple database, that's all you have to do. You can let Quickcode take care of the rest. It will generate an integrated series of dBase programs that will let you enter, update, or delete records within the database. Also it will allow you to generate reports, print mailing labels, and produce a WordStar/MailMerge-compatible data file. If you don't specify any parameters, Quickcode will make assumptions and decide for you how to print the reports,

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labels, etc. It will even decide how to set up menus so you can tell the program what to do next!

If you have a clear idea of what you want the program to be generated to do, you can give Quickcode all of your specifications and it will use them instead of making assumptions. For example, you can specify the exact nature and contents of each report, the actual wording of each menu, and perform complete data-entry error checking. If you are willing to learn all of the intricacies of Quickcode, you can tailor the programs it generates to your heart's content. However, if you *don't* feel like specifying every detail, Quickcode will not reproach you but will use its default parameters to produce a complete, working dBase program.

The Quickcode manual has almost 170 pages. It is well organized and easy to understand. Its first section, "Instant Programs," gives an overview of Quickcode and shows how to create simple dBase programs very quickly. We generated a name-and-address database program in less than 15 minutes!

The second section of the manual, "Quickcode in Detail," explains how to make Quickcode generate tailored database programs. With a little practice, it was possible to set up relatively complex programs in half an hour. All this without once typing a dBase command! It is far easier to master Quickcode than it is to master dBase.

The third part of the manual, "Your Quickcode Programs," gives an insight into the dBase programs that Quickcode generates and is intended for those who are already somewhat familiar with dBase programming. Unfortunately, although the manual does explain every command, and gives examples of how to use each one, it does not contain a complete example of how to set up a database from beginning to end. You have to study the manual and learn what each command does. This means that if you are an absolute beginner, it may be difficult for you to follow the manual. Although a brief section on database terminology is included, it assumes you already have some background.

We didn't realize all that Quickcode was really capable of doing until we asked it to set up a simple database and saw the results. All in all, we were really impressed by Quickcode.

Autocode 1

Autocode 1, by Stemmos, Ltd., is a compact program generator for dBase II that should run well, even in floppy disk based systems. (The .COM file is only 7K long; the distribution disk contains a total of 138K.) To generate a database program, you must use it in conjunction with dBase; Autocode cannot stand alone the way Quickcode can. The manual consists of a user's guide of some 50 pages, and a larger "Book of Examples."

To use Autocode, you must first decide exactly what the program you want it to generate is going to do for you. Autocode will not make any decisions for you and has no default parameters. Although using Autocode is considerably easier than using dBase, it has no "quick-and-dirty" mode, so you must define all parameters for all databases. Fortunately, Autocode prompts you for all of the information it needs through a series of well-documented menus.

To set up a data-entry form, dBase must be used. You use the dBase Modify text editor to create the form using your terminal's cursor controls. This is similar to Quickcode's "Quickscreen" mode as explained above. Once you have used the dBase screen editor to set up the data-entry form, you can use the Autocode to generate the program that will employ the form.

When Autocode is run, it presents a simple menu with the following three selections: Menu Generation, File Maintenance Generation, and Report Generation. Each of these must be selected in sequence so that Autocode can generate the necessary dBase programs. Then, through sub-menus and prompts, Autocode asks you for every single scrap of information it needs. The user's guide has excellent examples that lead you step by step through the entire process.

Menu generation allows you to define the exact wording of whatever menus you may need to handle your database. This is actually the easiest part of Autocode.

The report generation lets you define your report formats very easily. Autocode simply presents on the screen a form for you to fill out with specifications such as page heading, lines per page, page width, totals and subtotals, formats for each column, selection criteria, and so forth.

Evaluation

It is difficult to say which of the two programs, Quickcode or Autocode, is better. Each has its pros and cons.

Quickcode is totally self sufficient, while Autocode relies on dBase's Modify command for screen generation. Although this seems to give Quickcode an edge, it is not necessarily a big one. Quickcode is great for quick-and-dirty work, but also allows you to go into detail should that be required. Autocode has no quick-and-dirty mode, but its menus and prompts make even detail work a snap.

The Autocode manual is definitely easier to read and understand. All of the instructions are printed on white paper, while the examples are printed on light blue paper. This allows you to easily distinguish instructions from examples as you leaf through the manual, and is a terrific idea. Autocode also has a separate book of examples that contains nine complete Autocode-generated programs covering such areas as payroll and stock control. Quickcode has the built-in ability to print mailing labels, as well as the WordStar/MailMerge interface referred to as the "WordStar Connection."

Both programs are well documented, easy to use, and require no dBase programming knowledge. Best of all, both seem to work quite well, although they are sold "as is" and neither is guaranteed by its manufacturer to produce perfect results.

If you are interested primarily in simple databases requiring virtually no work on your part, Quickcode is for you. If you are willing to do a little work to produce better application software, either program will do, although Autocode 1 is probably easier to use because of its example-filled manual. ◇

OVERVIEW

Program	Quickcode	Autocode 1
Supplier	Fox & Geller 604 Market Street Elmwood Park, NJ 07407	Stemmos, Ltd. 666 Howard Street San Francisco, CA 94105
Price	$295	$200
System(s)	CP/M-80, PC-DOS, MS-DOS	CP/M-80, CP/M-86, PC-DOS, MS-DOS

Both programs do their job well, although, in some cases, it may be possible for a programmer on intimate terms with dBase II to create a more elegant code. If disk space is no problem and your needs not too demanding, use Quickcode. If your disk capacity is limited, or if your needs are complex and require some customization, use Autocode.

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WITH IBM PC AT THE OFFICE AND PC*jr* AT YOUR HOUSE, YOU CAN TAKE WORK HOME ON YOUR LITTLE FINGER.

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Many business people already know about the IBM® Personal Computer family.

Many are now hearing about its new member, the IBM PC*jr*.

And some have already discovered how PC and PC*jr* can work together.

THE JOY OF PERSONAL COMMUTING

PC*jr* bears a strong resemblance to the rest of the family.

If you know how to operate PC or PC/XT, you can operate PC*jr* easily. If you have programs for PC or PC/XT, you'll find many of them will run on PC*jr*.

Now, much of what you start at the office, you can finish at home, and vice versa.

And while you're at the office, your family will find plenty to do with PC*jr*.

THE BRIGHT LITTLE FAMILY ADDITION THAT CAN GROW UP FAST

PC*jr* is a powerful tool for modern times. With easy-to-follow new IBM Personal Computer programs, and with options like a printer and an internal modem for telecommunications, it can handle a great variety of jobs.

Children can learn new ways of learning, and make short work of homework. Adults can keep track of household expenses, write letters, file tax data, plug into information networks. And everyone can enjoy challenging new cartridge games.

IBM designed PC*jr* with lots of bright ideas to make computing easier.

The "Freeboard"—a keyboard that doesn't need a connecting cord—is easy to get comfortable with.

Built-in picture instructions can help the first-time user get started.

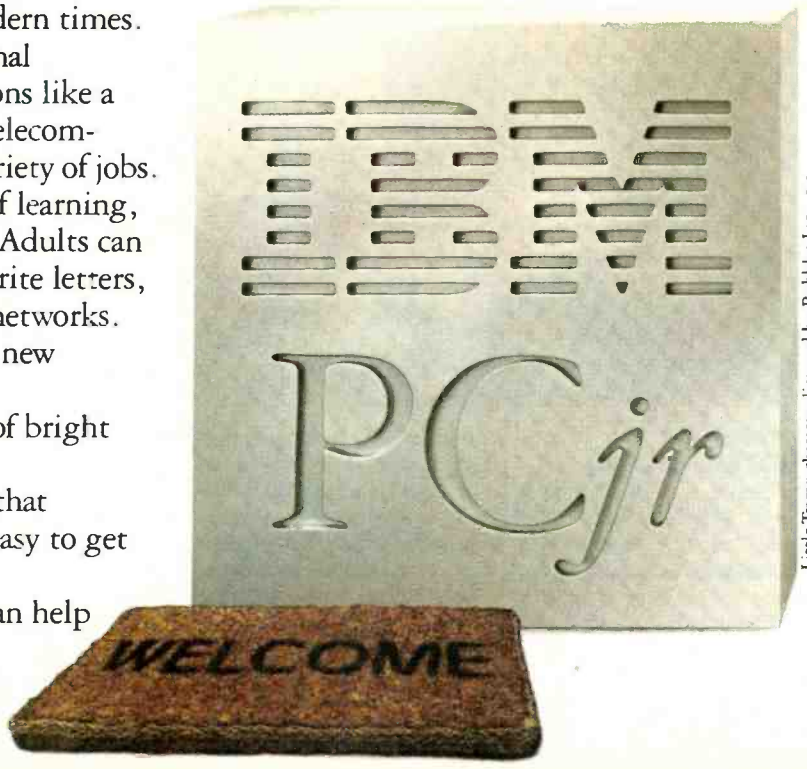
Diskette-drive systems include a program that allows users to explore computer fundamentals at their own pace. And to get PC*jr* up and running from the very first day, a sample diskette with eleven useful mini-programs is also included.

HOME ECONOMICS: IBM DISKETTE COMPUTING FOR ABOUT $1300

PC*jr* is the most affordable of the IBM personal computers.

A diskette-drive model with a 128KB user memory is about $1300. An expandable 64KB cassette/cartridge model is about $700. (Prices apply at IBM Product Centers. Prices may vary at other stores.)

For a demonstration, visit an authorized IBM PC*jr* dealer or an IBM Product Center. And you can find the store nearest you with your little finger. Just dial 1-800-IBM-PCJR. In Alaska and Hawaii, 1-800-447-0890.



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NEW PRODUCTS

IBM-COMPATIBLE COMPUTERS

Zenith Data Systems' new Models Z-150 PC and Z-160 PC are claimed to be fully hardware and software compatible with third-party hardware and software designed and written for the IBM PC. The desktop Model Z-150 PC and Model Z-160 PC transportable share features: 5-MHz 8088 16-bit CPU; 128K (expandable to 640K) of RAM; color/monochrome graphics with 80 × 25-character text and 320 × 200-pixel color or 640 × 200-pixel monochrome graphics resolution; detached keyboard with large RETURN and SHIFT keys; two RS-232 serial and one Centronics parallel I/O ports; RGB color and composite monochrome video outputs; and four user-available expansion slots. With the Z-150, display monitor is optional, while the Z-160 has a built-in 9" amber picture tube. Both computers are available with one or two

320K 5¼" disk drives. The Z-150 is also available with a single 5¼" floppy drive and 10.6M hard disk system. Z-150: $2699 with single drive, $3099 with dual drives, $4799 with one and one 10.6M hard disk; Z-160: $2799 with one, $3199 with dual floppy drives.

Circle No. 83 on Free Information Card

INTELLIGENCE FOR DUMB TERMINALS

"Screenstor" from Climax Computer Corp. provides dumb terminals with off-line intelligence and memory. It connects to any dumb terminal's RS-232C serial port and provides: up to 100 pages of memory; parameter and character conversion features and translation facilities to standardize different terminals; auxiliary printer/computer port; easy-access prompt menu; back/forward scrolling; character search facility; function key capabilities; character-by-character display. Technical features: three programmable RS-232C serial ports; 300 to 9600 baud rates; odd/even/no parity; 1/1.5/2 stop bits; full/half duplex and synchronous/asynchronous operation; XON/XOFF protocol; battery backup of parameter memory. $485. **Address:** Climax Computer Corp., 4790 Irvine Blvd., Suite 105-172, Irvine, CA 92715.

COMPUTER PROTECTOR PAD

3M Static Control Systems' "First Touch" Series 900 Static Control Computer Pad for desktop computers is designed to save on computer malfunctions due to static discharges. The 24" × 26" × ⅛" (trimmable) pad consists of a semiconductive vinyl overlay and a highly conductive "scrim" intermediate layer bonded to a nonskid, noise-reducing foam backing. When grounded, the pad protects the computer from static-induced damage by draining static charges from the operator to ground in less than 0.5 second. $69.95.

Circle No. 84 on Free Information Card

SOFTWARE SOURCES

Spreadsheet Calculator. Videx's UltraPlana spreadsheet program for use in **Apple II** and **IIe** computers is designed to automatically take advantage of a wide range of memory cards, up to a total of 512K, as well as Videx display cards. The program has a command structure similar to that of VisiCalc and includes individual column widths and a variety of security commands. With UltraPlan, standard VisiCalc or DIF data files can be used to insure compatibility with a wide range of programs. UltraPlan has easy-to-follow menus for printing and accessing the disk and can be used with Videx's own 132-column by 31-line display peripheral or in Apple's 40-column mode. UltraPlan supports upper- and lower-case text characters, uses control characters to home or move the cursor around the screen, and features individually adjustable column widths.

Circle No. 92 on Free Information Card

Graphics System. Chalk Board's "Leo's 'Lectric Graphics" computer graphics package gives the user the ability to construct finger-painted multiple-contact drawings or to draw fine point-to-point pictures. Built-in structures permit pushbutton creation of such basic shapes as circles, triangles, rectangles, and straight lines. 'Lectric Graphics also features a slide-show capability. $199.95 for **IBM PC**. Versions also available for most home computers.

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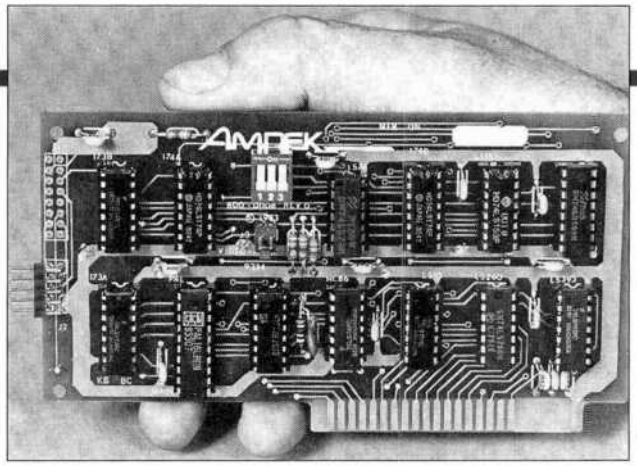
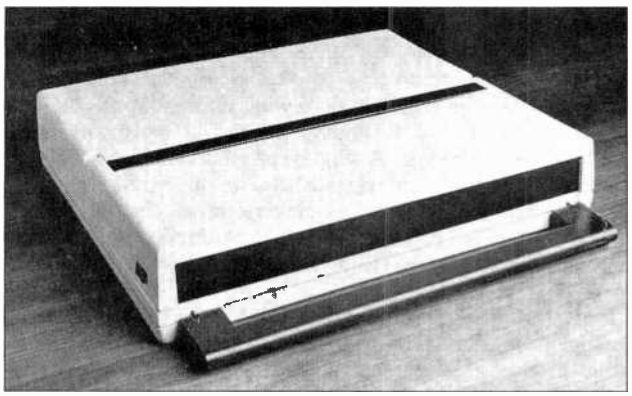


RGB CARD FOR APPLES

Amdek has introduced the Model DVM-III RGB card for Apple computers. The card fits into slot seven of the computer and reproduces on RGB monitors the video modes that the computer is capable of displaying in NTSC or composite-video monitors. The DVM-III permits user selection of text color by setting soft switches on the board. Modes supported include: 16-color low resolution with option of mixing 40- or 80-column text; 16-color medium resolution with option of mixing 80-column text; 6-color high resolution with option of mixing 40- or 80-column text; 16-color double high resolution (140 × 192 pixels) with option of mixing 80-column text; and monochrome double high resolution (560 × 192 pixels). The card is compatible with all Apple II 40-column software. $195.

Circle No. 85 on Free Information Card



PORTABLE 16-BIT COMPUTER

Packaged in an 18″ × 15″ × 3″ attache case and weighing less than 16 lb, the Commuter from Visual is an IBM PC workalike in a go-anywhere portable. It is claimed to be hardware and software compatible with the PC and includes as standard features: 8088 CPU; 128K (expandable to 512K) of RAM; MS-DOS 2.1; keyboard with all IBM functions and identical keyboard layout; 5¼″ (360K) floppy-disk drive with room for a second optional drive; bit-mapped color graphics support (display is optional); support logic for 80 × 25- and 40 × 25-character display; parallel and RS-232C serial ports; RGB, composite-video, and r-f outputs; and a connector for using an IBM expansion chassis. An 80 × 16-character LCD display is optional. $1995 base; $2450 with optional second drive and display.

Circle No. 86 on Free Information Card

SOFTWARE SOURCES

Flowcharting Program. Automatic drafting of program flowcharts is now possible on the **Sharp PC-1500/1500A** and **Radio Shack PC-2** handheld computers with the Flowcharter program from PocketInfo. The program lets you select from among 15 different symbols, which are then drawn on the computer's printer/plotter. A multiple-line description can be printed alongside the symbol. $29.95 cassette. **Address:** PocketInfo Corp., PO Box 152, Beaverton, OR 97075.

Text Formatter. Textform from Gibson Software is a CP/M-based text formatting program for the **Heath/Zenith H/Z-89/90** computers. It recognizes more than 30 text-imbedded commands, allowing the user to control page and line lengths, margins, line spacing, text centering and justification, headlining, footnoting, and text underlining. Included are commands that provide access to many of the special print modes of Epson printers. Requires a minimum of 48K of RAM and at least one disk drive. $49.95 hard- or soft-sectored disk. **Address:** Gibson Software, Rte. 1, Box 317, Iron Station, NC 28080.

File Management System. MegaFinder from Megahaus is a database management program for **Apple II** and **IIe** computers. It comes complete with a report generator and includes a selection of ready-made forms and reports models. With MegaFinder, you can custom design forms from scratch, as well as change existing forms, using its built-in screen editor. The program maintains information in up to four sorted orders simultaneously, each of which can be sorted in up to five sublevels. A preview mode allows any report to be checked before printing. An on-line help facility is provided to make the system user-friendly. $149.95. **Address:** Megahaus Corp., 5703 Oberlin Dr., San Diego, CA 92121.

Cataloging Program. Cat*Man from Zephyr is a mini-file system that lets you catalog your books, records, tapes, etc., on an **IBM PC** or **Apple II/III** computer. You input title, author, and subject for each item to be cataloged, according to prompts from the computer. Up to 5000 items can be cataloged on a single IBM PC disk (2000 on an Apple disk). The program makes it easy to add or delete items and includes a handy search function that quickly pinpoints any item or group of items called by name. Requires 64K of RAM and at least one disk drive. $19.95 for disk. **Address:** Zephyr Services, 306 S. Homewood Ave., Pittsburgh, PA 15208.

Spelling Corrector. Star-Kits' Spell 'N Fix Level II is a spelling correction program for the **Radio Shack Color Computer.** The program splits the CoCo's screen into two windows. The upper window displays upper/lower-case text as it is being read, while the lower window displays program status, misspelled words, and possible alternative spellings. Supplied is a 20,000-word dictionary, to which you can add an additional 20,000 words or use alternative dictionaries. The program is self-prompting and has extensive error-recovery routines that eliminate the need for you to refer to the manual after first use. Requires 32K minimum RAM and at least one disk drive. $69.29. **Address:** Star-Kits Software Systems Corp., PO Box 209, Mt. Kisco, NY 10549.

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NEW PRODUCTS

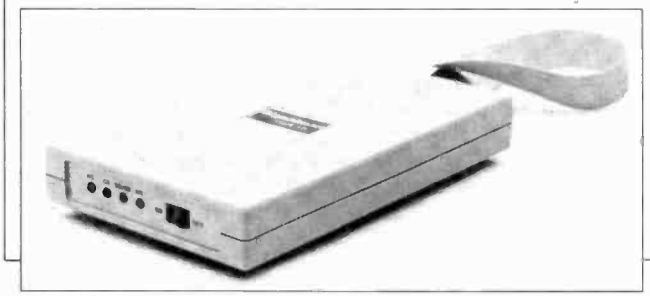
DUAL-DISK DRIVE

A new floppy-disk drive unit containing two half-height, 140K drives side-by-side in a single case has been introduced by Apple. Called Duodisk, the system offers improved technology and full compatibility with Apple II software at a lower price than two separate Disk II drives. Duodisk is exactly as wide as the Apple II computer and can sit between computer and video monitor. Technical improvements include a new disk-eject mechanism and advanced head-positioning mechanism for more precise reading of half tracks. Operationally identical to the Disk II floppy drive, Duodisk runs all Apple II software and is supplied with a controller card that connects to any Apple II, II+, or IIe computer. $795.

Circle No. 87 on Free Information Card

INTELLIGENT MODEM

Anchor Automation's Signalman Mark XII intelligent low-noise auto-dial/auto-answer modem is said to emulate the command structures used in the Hayes Smartmodem. It can be operated manually, through a keyboard, without computer coding, or automatically to answer or originate calls at 1200 bps for Bell 212A and up to 300 bps for Bell 103 compatibility. The Mark XII detects dialtone and busy signals and automatically displays dialing status on-screen. A CMOS microprocessor assures very low power consumption and high reliability. An RS-232 cable and two telephone jacks (one for an attendant phone) are built in. $399. **Address:** Anchor Automation, Inc., 6913 Valjean Ave., Van Nuys, CA 91406.



PRINTER UPGRADE ACCESSORY

Finger Print from Dresselhaus upgrades Epson MX and FX series and IBM PC printers by providing easy access to special print functions such as compressed, italic, or emphasized. The plug-in module puts numerous modes at the user's fingertips, permitting instant selection from a variety of print functions simply by tapping the printer's control panel buttons. The increased capabilities do not interfere with normal printer operations. Installs without soldering and is accompanied by instructions. $59.95. **Address:** Dresselhaus Computer Products, 837 E. Alosta Ave., Glendora, CA 91740.

SOFTWARE SOURCES

Word Processor. OmniWriter from Human Engineered Software offers a word processor and integrated spelling checker for **Commodore 64** users. The page-based WP program provides such features as multiple line headings and footings; name, address, and label merging; underlining and boldfacing; full scrolling and function keys to page forward/backward; global search/replace; and support for a wide variety of printers. The integrated 30,000-word OmniSpeller can be expanded to include additional words. A simple conversion allows files from Microsoft's Multiplan spreadsheet to be transferred to OmniWriter. Supplied are a quick reference card, keyboard overlay, and reference manual. $69.95. **Address:** Human Engineered Software, 150 N. Hill Dr., Suite 35, Brisbane, CA 94005.

Mainframe Graphics Link. CompuView Products has announced availability of Vgraph, a software package designed to allow microcomputer users to access powerful mainframe graphics packages. The program emulates a Tektronix Model 4010, the industry standard display terminal. It also allows the user to print out his display screen and, with the aid of a color monitor, to display text in up to eight colors. The software is menu driven and permits modification of communications parameters during execution. Computers currently supported include the **Heath/Zenith H/Z-100** series and **Victor 9000**. $120. **Address:** CompuView Products, Inc., 1955 Pauline Blvd., Suite 200, Ann Arbor, MI 48103.

Word Processor for PC*jr*. Word-Jr from Micro Architect is a word processor for the IBM PC*jr* that supports both color and monochrome monitors. The program consists of a full-screen editor and a powerful text processor. Also included is a built-in file/merge capability. Word-Jr requires a minimum of 128K of RAM and at least one disk drive. $59. **Address:** Micro Architect Inc., 6 Great Pines Ave., Burlington, MA 01803.

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COMPUTER MAIL ORDER

commodore

SX-64 PORTABLE $839

CBM 8032	**$599**
CBM 4032	**$599**
CBM 12880	$769.00
CBM 64K Memory Board	$269.00
8032 to 9000 Upgrade	$269.00
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8050 Disk Drive	$949.00
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4023 Printer	$379.00
8023 Printer	$569.00
6400 Printer	$1399.00
Z-RAM	$499.00
Silicon Office	$699.00
The Manager	$199.00
Soft ROM	$125.00
VisiCalc	$159.00

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Word Pro 2 Plus	$159.00
Word Pro 3 Plus	$189.00
Word Pro 4 Plus/5 Plus...each	$279.00
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AdminIstrator	$399.00
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VIC 20	**CALL**
MSD-1 Disk Drive	$349.00
MSD-2 Disk Drive	$599.00
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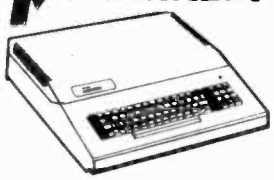
C1530 Datasette	$69.00
C1520 Color Printer/Plotter	$169.00
M-801 Dot Matrix/Parallel	$219.00
C1526 Dot Matrix/Serial	$279.00
C1702 Color Monitor	$249.00
C1311 Joystick	$4.99
C1312 Paddles	$11.99
C1600 VIC Modem	$59.00
C1650 Auto Modem	$89.00
Logo 64	$49.00
Pilot 64	$39.00
Word Pro 64 Plus	$59.00
Parallel Printer Interface	$49.00
CalcResult 64	$65.00
CalcResult Easy	$39.00
Codewriter 64	$75.00
Quick Brown Fox	$49.00
Vidtex Telecommunications	$34.95

FRANKLIN



ACE 1000 Color Computer	CALL
ACE Family Pack System	CALL
ACE PRO PLUS System	CALL
ACE 1200 DMS	CALL

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A2	$219.00
A40	$299.00
A70	$319.00
C2 Controller	$79.00
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RANA

Elite 1	$279.00
Elite 2	$389.00
Elite 3	$569.00

APPLE IIe STARTER PACK

64K Apple IIe, Disk Drive & Controller, 80 Column Card, Monitor II & DOS 3.3.
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AT-846 Atari Interface	$89.00
AT-100 Atari Interface	$239.00
GP-100 Parallel Interface	$199.00

BMC

401 Letter Quality	$589.00
BX-80 Dot Matrix	$269.00

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SMITH CORONA

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Delta 10	$559.00
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TRANSTAR

120P	$499.00
130P	$689.00
315 Color	$499.00

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4013 Asteroids	$29.00
5049 VisiCalc	$159.00
7097 Logo	$79.00
7101 Entertainer	$69.00
7102 Arcade Champ	$75.00
8026 Dig Dug	$33.00
8030 E.T. Phone Home	$33.00
8031 Donkey Kong	39.00
8033 Robotron	$35.00
8034 Pole Position	$39.00
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JB 1201 Green	$149.99
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SAKATA

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1400 Color	$269.99

ZENITH

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RANA

000	$329.00

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ANCHOR

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TRS-80 Color Computer	$99.00
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212 Apple Cat	$569.00
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Cat	$139.00
D-Cat	$149.00
PC-Cat	$339.00

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ZT-11	$399.00

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In Toronto call (416)828-0866, Dept. 40507
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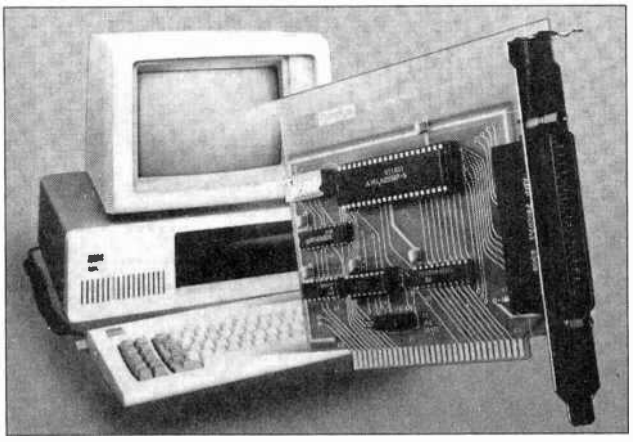
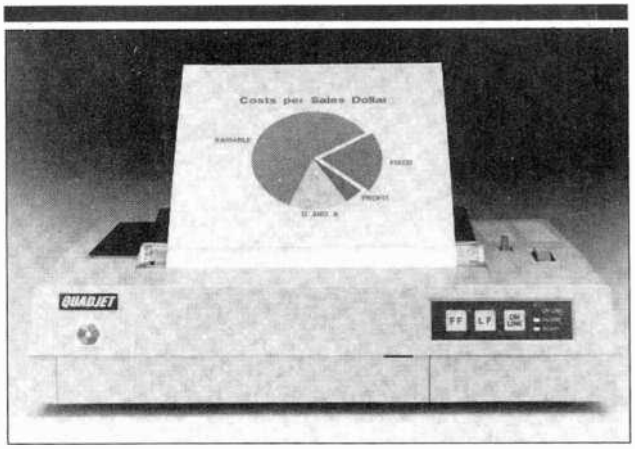
NEW PRODUCTS



PARALLEL I/O INTERFACE

MetraByte's Model PIO-12 I/O parallel interface board for the IBM PC and XT provides 24 TTL/DTL-compatible lines. It also offers interrupt input, enable lines, and external connections to the PC's power buses. Interrupt handling is via a tristate driver with a separate enable line, and it can be configured to any of the available interrupt levels on the IBM PC by means of a plug-type jumper on the board. All outputs can drive one standard or four low-power Schottky TTL devices, and CMOS compatibility can be obtained by adding a pullup resistor. Three programming modes are available to the user to permit standard, strobed, and bidirectional I/O. $89. **Address:** MetraByte Corp., 254 Tosca Dr., Stoughton, MA 02072.



INK-JET COLOR PRINTER

Quadjet from Quadram Corp. is a compact, lightweight inkjet printer that prints out in up to seven colors at a speed of 40 characters per second. It uses a drop-on-demand ink-jet printing system capable of a text and graphics resolution of 640 dots per line. Its bidirectional scanner prints 80 standard or 40 enlarged text characters per line. Each color user-replaceable cartridge is rated at 4-million characters. Quadjet has both image printing and hard-copy functions and can use almost the entire width of an 8½" sheet of paper. Operating sound level is rated at less than 50 dB. The printer measures 15¾"W × 11⅝"D × 4¼"H and weighs only 12.3 lb. Accessory kits containing software programs to take advantage of Quadjet's features, are available for the IBM PC and Apple II series computers. $895.

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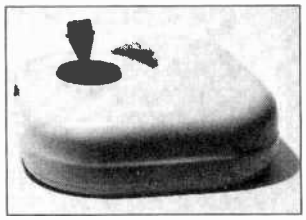
HIGH-SPEED/RES JOYSTICK



The Turbo Stick is a new type of joystick from KA Design Group. It offers high pointing speed, high resolution (one part in 4096), and full RS-232 ASCII output. Incorporated into the handle are two fingertip-operated microswitches that allow the user to switch between an absolute mode with high pointing speed and a rate mode with high resolution. These switches can also be redefined through software to perform different functions. $395. **Address:** KA Design Group, 6300 Telegraph Ave., Oakland, CA 94069.

SOFTWARE SOURCES

Financial Management. Turning Point Software's Time is Money™ personal/small-business management tool is designed for the person with no accounting or bookkeeping background. It balances checkbooks, calculates and monitors budgets, calculates net worth, prints out checks, and tracks fully or partially deductible items. Full report generation and graphics capabilities are included. The program can keep track of 240 accounts, 240 expense categories, and 240 income types from 240 sources. Any transaction in any category can be added, deleted, or edited at any time. A system of virtual menus allows instantaneous movement to any point within the program. Available for **Apple II, II+, IIe,** and Apple-compatible computers with at least one drive. $100. **Address:** Turning Point Software, Inc., 11A Main St., Watertown, MA 02172.

Information Control System. Precision Software's Superbase 64 is a comprehensive database management/information control system for the **Commodore C-64** computer. It is claimed to be the only multifile information retrieval system available for the C-64. The number of possible databases Superbase 64 can handle is claimed to be unlimited. Each database can contain up to 15 files, while the number of records possible for each file is constrained only by disk capacity. The program comes with a user-programmable interface that permits creation of custom applications packages within the Superbase environment. The program can also be menu-driven or accessed via direct commands to the database. Linking to other programs is also supported.

Circle No. 94 on Free Information Card

Operating System Enhancer. DoubleDOS from SoftLogic Solutions lets the **IBM PC** and **XT** run foreground and background programs simultaneously. It divides memory into two separate areas, in either one of which a program can run in the background without keyboard interaction. When that program is recalled, the current screen display reflects any processing that has occurred while the program was running. Meanwhile, the operator can run any other program in the foreground. If two video displays are used, one can be assigned to display background runs while the other displays the foreground run. DoubleDOS can run in systems with as little as 128K of RAM, but 192K is recommended. DoubleDOS supports PC DOS versions 1.2 and 2.0. $299. **Address:** SoftLogic Solutions, 530 Chestnut St., Manchester, NH 03101.

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Modems

(Continued from page 51)

The fancy cases, indicator lights, and elaborate switches are also conspicuously missing. Most budget modems have cases made of molded plastic, not metal. And few have fancy panels or expensive nomenclature.

The only indicator you will find on a budget modem is an LED that lights up when the modem has locked onto the carrier signal. Acquisition of the carrier permits you to carry on a conversation.

Switch count is reduced by eliminating the self-test function from the modem. And some budget modems don't even have an off/on switch! Now, that's really cutting costs to the bone.

Almost all low cost modems connect to the computer through an RS-232C interface. This is done with a DB-25 connector built right into the modem. All you have to do is hook a cable from the modem to the RS-232 port of your computer.

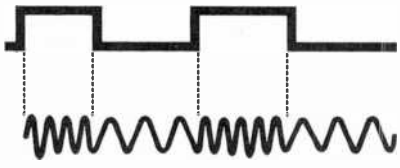

Fig. 23. FSK modulation is a form of FM.

Unfortunately, few budget modems come with this cable, although you will need one to make the modem work. So be prepared to dish out another $20 or so above and beyond the cost of the modem itself for a cable.

Connecting the modem to your telephone line, though, is quite another matter. It seems everyone has a different idea of how to do it.

Direct-Connect Modems

Most budget modems, you will find, are of the direct-connect type. What this means is that they plug directly into a standard RJ-11 modular phone jack.

In some cases, as with the Radio Shack IB modem, you disconnect your telephone from the wall jack and insert the phone plug into a modular jack on the modem. You then connect the modem to the wall jack.

Sometimes a modem comes with a telephone extension cord, other times you will have to supply your own. One modem, the Teledata model TD200 by Compro Electronics, has only one telephone outlet on the modem, and no provision is made for you to connect the telephone. In this case, you will need to purchase a "Y" adapter that accepts one input from your phone and another input from the modem and connects them to a single wall jack.

In direct-connect modem setups, the modem and telephone are connected in parallel with each other. This means you are free to use your telephone normally, as if the modem weren't there.

When the modem is engaged, though, it seizes control of the telephone line and directs phone operations. Even though you are instructed to replace the receiver of the phone back into the cradle after dialing the number, the modem keeps the circuit alive until it is requested to hang up the phone.

Disconnecting the modem from the line is done in many different ways. More often than not, however, you simply turn the modem off.

Telephone-Based Modems

Another way to approach the problem of connecting a modem to a telephone line is to make use of the telephone itself. The H.E.S. (Human Engineered Soft-

FCC REQUIREMENTS

Since a modem connects to the telephone lines, it actually becomes part of the telephone system. Therefore, it must meet certain FCC requirements, as laid out in Part 68 of the Rules and Regulations for direct telephone connection. Don't worry, though, the rules aren't terribly restrictive.

First, direct connection to the telephone lines may only be made using a standard RJ-11 modular plug. No other type of direct interface is acceptable.

If your present telephone doesn't have a modular plug outlet, one can be easily added. All telephone stores and Radio Shacks sell a modification kit (for a couple of dollars) that changes your current junction-box into a modular jack. All you have to do is remove the old cover and replace it with the one supplied in the kit. Everything is color coded, so you can't make a mistake.

You can also have the telephone company make the conversion for you. Just remember, they're going to charge you a service call for doing it, which could cost as much as $50. If you have the older 4-pin phone jack, you don't have to change it. You can buy an adapter that simply plugs into the outlet and converts it to a modular hook up.

Direct-connect modems cannot be connected to telephones on a party line, in multi-phone systems or to coin-operated phones.

Some telephone companies require that you inform them before installing an alien device such as a modem, and register it with them. You need to give them the telephone numbers(s) of the line(s) the modem will be connected to, the make and model of the modem, the FCC registration number, and the ringer equivalent. This information is printed right on the modem itself.

Not all phone companies require you to alert them of your intentions, though. Mine doesn't. You are, however, responsible for the modem's actions while it is connected to their system. If a modem causes abnormal operation of the phone or induces noise on the lines, you must disconnect it immediately. This is *your* responsibility.

Should the telephone company have to notify you that your device is causing harm, it has the option of discontinuing your phone service. If this becomes the case, the telephone company will notify you in writing of a temporary discontinuance of service, give you an opportunity to repair the modem, and inform you that you have the right to bring an FCC complaint against them if you feel they are in error.

All repairs to the modem must be made by the manufacturer or an authorized service agency. In other words, don't try to repair it yourself. Failure to comply with this rule voids the FCC certification, making it illegal to use the modem until restored to its original condition.

Modem circuits operate at and generate radio frequencies. Consequently, they must also adhere to Part 15 of the FCC's Rules and Regulations concerning spurious radio emissions.

Part 15 states that no electronic device may cause interference to other electronic equipment. This section refers primarily to radio and television, but does not exclude other devices that may be affected.

If your modem does happen to cause interference with your television set or a neighbor's, the problem is usually easily corrected. Look for excessively long cables or loose connections. Chances are you will find the problem there.

In more stubborn cases, you may have to reorient the TV antenna or relocate the modem with respect to the receiver affected. If necessary, contact the manufacturer or an experienced repair technician to resolve the problem. ◇

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ware) HESModem I is a good example of this type of modem, although others exist. The H.E.S. modem actually uses part of the telephone as an extension of the modem.

To use the modem, you dial your phone normally and establish contact with the receiving modem. Once the link is made, you unplug your handset from the phone base and connect the modem to the telephone base, not to the telephone wall jack.

Of course, you must have a telephone with modular plugs on both ends of the coiled cord and the dialing mechanism

Does a lower price reflect an inferior product?

in the base of the phone. You can't use a phone that has the dialing portion of the telephone contained in the handset, like the Princess or Trimline models.

Furthermore, not all phones will work with this scheme even if they meet the above requirements. You're probably not aware of it, but pushbutton phones actually come in two different styles. There is the short-keystroke model, and the full-keystroke version.

To identify which is which, you need to measure the travel of the button as you depress it. If the travel is only 1/32", the phone is a short-keystroke model. A movement of 1/8" or more means it has a full keystroke.

The HESModem I (by H.E.S.) won't work on telephones with a short keystroke. It will, however, on all full keystroke models and on all rotary dial phones that have removable handsets

MODEM CHIP SETS

THE introduction of modem chip sets has dramatically reduced the complexity of modems and is chiefly responsible for the appearance of the low cost modem. Although modem chip sets are available from a number of manufacturers, notably Motorola, Texas Instruments, and Exar, most modem makers have adapted Motorola's MC14412/MC145440 chip set to their designs.

The actual modem is the MC14412 chip. Inside this single 16-pin package reside all the functions needed to generate and receive modem communications. A block diagram of the chip is presented in the drawing shown here in Fig. A.

The modem chip contains its own 1-MHz oscillator which generates the clock signal necessary for modem operation. The clock-output frequency is divided several times to create the carrier frequencies used for modem communications. A sine-wave generator shapes the square wave clock pulses into distortion-free sine waves, which the telephone lines are better equipped to handle.

The MC14412 modem also contains circuitry to process incoming modem signals. The signal is first passed through a level change detector, which monitors the input voltage, then sent along to a demodulator. With the help of the clock signal, the demodulator decodes the incoming frequencies and changes them back into digital 1s and 0s. The reconstructed digital message is buffered and output to the computer.

The modem chip even has provisions for self-testing. It does this by internally routing the transmitter's output to the receiver's input. This way, you test the modem alone, not the telephone lines. A similar test for the entire system is also possible by placing the modem in the echo mode.

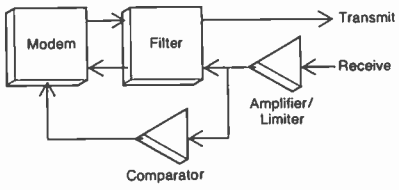

Fig. B. Bare essentials of a modem circuit.

The second half of the modem chip set is made up of the MC145440 filter network. This chip is a switched-capacitor digital filter that provides the necessary upper- and lower-band separation for full duplex (simultaneous two-way) operation at 300 baud. Without filtering, the narrowly separated information frequencies could become entangled.

When these two chips are used together, the result is a modem. Some external circuitry is required, however, to support the modem in its efforts. The simple modem block diagram in Fig. B better explains the story.

Basically, the external amplifier, limiter, and comparator receive and condition the incoming modem signal before the modem chip ever sees it. They also evaluate the quality of the transmission by monitoring the level of the signal. If the input level is too low (usually less than −42 dBm), it forces the MC14412 to ignore the signal, thus preventing the deciphering of erroneous data. ◇

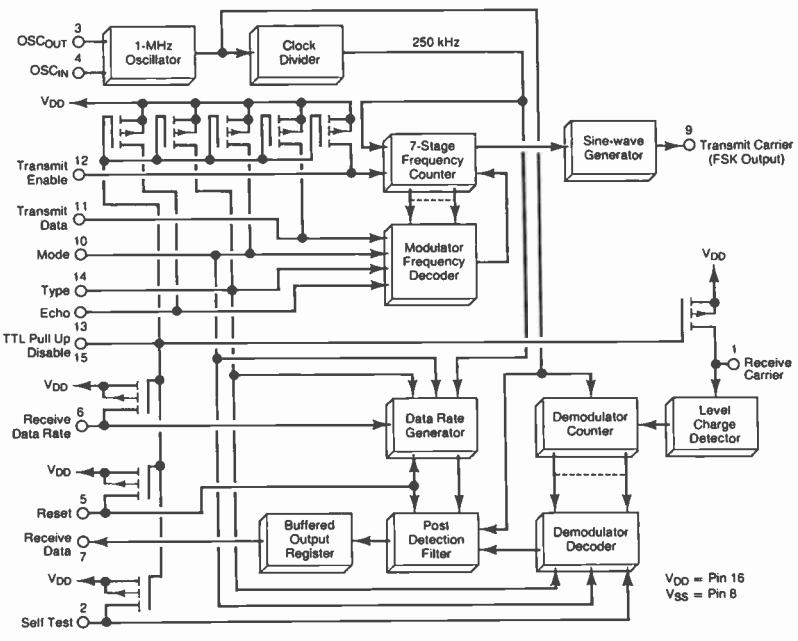

Fig. A. Block diagram of Motorola's MC14412 modem chip.

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HB-1210	1	2	yes	840	9	13.95

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HB-2313	2	3	3	1980	18	31.00
HB-3514	3	5	4	2420	27	47.95
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and the dial in the main body of the phone.

In other words, check your phone *before* considering a modem that uses the phone base for its operation. You might wind up buying a new phone just to accommodate the modem if you don't. And that's no bargain.

Dedicated Modems

Another trick the manufacturers have used to bring down the cost of modems is to specifically tailor a modem to work with only one computer model. In fact, the HESModem described above is a dedicated modem. The Model 6420 modem from Westridge Communications, Inc. is another.

With VLSI an entire modem circuit can be put on one chip

Unlike the universal modems so far discussed, which are made to interface to all computers with an RS-232C port, the HESModem I and the Model 6420 are specifically designed to work with the Commodore 64. Two benefits are gained by using this approach.

The first is the lack of connecting cables. As we've seen, most budget modems come without connecting cables. To use them, you must purchase one, which adds to the total cost of the modem system.

The 6420 and H.E.S. modems, on the other hand, use the expansion outlet of the Commodore 64 for connection. In fact, the modem cases have the edge connector molded right into them, and the entire modems plug into the back of the computer. No cables are needed!

Software

The second benefit is derived from the software. Most universal modems don't come with a software package, but one is needed before the computer can communicate over telephone lines.

Depending upon the computer you are using, this software can run you anywhere from $20 to $150. Suddenly, our budget modem begins looking pretty expensive.

Dedicated modems have eliminated this expense. The Westridge Communications modem and the HESModem I come complete with software—and sell for under $100. The reason is, the software has to be written for only one machine: the Commodore 64.

But that's not all that happens. Remember our mentioning that the modem chip comes with automatic features built right into it? It could originate and answer calls—if extra hardware were added.

Well, the same thing can be done with a software package. By tying the automatic-function pins of the modem chip to the I/O ports of the computer, we can use software to control its operation.

In fact, the Model 6420 does just that. It has automatic answering and dialing—all controlled from the keyboard. In effect, this budget modem has become a smart modem. Computer controlled, of course.

You will probably see more and more of this type of modem in the near future. Dedicated modems that plug right into the expansion slots of computer cabinets will eventually replace many of the universal designs now on the market—and at lower prices with better features. ◇

MODEM POWER SOURCES

THE means by which budget modems are powered are just as diverse as the modems themselves. Some simply use a battery. The Volksmodem is such a model. It uses a standard 9-volt transistor battery.

In order to make the battery last, though, some design improvements had to be made in the circuit. The use of a small battery precluded the inclusion of any indicator, including the carrier-monitoring LED. In its place is a piezoelectric beeper that emits an audible carrier-detect tone when the carrier has been acquired. To further reduce power consumption, all chips are of CMOS design.

A unique approach has been ventured by Compro Electronics in its Teledata model TD200 modem. It actually takes power from the telephone lines and uses it to operate the modem!

No batteries, no cables; no muss, no fuss. Simply plug the modem into any telephone jack and it's ready to go. One disconcerting feature of this design, though, is that the modem may hang up if someone picks up an extension telephone while the modem is in operation. This forces you to re-establish the contact and begin transmission of your information over again.

Radio Shack and several others power their modems right from the ac line. In all cases, a stepdown transformer plugs into a wall outlet and a cable runs from the transformer to the modem, where the ac input is rectified and used to power the modem.

Dedicated modems, naturally, receive their power directly from the computer's I/O expansion port. ◇

MODEM MANUFACTURERS

Manufacturer	Make	Price	Power Supply	Features
Anchor Automation, Inc. 6913 Valjean Avenue Van Nuys, CA 92626	Signalman Mark I	$99.95	AC Adapter	Universal Type
	Volksmodem	$69.95	Battery	Audio carrier-detect tone
Compro Electronics 3185-A Airway Costa Mesa, CA 92626	Teledata TD-200	$79.95	Phone lines	No power supply needed
Human Engineered Software 150 North Hill Drive Brisbane, CA 94005	HESModem I	$69.95	I/O port powered	Uses telephone base
Radio Shack One Tandy Center Fort Worth, TX 76102	Radio Shack Modem IB	$99.95	AC Adapter	Color Computer interface
Westridge Products, Inc. 330 Washington Street Marina del Rey, CA 90291	Westridge 6420	$99.00	I/O port powered	Commodore 64 dedicated modem/ with software

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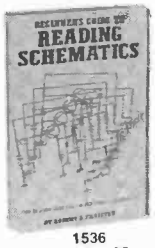

1536
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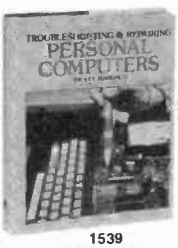
1218
List $17.95

1604
List $21.95

1473
List $19.95



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1532
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1543
List $17.95

1685
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1451
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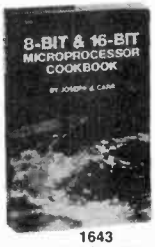

1643
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1337
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1633
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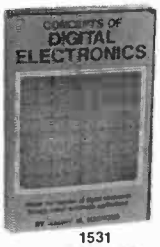

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1665
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1673
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1577
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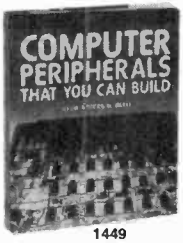

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List $19.95

1423
List $10.95 (paper)

1671
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1409
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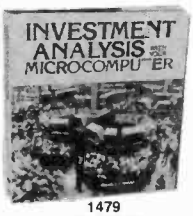

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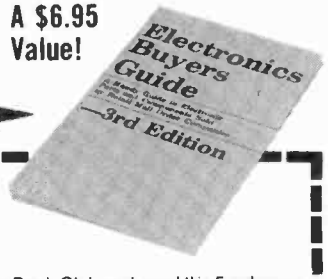

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In-Circuit Emulation

(Continued from page 82)

$400 will bring a host of such low-cost instruments on the market. This fresh approach to problem solving should go a long way to easing many headaches in both the hardware and software areas for microcomputers. ◇

TABLE 1—EMULATOR COMMANDS

Command Description	Type in Command
1. Display a block of memory starting at the last referenced memory address.	D
2. Display a block of memory beginning at a given start address (sa).	D sa
3. Display a block of memory beginning at a given start address (sa) and stopping at a particular last address (la).	D sa,la
4. Examine the data at an I/O port address (pa).	E pa
5. Fill memory from a starting address (sa) up to and including the given last address (la) with a particular 8 bit data byte (d8).	F sa,la,d8
6. Go into run mode starting at the current program counter location.	G
7. Go into run mode beginning at the given start address (sa).	G sa
8. Use hex arithmetic to calculate the sum and difference of the two given 16 bit data values.	H d16,d16
9. Move memory between a given start address (sa) and a given last address (la) to a destination address (da).	M sa,la,da
10. Run a memory test on the target system RAM between a given start address (sa) and a given last address (la).	MT sa,la
11. Output to the specified port address (pa), one or more 8 bit data bytes (d8).	O pa,d8,d8,...
12. Quit full speed run mode.	Q
13. Read an Intel hex file and load the data into the target system's RAM.	R
14. Read an Intel hex file and apply the given offset (off) value prior to loading the target system RAM.	R off
15. Repeat the given command line in order to provide a loop. (Useful for oscilloscope troubleshooting.)	RL
16. Substitute into memory starting at the last referenced memory address.	S
17. Substitute into memory beginning at the given start address (sa).	S sa
18. Trace one instruction.	T
19. Trace one or more instructions.	T d16
20. Untrace one or more instructions. (Only display the registers for the last instruction traced.)	U d16
21. Verify that target system memory is the same [beginning at a given start address (sa) and ending at a given last address (la)] as that value beginning at a given destination address (da).	V sa, la, da
22. Display all the Z80 internal registers and flags.	X
23. Display and allow for modification of one of the Z80's internal registers, where z can be any one of the given registers as indicated below: z = F, F', A, A', B, B', D, D', S, P, X, Y, I	Xz
24. Have the emulator wait a given amount of time before executing the next command. (Good for scope loops.)	Z d16
25. Set breakpoint address 1 to the given 16 bit value (d16).	BP 1,d16
26. Set breakpoint address 2 to the given 16 bit value (d16).	BP 2,d16
27. Set breakpoint address 3 to the given 16 bit value (d16).	BP 3,d16
28. Set breakpoint pass counter 1 to the given 8 bit value (d8).	BPC 2,d8
29. Set breakpoint pass counter 2 to the given 8 bit value (d8).	BPC 2,d8
30. Set breakpoint pass counter 3 to the given 8 bit value (d8).	BPC 3,d8
31. Enable all three breakpoints.	EBP
32. Enable breakpoint 1,2 or 3, where (n) is the breakpoint number.	EBP n
33. Disable all breakpoints.	DBP
34. Disable breakpoint 1,2 or 3, where (n) is the breakpoint number.	DBP n
35. Enable all printpoints.	EPP
36. Enable printpoint 1,2 or 3, where (n) is the printpoint number.	EPP n
37. Disable all printpoints.	DPP
38. Disable printpoint 1,2 or 3, where (n) is the printpoint number.	DPP n
39. Enable interrupts to be received from the target system.	EI
40. Disable interrupts from the target system.	DI
41. Enable bus requests to be received from the target system.	EB
42. Disable bus requests from the target system.	DB
43. Enable the emulator's automatic refresh function.	ER
44. Disable the emulator's automatic refresh function.	DR
45. Display the emulator's status which includes: breakpoint address pass counters breakpoint enable or disable printpoint enable or disable interrupts enable or disable bus requests enable or disable refresh enable or disable	ST
46. Soft reset the Z80 by storing zeros into all the internal registers.	SR
47. Accept assembly language inputs at the terminal and place the machine-language equivalents in the target system's RAM beginning at a starting address (sa).	A sa
48. List Z80 machine-language instructions as disassembled English-language mnemonics. The list will begin at starting address (sa) and end at last address (la).	L sa,la

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Mainframe to Micros
(Continued from page 63)

• Each time the user wants a copy of the latest data stored in the mainframe, the "data fetch" program is used to bring a copy of the data shown to the micro, sometimes formatting it in a way that makes it accessible to a micro spreadsheet such as Lotus 1-2-3 or VisiCalc.

Popular fourth-generation languages or "decision support tools" for which personal computer bridges have recently been announced include Express (Management Decision Systems, Waltham, MA); System W, a financial manipulation language (Comshare, Ann Arbor, MI); Focus (Information Builders, New York, NY); Empire (Applied Data Research, Princeton, NJ); and Ramis (Mathematica, Princeton, NJ).

The second type of software provides a bridge from mainframe database management software to a micro spreadsheet or other application. It also extracts, formats and downloads data. As a rule of thumb, however, the database bridge requires more technical skill or learning time than a fourth-generation language.

A skilled programmer will still be required to insure that the "right" data is written onto the mainframe database. However, the latest database-to-PC programs have built features into themselves that make it easier for non-sophisticated users to do their own "data fetching." Typical of the way the easier-to-use database links work is the recently announced PC/204 from Computer Corporation of America (Cambridge, MA). It allows the user to position a cursor over an empty spreadsheet on his or her micro and scroll through data labels on the mainframe database until the name of the right data is "pointed" into

How does a company handle thousands of users and still maintain a semblance of security?

the spreadsheet. Examples of other database bridge vendors include: Applied Data Resources's ADR/Datacom DB (Princeton, NJ); Cullinet's Information Database/Cullinet PC Software (Westwood, MA); Informatics General Answer/DB (Canoga Park, CA).

The third type of bridge extends from a mainframe application package to a personal computer. Most of the application package vendors who have announced personal computer bridges are in the accounting area, although others (for example, vendors of Manufacturing Resource Planning systems) are likely to follow suit. Whereas fourth generation languages and database management systems usually serve as a common storage facility for data that originated under a variety of application programs, these mainframe software products are themselves applications. This is an advantage if the information you need on the micro comes entirely from a single application (for example, a payroll system). But if you need to combine types of information, you will probably need a programmer's help to get it. The most advanced application package-to-PC programs (for example, Management Science's Peachpack series from Atlanta, GA; McCormack and Dodge's PC Link from Natick, MA) do provide help in accessing information generated by other than their own mainframe applications.

The obvious limitation of each of these three "bridge" packages is that the data you want to access must already reside in the mainframe version of the vendor's software. If they don't—either because your company doesn't have the software, or because some of the data you want are kept somewhere else (for example, in an old fashioned "flat file" of the sort maintained by a 15-year-old COBOL program)—none of these solutions will help you.

The final bridge type is a file-to-file transfer facility from a mainframe to a personal computer (one example is Omnilink). This software does not require that the data you are looking for be in any vendor's proprietary structure. Unfortunately, it only reformats and downloads data. You (or your data-processing department) must write a program to actually find and extract the data you want, and store it in a transfer file. It also requires a special batch job to be run on the mainframe every time you want to update the stored data. Examples of these simple bridges are Simware's SIM3278 (Ottawa, Ont.); VM Personal Computing's Please and Relay (New York, NY).

The Business Issues

Even assuming your company is able to justify the investment in time and money to link micros to its mainframe, there is still a vital business question to be reckoned with. Namely, how does a company let potentially hundreds or thousands of personal computer users into the mainframe database, while still maintaining some semblance of security, system resources, and sanity?

One of the reasons companies have mainframes (even though the power of personal computers is approaching that of the mainframes of the early 1970s) is that they have to support hundreds or even thousands of users and devices at one time with just one set of data. Balancing the potential benefits of linking micros to mainframes for greater productivity are a number of potential drawbacks.

For instance, whose numbers should you believe? Once data are transferred from a mainframe to a micro, they no longer stay up to date with the mainframe files. When sales figures are

Business issues will be solved more slowly than those of hardware and software

updated or revised today on the mainframe, the month-end total you downloaded last night for your VisiCalc spreadsheet will no longer be correct.

Horror stories are common in the mainframe world about managers arguing over who has the "right" value for sales, costs, inventory levels, etc. But at least the concept of a central database—a single collection of data maintained for all users—minimizes such conflicts. As "personal databases" start to spring up on diverse personal computers around the office, arguments (or worse, bad decisions) are likely to increase. At the least, corporate policy for micro users should insist that all users timestamp the time and source of their downloaded data, and refer to the timestamp whenever they use or present analyses based on that data.

Also, how do you keep a corporate secret? Another reason companies continue to use mainframes is the elaborate security precautions built into the system itself and into individual data files. Once a copy of sensitive data is downloaded to a microcomputer, and saved on a floppy disk, security for that data is about as primitive as a locked file drawer.

Finally, how do you avoid personal computer users tying up the mainframe? Unfortunately, one of the functions with

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BY ROBERT MAUNDER

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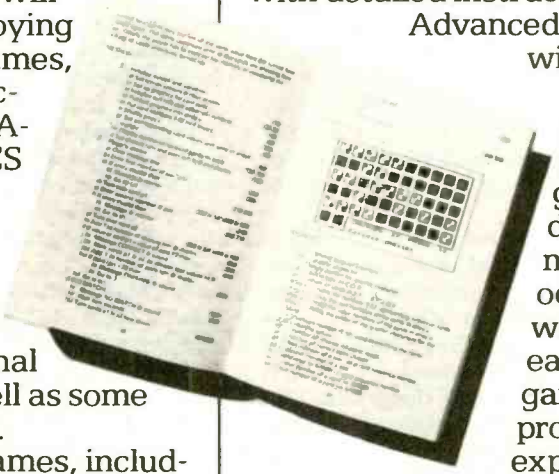

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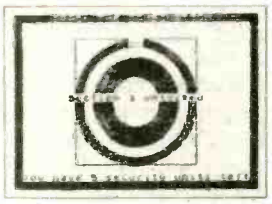

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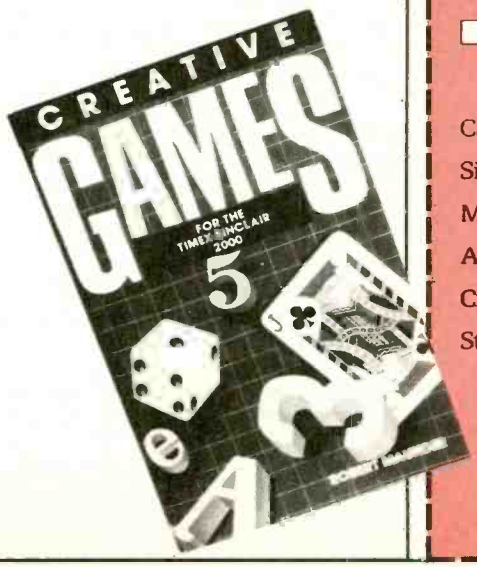

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the highest "overhead" performed by a mainframe is I/O—moving data out of and into the computer to and from various peripheral devices. And downloading data to a personal computer is a classic example of high-overhead I/O. As increasing numbers of personal computer users place heavy I/O demands on a mainframe, companies have a limited number of alternatives. Among them are:

- Giving low priority to basic transaction-processing applications; that is, slowing up order entry, payroll, accounting or inventory control users who are generating the numbers that the personal computer users in management want to access. This solution is not likely to please operating departments.
- Giving low priority to personal computer users; i.e., come in at 3 a.m. to do your download, or expect the application to take a few hours to complete. This may defeat the purpose for making the micro-to-mainframe link, increasing management productivity.
- Buying another mainframe dedicated to personal computer users. This alternative may defeat the argument for personal computers—an inexpensive way to put computer power in users' hands.

In Conclusion

There are no easy answers at this time for those who would link micros to mainframes. Because of the overwhelming appetite personal computer users have better, faster and more data, vendors of packaged solutions have great incentive to work on the problems that technology can address. These include integration—which provides a single-package answer to the questions of the physical link, the data link, and system-security assurance—and universality.

A system utilizing the concept of universality would embody a single piece of software or hardware able to speak and translate among the hundreds of differing hardware, telecommunications, data storage, and data interchange standards that exist in the typical corporate mainframe environment, as well as the relatively broad line of personal computers and applications programs that find their way into the office.

The business issues will be solved more slowly than those of hardware and software, and on a company-by-company basis. But it is safe to predict that the personal computer on a manager's desk is here to stay, and it's just a matter of time until that computer is linked into the corporate mainframe. ◇

MAINFRAME COMMUNICATIONS TERMINALS

By Charles Daney

THE most common kind of communication terminal used with the IBM mainframes is a member of what IBM calls the 3270 family. That family includes a number of different devices. Some of them are terminals that differ from one another in many respects. Some devices in the family are not really terminals at all, but specialized pieces of communications equipment that are called "communications controllers."

The first members of the 3270 family were announced by IBM more than ten years ago, at approximately the same time that the 370 line of mainframes was introduced. The earliest terminal model in the family was known as the 3277. Subsequently, models designated 3278 and 3279 have also appeared. In addition, each model has had a number of subtypes that differ in such details as the number of characters displayed per line, the number of lines per display, and other features and capabilities.

The "architecture" of the 3270 family is, as we shall see, very complex and elaborate. Because of this, IBM chose to separate some of the functions and build them into a "controller" device. Communications controllers in the 3270 family have included the 3271, 3272, and 3274. Each model has had a number of subtypes differing in such respects as how they are connected to the mainframe computer, how many terminals they can control, and the communications protocols they use. Individual 3270 terminals are usually grouped in "clusters" attached to a single control unit which is, in turn, attached to a mainframe in one of a number of different ways. This approach reduces cost somewhat by sharing certain functions provided by the control unit rather than duplicating them in each terminal. There was, however, one model called the 3275 that included a terminal and control unit in a single package.

The complexity of the 3270 architecture, and the ways in which it differs from the more familiar "async" terminal lie in several different areas. The first of these is the communications protocol employed.

In the early 1970s IBM introduced a new type of data link protocol called SDLC (for "synchronous data link control") as part of its Systems Network Architecture (SNA). SDLC protocol is supported by different types of 3270 terminals and control units. IBM has tried very hard to convince its customers of the wisdom of using SDLC and SNA, at the expense of both the bisync and async protocols. Indeed, most IBM mainframes support asynchronous communications very poorly, if at all. The newest and most advanced facilities are generally provided chiefly for SDLC terminals, and sometimes grudgingly, for bisync terminals. This has created a rather awkward and difficult situation for the very popular IBM PC, which is usually equipped to communicate only in the async mode. Although both bisync and SDLC hardware and software are available for the PC, they are considerably more expensive. This often makes it almost impossible for PC owners to use their computers with their office mainframe.

A second primary respect in which 3270 terminals differ from most async terminals is that 3270s generally use the EBCDIC character set. EBCDIC (for "Extended Binary-Coded Decimal Interchange Code"), which assigns hexadecimal values to printable characters, is used on most IBM mainframes. It is quite different from its principal alternative, ASCII (for "American Standard Code for Information Interchange"), which is, of course, what is used by the IBM PC and most "ASCII" terminals.

While conversion between EBCDIC and ASCII is reasonably straightforward, there are a few symbols that are in one set and not the other. For example, there is a "cent" character and a "logical-not" character in EBCDIC but not in ASCII. The latter, however, has the tilde and grave accent all to itself. Since these symbols aren't too commonly used, this is mainly just a nuisance in trying to simulate an ASCII terminal on a 3270, or vice versa.

A third and final area in which members of the 3270 family differ from most asynchronous terminals is in specific capabilities and features. Most important, 3270s are essentially block mode devices. That is, the basic unit of data is a field or

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Protocols
(Continued from page 63)

even a full screen. (A field is a portion of the screen used for a specific type of data. In a database there may be, for example, a "name" field, a "zip code" field, a "customer" field, and so forth.) Data is identified according to the field on the screen to which it belongs, and its position on the screen has little or nothing to do with the order in which it is sent in relation to other fields. Most asynchronous terminals, in contrast, are serial devices that display data in sequential order, unless this is modified by "cursor pointing."

This distinction is very significant in terms of the way programs are written to use the terminals. It is, for example, much easier to create screens having fields of diverse types (protected or unprotected, highlighted or not, of a specific color, etc.) on a block mode terminal like a 3270. Some 3270-family models even permit arbitrary redefinition of their displayable character sets. On the other hand, the 3270 hardware is incapable of the scrolling that almost all asynchronous terminals can perform.

As mentioned earlier, 3270s can be attached to mainframes in a variety of ways. A 3270 terminal is always first attached to a control unit (unless it has one built in). The control unit, in turn, can be connected directly to a mainframe I/O channel. This is by far the fastest type of connection (capable of supporting a data rate of about 650,000 characters per second!). Needless to say, it is also the most popular kind of connection for people who can conveniently work near the location of the computer. This kind of connection is known as a **local attachment.**

For those not so fortunate, who must work remotely from the mainframe, the connection must be by means of a communications line, which is considerably slower—at most 9600 baud, or about 1000 characters per second. This is known as a **remote attachment.** Although 9600 baud may sound fast to PC users who are accustomed to 300 or 1200 baud, it can be very unsatisfactory, since many 3270 applications are written, inefficiently, to send full screens of data (1960 characters or more) back and forth quite frequently on the assumption that most users will be attached to the high-speed channel.

The communications protocol used for remote terminals can be either bisync or SDLC. In the latter case, the terminal will be part of an SNA network. Although there is no such thing as a concise description of what SNA is, a little can be said about the general functions of communications networks.

It turns out that the problems that a data link protocol like bisync or SDLC is intended to solve are just a small subset of all the concerns of a network. The data link protocol "merely" ensures the reliable transmission of data from one point to another. Other problems of equal or greater difficulty include how data is routed over a variety of different transmission facilities, how a legitimate user connects to a particular application by name, and how the data is formatted so as to be comprehensible to both the sender and receiver.

All these problems are the concern of network architecture in general, and IBM's SNA is just one example. SNA is organized into a number of different layers, each of which deals with a particular class of problems. Data link control is the function of one specific layer. Other layers are known as the "path control layer," and there are still others as well.

An SNA network consists of a number of **nodes** (computers or terminals usually, although other peripheral devices may be included) connected by communications lines. Only the lowest logical layer of each node actually controls the physical communication with other nodes but, in a more abstract sense, the higher layers of each node also communicate with their peers in other nodes. The situation is analogous to communications between nations or large corporations: the "higher-ups" generally communicate with each other via intermediaries at lower layers (ministers, managers), who in turn use even more basic means (couriers, telephones).

Like the 3270 itself, but on a much grander scale, SNA is complex and elaborate. Indeed, since the 3270 terminal and control unit have many duties to perform in the network, their own complexity is understandable. SNA was designed to serve the needs of many other types of communications devices besides terminals as they are normally conceived of. It also supports such devices as point-of-sale terminals and RJE (for "remote job entry") workstations.

The IBM 3770 product line is typical of RJE terminals. An RJE terminal is usually distinguished from an ordinary terminal by having a card reader and high-speed printer for servicing batch job submission and output. It is intended for performing the typical batch-job processing functions at locations remote from the mainframe. The 3770 uses SDLC protocol in an SNA network. There is also an analogous product, the 3780 terminal, that communicates in bisync. Hardware and software are available for the IBM PC to emulate 3770 and 3870 terminals and the 3770. ◇

special character, DLE (for "data link escape"), is defined. It must be sent preceding any attempt to use one of the other special characters for its special protocol function. To use DLE as normal data, it has to be sent twice.

Obviously, a lot of computation must take place if bisync is to be spoken correctly. The algorithms used for this are typically hard-wired into bisync terminals for greater efficiency; that is, they are built right into the terminals. Ordinarily, a personal computer can speak bisync only if it has a special bisync communications card installed. Special (and expensive) modems are also required.

Many of the older terminals produced by IBM and others used bisync. Those include certain models of the 3270 communications terminal and the 2780/3780 RJE terminals. However, bisync has a number of shortcomings. To give just one example, it tends to use a lot of extra characters to control communications, which, in turn, lowers the net throughput of useful data. Also, it is half duplex, which is a disadvantage because time is wasted in "turning the line around."

A newer protocol that attempts to overcome some of the problems of bisync is called SDLC (for "synchronous data link control"). This is part of IBM's very general Systems Network Architecture (SNA). In addition to support of full duplex (two way) communications, SDLC distinguishes protocol information from other data sent by a technique called "bit stuffing." This method manipulates bit patterns in such a way that control information can be readily distinguished from data with less communications overhead than bisynchronous "byte stuffing" protocol.

SDLC, too, has its disadvantages. It is computationally more expensive, so again, specially wired hardware—SDLC terminals—must be used. Most new IBM communications products, including the latest of the 3270 line, use SDLC. Also, special SDLC modems must be used with such terminals.

Although we have spoken of bisync and SDLC as if they were specific unambiguous protocols, this is not really the case. Various dialects exist. There are additional protocols that terminals can use in addition to either bisync or SDLC. This situation, coupled with the fact that specialized hardware must be used to support the protocols, makes agreement on standards among terminal manufacturers and communications services very important. Fortunately, this is taking place. Even so, plain old async will still be around for a number of years. ◇

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Glossary of Terms
(Continued from page 62)

from one computer to the other by one of two means.

If the distance between the two is short, the character can be transmitted directly as electrical impulses through a **null modem** connection. (A null modem connection actually involves no modem at all—the serial ports of the two computers are simply connected one to the other by a cable.) This method is limited to distances of about 3000 feet.

When longer distances are involved, modems are used to send the data over a medium such as a telephone line. The modem connected to the computer converts the serial pulse train into tones. A tone of one frequency represents a high voltage, and a tone of another a low voltage. Tones are used because voice-grade telephone lines are not equipped to handle information in digital form.

At the receiving end, the modem translates the tones back into true digital form and feeds the resulting electrical pulses to the second computer's serial port. There they are converted back into parallel form.

There are two types of modems. **Acoustic** modems have two soft rubber cups into which a telephone handpiece is placed. One cup has a microphone, and the other a speaker. These pick up and generate the audio tones used for data transmission. There is no electrical connection to the phone lines—the coupling is acoustic.

Direct connect modems are connected directly to the phone line, usually through a standard modular jack. They are usually more "intelligent" than acoustically coupled modems, and eliminate the possibility of ambient room noise being mixed with the audio tones and "garbaging" the data.

Transmission media for data transfer, besides ordinary telephone lines, include coaxial cable, CATV (broadband radio-frequency), fiber optics, infrared light (with air being the transmission medium), microwaves, and satellites (a special case of microwave transmission).

The characteristics of the transmission medium determine the speed at which data can be passed back and forth between computers. For example, **dial-up voice-grade** telephone lines are considered reliable at speeds up to 2400 **baud** (bits per second), or about 240 characters per second. Special **leased phone lines** can handle data rates of up to 19,200 baud. Coaxial cable and broadband media permit rates up to 56,000 baud, and the more exotic media extend rates to millions of bits per second.

The last point to be addressed on the subject of physical links is that of **configuration.** The simplest configuration, **point-to-point,** uses a serial port and modem at the mainframe connected by some medium to a modem and serial port at a terminal or personal computer.

This one-to-one connection is expensive both in terms of the number of serial ports and modems, and the number of feet (or, more commonly, miles) of transmission medium required to support a large number of users. It is also wasteful in that a single user rarely requires the full capacity of a 4800-baud-or-greater line. Mainframe manufacturers have therefore developed some ways to reduce these costs and increase the utilization of a link.

One method used is a **multi-drop** line. One serial port and modem, and a medium-speed line (usually 4800 baud) at the mainframe connects to a star or daisy-chain network of terminals or personal computers. This eliminates the need for multiple modems and lines at the mainframe, but each terminal or personal computer still requires its own modem.

An alternative to multi-drop networking is to put small special-purpose computers, known as **cluster controllers,** in an area serving several terminals, personal computers, remote line-printers or other peripheral devices. Cluster controllers use one fast, expensive modem and line (usually rated at 9600 baud) to communicate with the mainframe, and cheap null modems or coaxial cable to make the connection to each computer or peripheral. The major advantage of this system is the elimination of expensive modems for each user station (or **node**), although the controller itself is a costly piece of hardware.

Transmission Protocols

After deciding how to make the physical link, we need to look at the **transmission protocols** used in telecommunications. There are two ways for information to be communicated between a modem and a serial port: **synchronous** (favored by IBM and other mainframe manufacturers) and **asynchronous,** which is used by most mini- and microcomputers. The difference between the two protocols is the way in which characters are "framed"—that is, how the beginning and end of a single character are signaled to the computer.

Asynchronous protocols frame data by adding a bit to each end of the stream of bits representing one character. These are called "start" and "stop" bits.

Synchronous protocols rely on internal clocks to time the start and finish of a block of characters by sending three to six "sync characters" at the beginning of a transmission. If the transmission consists of many characters, additional sync characters are transmitted every now and then to keep the computers in sync. Synchronous transmission requires more overhead in the form of software protocols to keep everything running smoothly, but allows about 15% greater throughput than asynchronous transmission at the same baud rate. This is because synchronous transmission requires two fewer bits per character than asynchronous transmission.

Software Protocols

Personal computers require relatively little in the way of software protocols. Commonly used is the XON/XOFF protocol (which allows one computer to indicate to another when to send and when to stop sending) to govern the transmission of large amounts of data. Error checking schemes using a **CRC** (cyclical redundancy check) or **checksum** method are also being included in a growing number of communications packages.

Mainframes have developed far more complex protocols over the years to allow them to be connected to a large number of devices without interfering with applications software. These more complex software protocols have evolved in layers to service today's networks of terminals and other peripherals. The following descriptions are abstracted from the International Organization for Standardization (ISO) DP7498 Reference Model for Open Systems Interconnection.

- **Data link protocols** are the lowest layer, dealing with initialization, control, termination and error recovery relative to the physical link and the transmission protocols.
- **Network protocols** deal with network management, message formats, and data-block structure.
- **Transport protocols** handle message or packet assembly and disassembly, and message priority in a network. These protocols also ensure end-to-end control of network transmissions.
- **Session protocols** control the dialogue between processes in a network, as well as buffering and segmenting large transmissions.
- **Presentation protocols** are used to handle data formats, and to translate various sending codes to representations understood by the receiving equipment. ◇

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TRS-80 Model 4P

(Continued from page 43)

to the full 64K of RAM and switch the screen display to 80 characters by 24 lines. To say that the system works well is an understatement. It is superb.

Since the Model 4P does not contain the Model III ROMs, a software utility creates an image of the ROMs in the first 16K of RAM. To get into the Model III mode, it is necessary to first load a MODELA/III utility (supplied with the computer). Screen prompts tell when to load the utility and when the disk can be removed and be replaced by the Model III applications disk. If the system is to come up directly in the Model III mode, the MODELA/III utility must be copied onto the applications disk. Then when the disk is booted up, the utility will auto-load the ROM image in RAM and automatically start the program. As far as the user is concerned, the computer functions as if the Model III ROMs are present.

User Observations

Experiments with a broad range of Model III software, including operating systems from sources other than Radio Shack, produced no unusual effects because of the pseudo-ROM image. The only Model 4 software that would not work in the Model 4P was a CPU speed-up. At the time we tested the Model 4P, Radio Shack still had not released its CP/M operating system for either the Model 4 or the 4P. So we used Montezuma Micro CP/M Version 2.2, which worked notably well.

More About the Keyboard

Perhaps the reason Radio Shack has delayed providing CP/M for its Model 4 series computers has to do with their "programming keyboards." Both computers have almost the same keyboard used in the Model I computer, plus a numeric keypad, a CONTROL key for CP/M, an alpha caps-lock key, and three function keys labeled F_1, F_2, and F_3.

Unlike the ASCII keyboard in general use today and patterned on the typewriter keyboard, a programming keyboard is derived from the Model 33 Teletypewriter, which was the original standard terminal for time-share computers. Its slightly different key arrangement makes BASIC and other programs somewhat easier to enter, but certain keys—tab, left and right brackets, backslash, line feed, escape, underscore, and vertical line—required for CP/M and most CP/M-based applications programs are not present.

To make its Model 4 series computers CP/M-compatible, Radio Shack synthesizes the "missing" keys by permitting simultaneous pressing of two or more keys to obtain the desired functions. CLEAR and comma are used for the left bracket, CLEAR and ENTER for underscore, etc. This approach, however, can lead to conflict. For example, the ASCII EM is used to advance the cursor in the Model 4 series and also happens to be the automatic underscore command for a popular daisy-wheel printer.

Aftermarket vendors of CP/M for the Model 4 series such as Montezuma Micro, provide the missing keys through the use of two keys simultaneously, such as SHIFT and ↑ to create the escape function, SHIFT and ← for the left bracket,

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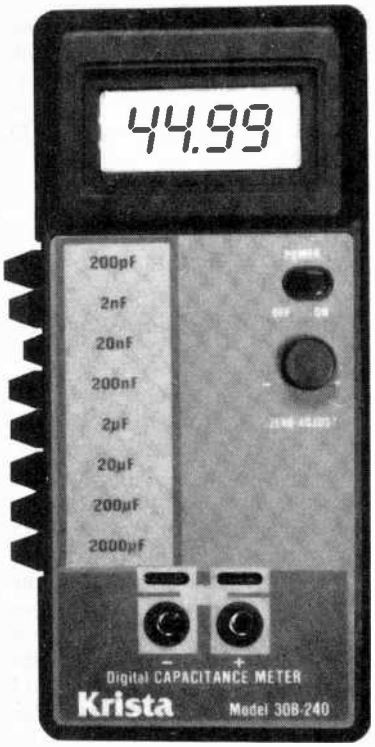

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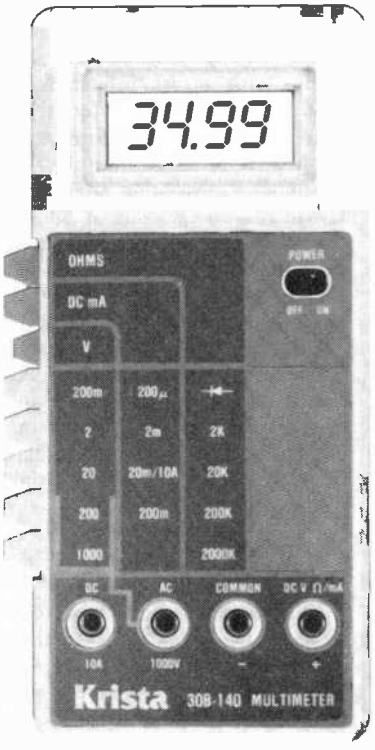

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TRS-80 Model 4P

and only → for tab in Montezuma Micro's CP/M. Additionally, this version of CP/M simplifies the use of CP/M software by causing the Model 4 series to function as the ADM-3A terminal, which is recognized by almost all CP/M software. We tried a sampling of popular CP/M applications software, including WordStar, Word Plus, MultiPlan, and DataStar, with Montezuma CP/M and found that they operated the same as they would have in any CP/M-only computer.

Remarks

Our only complaint with the Model 4P is the same as for most other computers in which thin-line disk drives are used. These drives depend on a mechanical system to pop out disks, which does not always work—particularly if a disk's write-protect tab comes loose while the disk is in the drive. The fault is not in Radio Shack's choice of thin-line drives but, rather, in the fact that *all* thin-line drives tend to jam. The industry simply needs a better eject mechanism for these drives.

Otherwise, the 4P is a magnificent machine. It runs quietly, without a trace of heat, and is convenient to use and transport. It is almost the ideal portable computer, "almost" because the disk drives are single-sided when the competition has double-sided drives. While Radio Shack does not have its own version of CP/M for the Model 4 series, Montezuma CP/M works admirably and comes with a disk interchange utility that permits the computers to read or write 20 different disk formats, including MS-DOS. This allows the Model 4P to simulate most other 8-bit computers. It will run an Osborne or Kaypro program and copy the program or store or copy the data in either the Osborne (or Kaypro) or the Model 4P's own format.

Also, with an aftermarket TRSDOS-like operating system, such as NEWDOS Version 2.0, the Model 4 can simultaneously work in the Model III and Model I modes, either single- or double-density. With a conversion utility, it will even read or write Radio Shack Color Computer software.

The Bottom Line

The Radio Shack Model 4P computer has awesome potential. To really appreciate this computer and become a believer in its potential, you have to use it as I have. Words are inadequate to describe the level of software interchangeability it provides. ◇

Sanyo MBC550

(Continued from page 35)

screen cursor to a BASIC line to be edited and then delete or insert characters. At the same time the screen listing is edited, the BASIC program in memory is also changed. Some PC compatibles do not have this capability.

Documentation

The documentation for the Sanyo MBC550 consists of two manuals in the usual IBM "small notebook" format. The first is the operating manual for the system and consists of rudimentary operating instructions, a description of the BASIC, and a description of the MS-DOS commands. Using the IBM manuals as a criterion, I must say that the Sanyo operating manual (at least in the version that I received) is poor. A user unfamiliar with MS-DOS or PC BASIC would have to supplement the operating system manual with the IBM BASIC and MS-DOS manuals. One good feature in the manual, however, is the "Technical Reference" section. It gives you step-by-step instructions on installation of additional RAM, disk drives, the serial interface, and a joystick. Other technical information is sparse.

The other manual contains the installation and operating instructions for MicroPro WordStar, CalcStar, SpellStar, MailMerge, and InfoStar. This manual is adequate (and voluminous). The IUS EasyWriter I word-processing software includes its own operations manual.

Benchmarks

Benchmarking is an inexact science. Too often a benchmark program will be biased to tout the strong points of an individual machine. I've been running five benchmarks for some time now. They are not perfect but I've tried to make them general and unbiased. They will give you a rough idea of what the Sanyo can do in comparison to other IBM PC machines. The machines I'm comparing here are the IBM PC, the new Tandy 2000, and the ACT Apricot (an 8086 machine with 3½" disk drives).

Benchmark 1: This benchmark simply measures the time it takes BASIC to count from 1 to 30000 in a two-statement FOR . . . NEXT loop. The faster the time, the faster the clock rate of the system and the efficiency of BASIC.

Tandy 2000:	15.7s
IBM PC:	37.8s
ACT Apricot:	42.9s
Sanyo MBC550:	47.1s

Benchmark 2: This benchmark measures the time it takes for a BASIC program to compute and display SIN, COS values. It's a measure not only of "number crunching," but also the "display driver" software in the MS-DOS BIOS. Again, the faster the time, the higher the "throughput" of the machine.

ACT Apricot:	38.6s
IBM PC:	45.6s
Sanyo MBC550:	56.2s
Tandy 2000:	218.7s

Benchmark 2A: This is identical to Benchmark 2 except that no screen display is done. It is a measure of the computational efficiency of BASIC.

Tandy 2000:	7.9s
Sanyo MBC550:	15.2s
IBM PC:	17.6s

Benchmark 3: This benchmark measures the time to write out varying file lengths to a sequential disk file in BASIC. The test starts with 100 80-byte records and increases in 9 steps up to 1000 80-byte records. The test is a measure of the efficiency of the disk driver in the MS-DOS BIOS and of the disk drive itself, for such nonstandard drives as the 3½" disk the ACT Apricot uses. Disk VERIFY is off in all cases.

Sanyo MBC550:	19s
ACT Apricot:	34s
Tandy 2000:	37s
IBM PC:	69s

Benchmark 4: This is similar to Benchmark 3, but delays a random time between writes (greater than one disk revolution) to simulate random processing in BASIC. This is primarily a measure of the efficiency of the MS-DOS BIOS disk driver.

Tandy 2000:	39s
ACT Apricot:	52s
Sanyo MBC550:	64s
IBM PC:	107s

How Compatible is the Sanyo?

Sanyo literature says the the MBC550 will run 80% to 85% of off-the-shelf software for the IBM PC. I think this figure is exaggerated and would put it at closer to 50%. Any program with graphics that does not go through the BIOS (the software input/output driver programs) will probably not run on the Sanyo. Other systems with a high degree of IBM PC compatibility will run such programs as Lotus 1-2-3 and the Microsoft Flight Simulator, both of which bypass the BIOS drivers. The Sanyo definetely will not run these programs and also will not run such pro-

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grams as the Personal Editor and the Asynchronous Communications packages, as well as many others.

One would hope that the MBC550 would load and run BASIC programs from the 1.1 version of the IBM PC. However, BASIC programs stored with the normal SAVE command on the PC will not load at all on the Sanyo due to file format differences. Only BASIC programs stored in ASCII format on the PC (using SAVE "xxxx",A) will load and run on the Sanyo, for the most part. Additionally, Sanyo BASIC is not identical to IBM BASIC. (The versions differ in commands relating to sound generation, joysticks, light pen operation, and disk directories.) Be prepared, then, for disappointments if you expect your favorite IBM PC BASIC program to execute properly on the Sanyo. Also be prepared to do some work transferring your PC BASIC programs over to Sanyo BASIC. In my case, one of the main things I wanted to run was the PC Macro Assembler. It runs fine on the Sanyo. The mistake I made was believing the Sanyo documentation and using the Macro Assembler as a test program for compatibility before I purchased the system!

The good news on the compatibility front is that sales of the Sanyo should be impressive enough so that companies producing IBM PC software will produce versions to run on the Sanyo as well. This appears to be happening already. Companies such as IUS, MicroPro, and Ashton Tate are producing Sanyo versions of their products or certifying that existing packages will run on the Sanyo.

Conclusions

The Sanyo MBC550 is a fine microcomputer regardless of its compatibility problems with the IBM PC. The results of the benchmarks given above indicate that the MBC550 compares favorably with the IBM PC, even surpassing it in computational speed and disk file benchmarks. My primary criticisms of the Sanyo are the current lack of double-sided disk drives, and its inadequate documentation. In the latter case, you can solve the problem by borrowing a friend's IBM documentation.

If the Sanyo MBC550 were closer in price to the IBM PC, I'd have to opt for the name and software base of the PC. But at about one third the price (considering the bundled software), I consider the Sanyo a great bargain. The MBC550 commands attention now, and will be an even more attractive machine as its software base grows. ◇

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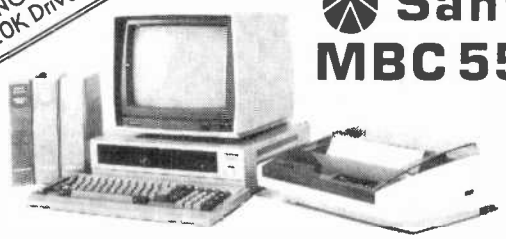

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Business Graphics

(Continued from page 56)

business graphics. Similar comments can be made for the IBM PC and PC-XT, whose third-party hardware support base rivals that for Apple IIs. (See "Hardware Upgrades for Apple and IBM" box for details.) No other make of computer rivals Apple and IBM for third-party support.

Business Graphics Software

The graphics software situation presents quite a puzzle. The basic packages for each computer are usually too rudimentary to be used for very sophisticated graphing. To approach what might be considered to be state-of-the-art performance, a great deal of power and flexibility are required.

Certain features of a graphics system are inherent to the software, and hardware devices must be chosen accordingly. The more important features the software should have are detailed in what follows.

From the artistic viewpoint, the ability to vary the size and type style of all text characters must be built into the software. The "window" for the body of the chart or graph must be locatable anywhere on a screen or page and be size-adjustable to fit any allocated space. There should be no practical limit placed on the number of data items a chart can contain. The ability to combine lines and bars on the same chart must be a standard feature. For maximum flexibility, the software should permit placement of multiple charts on the same page. It should be possible to develop pie charts with exploded segments. Additionally, a built-in feature should eliminate the possibility of text legends from overwriting each other or the graphics. Graphics software must have defeatable automatic scaling of the axes and permit logarithmic as well as rectangular coordinates. Finally, bar graphs must be orientable either horizontally or vertically.

To my knowledge, no currently available software package that fulfills all the above requirements exists, but GrafTalk comes closest. This software provides superior ease of use and a presentation quality approaching that available with mainframe graphics systems. For most graphs, Chartmaster is a good alternative. Though Chartmaster is not as powerful as GrafTalk, it is far better than the average graphics package currently being sold. Neither GrafTalk nor Chartmaster can develop area maps for marketing uses. These two products can serve as benchmarks for evaluating other graphics packages.

A true state-of-the-art graphics system should be able to construct images in both two and three dimensions, though most support the former and very few the latter. To meet this requirement a number of computer-aided drafting systems available for architects and design engineers are now beginning to

HARD-COPY DEVICES

Printers and Plotters:

Model	Manufacturer
Black-Print Printers:	

Almost any single-color impact dot-matrix model capable of printing screen graphics images can be used with business graphics computer/software systems. Printers made by Epson, Okidata, Star Micronics, IBM, Apple, and others are good choices. Of course, the higher-priced makes and models will usually yield higher-density, more precisely controlled graphics images.

Color-Print Printers:	

Among the more popular color models are those listed here. This list represents only a sampling of the makes and models available.

Color/Scribe DP-9725 (240 char./sec.)	Anadex
Quadjet	Quadram Corp.
Transtar 315 (4-color ribbon for 7 colors; 30 shades)	Vivitar Computer
Plotters:	

As with color printers above, the following list of products is provided as a representative sampling of the various models of plotters available in the marketplace.

Amplot II (11″ × 17″; 6 pens; 8 in./sec. write speed; 0.002″ resolution	Amdek
Color Plotter (11″ × 17″; 4 pens)	Apple Computer Inc.
945 (24.5″ × 48″; 4 pens; 30 in./sec. write speed; 0.0005″ resolution)	Calcomp
Sweet-P Six Shooter (11″ × 17″; 6 pens; 14 in./sec write speed; 2K buffer)	Enter Computer, Inc.
HP7475A (11″ × 17″; 6 pens)	Hewlett-Packard Co.
DPM-40-2 (11″ × 17″; 16K buffer; 2 pens)	Houston Instruments
XY750 (11″ × 17″; 8 pens; 0.004″ resolution)	IBM
Zeta 8 (8 pens; 20 in./sec. write speed)	Nicolet Zeta Corp.
Strobe 100, 200	Tektronix, Inc.

Direct-to-Film Hard-Copy Devices

Since many business presentations to large audiences are still best handled with color slides of graphics images, direct-to-film hard-copy devices deserve serious consideration. Among the low-to-medium-priced products that directly convert electrical image signals to 35-mm slide film are the following:

VFR-2000-TL-135 ($2495; 35-mm only)	Celtic Technology
635 ($12,950 for 35-mm 8″ × 10″ formats; adaptable to any format)	Dunn Instruments
Videoprint 5000 (about $7000; 4″ × 5″ Polaroid back is available)	Image Resource
VideoSlide 35 ($2599; 35-mm only)	Lang Systems
3000 ($10,000 to $12,000; 35-mm, SX-70, 4″ × 5″, 8″ × 10″, 16-mm formats)	Matrix Instruments
MFR-8 ($9000 to $11,000; 35-mm, 4″ × 5″, 8″ × 10″ SX-70, Kodak PR-10 formats)	Modgraph
Palette ($1300; 3¼″ × 4¼″ formats)	Polaroid Corp.

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GRAPHICS SOFTWARE SAMPLER

The following is an abbreviated listing of software packages that can be used to generate medium-to-high-density graphics on popular makes and models of personal computers.

Standard Graphics Packages:

Software Name	Source
Business Graphics	Business & Professional Software
Flexigraf	Computer Associates
ChartMaster	Decision Resources
D148S Color Slide System	DICOMED Corp.
GraphWriter	Graphic Communications
Display Telegraf	ISSCO Graphics
Executive Briefing System	Lotus Development Corp.
ZChart	Nicolet Zeta Corp.
GrafTalk	Redding Group Inc.
SAS/Graph	SAS Institute

3-D Graphics Software Packages:

Software Name	Source
AutoCAD	Autodesk, Inc.
Drawing Processor	BG Graphics Systems
Energraphics/PC	Enertronics Research
Vector Sketch	GTCO Corp.
Benchmark	MetaSoft Corp.
3D CAD; MCS Software, Space Tablet	Micro Control Systems, Inc.
PC-Draw	Micrografix
CADplan, CADdraft	Personal CAD Systems
VersaCAD, CADapple	T&W Systems
3Design	3Design

HARDWARE UPGRADES FOR APPLE AND IBM COMPUTERS

The following is a representative listing of plug-in cards that upgrade the graphics capabilities, including color, of popular Apple II and IBM PC personal computers. All products listed are printed-circuit-card assemblies that are designed to plug directly into the specific computers' expansion buses.

For Apple II Computers:

Product	Manufacturer
Number Nine (1024 × 1024 pixels, 16+ colors)	Number Nine Computer Engrng.
MicroAngelo	Scion Corp.
SuperSprite	Synetix Inc.
Arcade Board	Third Millenium Engrng.

For IBM PC series Computers:

Product	Manufacturer
BiGraphix II (640 × 400 pixels, 16 colors)	Applied Computer Products
Cono Color (640 × 400 pixels, 16 colors)	Conographic Corp.
Artist I (1024 × 1024 pixels)	Control Systems
RGB Boards (1024 × 1024 pixels, 4 colors; 640 × 280 pixels, 16 colors; 2 planes)	Frontier Technologies
Graphics Color Adapter	IBM
PC Peacock	MA Systems Inc.
MasterGraphics 1+ (640 × 200 pixels, 16 colors; 4096-color palette)	MicroGraphics Technology
ColorPlus (640 × 200 pixels, pixels, 4 colors; 320 × 200 pixels, 16 colors)	PC+Products—Plantronics
Graphics Display (640 × 400 pixels, 16 colors; 256-color palette)	PC Products Inc.
QuadColor (640 × 200 pixels, 16 colors)	Quadram Corp.
PC 640 (640 × 480 pixels, 16 colors; 4096-color palette)	Scion Corp.
Graphix Plus	STB Systems Inc.
Graphics Master (720 × 720 pixels)	Tecmar
Professional Graphics Generator (512 × 512 pixels, 16 colors)	Symtec
Multi-Display	USI Computer Products

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reach the business graphics arena. With these packages, new ways to easily and simply communicate complex business analyses become possible. (For a list of currently available graphics software packages, see "Graphics Software Sampler" box.)

Putting It All Together

Simply putting the best of each of the components of a graphics system together will not yield a system that works. Any added hardware must be able to support the features of the software that is to be used, which means that software *and* hardware must be selected together. Bear in mind, too, that any hardware component added to a computer must be physically *and* electrically installed in the working environment. In fact, addition of any hardware item—more memory, a super-high-resolution color graphics board, or any other device—redefines the working environment.

Any microcomputer that is selected will involve hardware trade-off decisions. As mentioned above, the IBM PC or PC-XT computers, as configured by IBM, are far from state of the art in terms of business graphics applications, but they may well fill the bill when mated with appropriate hardware and software from other vendors.

Advanced Systems

Since the objective of using business graphics is to tell a story, why not let the computer tell the *whole* story? Two computers currently on the market offer a special feature that takes them one step beyond other graphics systems. The Texas Instruments Professional Computer and the Digital Equipment Corp. Professional 350 offer a vocalizing feature that can add synthesized narration to a graphics slide show. The spoken words generated by these computers are digitized and replayed for a voice-over narration (16 minutes of text can be stored on one double-sided floppy diskette for the TI).

The DEC Professional 350 computer can be equipped with an optional text-to-speech device called DECtalk that converts standard ASCII text into vocalized speech. DECtalk generates very human-sounding speech in an adult male's, adult female's, or child's voice at rates of 120 to 350 wpm. It has a vocabulary of more than 20,000 words and an auxiliary dictionary for special terms. Added to the 800 × 240-pixel display in four colors (384 × 240 pixels in 16 colors), drawn from a selection of more than

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Business Graphics

4000 colors, this system offers much for the business graphics user. Furthermore, a variety of business software is available for the Pro 350.

The Tektronix Model 4109, with Model 4170 processing unit, provides an even more powerful graphics capability. For $16,000 to $20,000, this system gives access to the bottom line of engineering packages, providing a great deal more graphics power. At the same time, the CP/M-86 operating system should provide access to many business graphics programs.

The eight colors that this computer can put on a chart are chosen from a 64-color palette and can be changed on the graph easily with a "joy disk." The 480 × 360-pixel image is superb. And the system can drive a signal for video projection.

Hewlett-Packard represents the top level in microcomputer-based graphics systems. For about $17,000, the HP-8936 computer offers 4960 colors (or shades of gray) from which to choose and 500K (expandable to 7M) of user RAM. Its very-high-resolution 512 × 390-pixel screen brings more life to colors than other systems, since it is backed by four memory banks that provide 16 shades for each of the system's displayable 199,680 pixels. And to round things out, the HP-8936 makes it possible to use 3D graphics, even though software support for 3D is not yet really ready for the business user's needs.

Practical Considerations

A single graphics screen takes time to compose. Developing the 10 to 20 graphics screens that might normally be used during an hour-long presentation can require 4 to 5 hours of computer and composition time, which doesn't include time spent fussing with the data to get the charts to show what you want them to show and in what manner. To take advantage of microcomputer business graphics charting, plan to spend about one hour of work per chart.

In Closing

The ability to use 16 colors and 100 lines in a chart is a technical triumph. It is also a practical disaster! The brilliance of *not* using all the available technology simultaneously comes only with experience in constructing useful and informative graphics images. One learns fairly rapidly that communicating information effectively is best accomplished in relatively small, easy-to-digest bites. ◇

New Architectures

(Continued from page 74)

"One other thing worth mentioning," said Dr. Shaw, "is that there is at least one other project that we on the Non-Von project view as being of a kindred spirit, even though it's very different in some ways. That's the Connection machine up at MIT. One of the main people there is Dan Hillis. Like ours, the Connection machine is based on massive parallelism.

"They, too, are trying to put a number of processors on a chip. Like ours, it's based on something called SIMD (Single Instruction Multiple Data) execution, which says that all—in our case, it's actually large subsets of—the processing elements are at any given time all doing the same thing instead of working as completely independent processors. And many of our colleagues don't believe that's the right way to go. In fact, probably the majority of our colleagues think that it's a mistake. They think it's better to use a different approach where the processors are independent. But this approach to the problem doesn't allow you as many processors.

"So things are very controversial, but I think it's too early to say who's right. What would be exciting to all of us, I think, would be if one type of parallel architecture emerged ten years from now that turned out to be better than the Von Neuman machine. And it also turned out to be better for most purposes, even if not all, than most of the other kinds of machines.

"It's clear to everybody that, if you want to do a particular problem as fast as you can, and you have a large amount of money to spend (there are such applications), it will be best done by a special-purpose machine. None of us is going to come up with a general-purpose machine that will do as well. On the other hand, the big prize in the field, will be to come up with a successor to the Von Neuman machine.

"That's what we're all trying to achieve. It will be some new way of organizing computers that, although it isn't perfect, is good enough for people to adopt it for 90% of what they do. And it can be capable of being mass produced and sold to a very wide set of markets.

We don't yet have any evidence of whether that can be done. I rather suspect that it can. It would surprise me greatly if, by the year 2000, there weren't some other kind of machine that was general purpose enough for people to use it in a wide range of applications. But we still don't know what that is at this point." ◇

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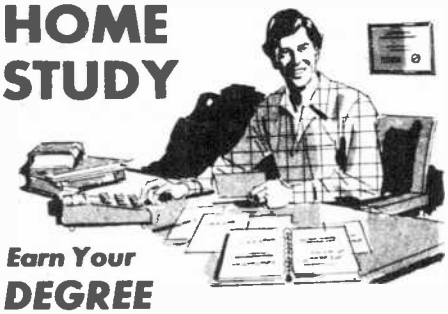

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Stocks and Bonds
(Continued from page 79)

propriate technology."

To achieve this aim, Hutton began to consider the private communications networks already capable of providing database access to owners of terminals of all varieties throughout the country. An agreement was soon reached with CompuServe, a subsidiary of H. & R. Block in Columbus, OH. CompuServe was to function as the first conduit into the Hutton network. Best-known to most consumers as an information utility, similar in many ways to The Source, CompuServe has for years provided network capability to industry as a competitor to the possibly better-known Telenet and Tymnet.

The agreement negotiated with CompuServe was of a nonexclusive nature and thus allowed Hutton to use other forms of information delivery that might seem attractive. Another method of delivery was found in the three-county area surrounding Miami, FL, where Viewdata Corporation, a subsidiary of Knight-Ridder Newspapers offers a videotex service called Viewtron. (See "Videotex and You," by John Helliwell in the February 1984 issue of COMPUTERS & ELECTRONICS.) Hutton adopted this delivery service for Huttonline on a different basis than the CompuServe service uses.

To the client accessing through CompuServe, using whatever terminal is available, the CompuServe link is completely invisible. CompuServe is nothing more than a conduit and the user does not have access to the CompuServe information utility unless a separate agreement has been signed. On the other hand, Huttonline is presented as an option to all Viewtron users, each of whom must have a dedicated videotex terminal (the AT&T Sceptre).

Both CompuServe and Viewtron lines connect with the Hutton Compass system in New York. Compass interacts with the CompuServe network at 9600 baud using X.25 protocol. Information is then transmitted to users at either 300 or 1200 baud, depending on the user's terminal. Data is transmitted to Viewtron using 3270 protocol at 9600 baud; and information goes to users at 1200 baud.

While Hutton wanted its information service to be accessible to as many types of hardware as possible, it also wanted to be in a position to recommend and sell a broad range of hardware that would suit the individual client's needs. It was decided to offer both a low-priced terminal and a full-service microcomputer. The low-priced terminal selected was the Quazon Quik-Link, which sells for $249 (suggested retail price). It connects directly to telephone lines and can be used with a standard telephone instrument. It can be expanded by adding a computer.

The choice of a microcomputer was relatively easy. Hutton sought one that was certain to be around for a while and that would accommodate the widest possible variety of software for uses other than Huttonline. Furthermore, Hutton did not preclude itself from eventually developing its own software or marketing someone else's. Obviously, then, Hutton wanted to select the equipment with the widest possible distribution. There was only one company with a product that met these criteria—IBM—and Hutton reached an agreement with Big Blue. Hutton also selected another MS-DOS system, the Wang Professional Computer, as an option for their clients. This provides a quasi-IBM-compatible alternative for users oriented toward word processing.

The most interesting of the hardware choices is the Workslate from Convergent Technologies (see the review of this product in the November 1983 issue of COMPUTERS & ELECTRONICS). This is a portable computer weighing less than 3 pounds and designed specifically for business people. Its components include a built-in modem, a calculator, a date book with alarm memory, a telephone answering machine, a speaker phone with electronic phone book and auto dialer, and a portable dictating machine. While the Workslate has the same lightweight portability as the Radio Shack Model 100, it has quite a different orientation as far as use is concerned.

The Model 100 is a traditional computer that includes Microsoft BASIC and various applications (including a text editor, a calendar, and communications) contained in ROM. The Workslate, on the other hand, is intended to be an end-user computing tool, centered around a spreadsheet similar to VisiCalc; it is designed as a productivity-enhancement tool for managers and professionals and performs extremely well in this capacity. In announcing the arrangement with Convergent, Epstein said, "We are very pleased to get into the area of personal computer distribution with a product as exciting as the Workslate. It's an excellent tool for many of our clients who require truly portable computing power." We would go slightly further than that and say that it is an excellent tool for almost every business person.

Options available for the Workslate are a microprinter, Portfolio Analysis TaskWare (a series of programs that analyze stocks and bonds, taxes, and cash flow and perform beta and internal rate-of-return calculations), and connections to financial databases of CompuServe, Dow Jones, and The Source. Hutton is selling the basic Workslate to its clients for $895, including the initial $25 Huttonline sign-up fee and one month's unlimited access to Huttonline. Workslate purchases, and all other purchases related to Huttonline, are made through the Hutton client's account executive and can be charged directly to the client's account.

System Operation

Clients sign on to Huttonline by dialing the local telephone number that Hutton has provided with the start-up instructions. (As mentioned, this is actually the local number for CompuServe.) Once connected, the system asks for a "Host Name" and the user responds by entering "EFH," which directs the system to the Huttonline facility. The system will then request "VIC" and, on receiving the user's response, will request a password. It is these last two entries that identify the user to Huttonline and also ensure the confidentiality of the user's records. The user is then presented with a menu allowing a choice of the following:

1. Use the service
2. About the service
3. Quit the service

This menu is the first of a series that takes the novice user through the system with little difficulty (see Fig. 1). The experienced user can bypass the menu tree by using GO commands to take him directly to the section desired (Table I). Access through either method is smooth and does not irritate the user with inordinate delays, even at 300 baud.

The presentation of information in all areas is both clear and concise and the information is certainly useful to the average investor. The only possible disappointment to the new user may come in the section of the "Your Account" menu entitled "Portfolio." This choice presents the user with a snapshot valuation of present holdings. It is not a classic portfolio management system that includes the original cost of each transaction, unrealized profit or loss of each open transaction, and other pertinent information. We do not see this as a serious limitation to the user, however, for the investor requiring such information can turn to software such as PEAR, Personal Investor, or Reveal (for the IBM PC). The Workslate user can take advantage of the Portfolio Analysis

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TaskWare, which provides some of these functions. The Huttonline approach to the portfolio section is consistent with the entire system, which presents current snapshots of balances, investment reports, and so forth.

The option "Send Message to Your Account Executive" allows the user to send instructions of a general nature and to request research reports, which are then mailed to the user the same day. It is not intended to be used as a means of order entry. This restriction is consistent with the system design considerations discussed above. The other menu items require little explanation.

Evaluation

The decisive question for investors considering the use of Huttonline—which for some will require switching accounts from another brokerage firm to EF Hutton—is "What will it do for me?" or "How will it improve my investment performance?" Unfortunately, the actual benefits are difficult to quantify. Huttonline allows the client to receive more information in a much more timely fashion than was previously possible. Making optimum use of the system, however, depends on both the client and the AE. The client must make intelligent use of the newly found abundance of information in making investment decisions. The AE must be tuned in to both the capabilities of Huttonline and the client's interests and needs in order to properly utilize the electronic mail facilities.

The availability of information is very important, but the ability to use it well is more important. Each potential client will have to evaluate the service in relation to these factors. From our point of view, Huttonline is well worth the investment of time and money.

In short, we find Huttonline useful to the investor in its initial implementation and very exciting in its potential. We expect other features to be added to it as time passes, and we expect it to have competition from other brokerage firms if they are to avoid losing customers to Hutton. We commend Hutton for its innovation and we recommend Huttonline to your attention. ◇

TABLE I—GO COMMANDS

ACC—Your account menu
BAL—Balances
BOU—Bought/sold (transactions by class)
CHE—AMA/ARA checking
COM—Communications menu
DEP—Deposits (transactions by class)
FEE—Feedback to EF Hutton
INC—Income (transactions by class)
INV—Investment briefs
MAI—Read your mail
OPE—Open orders
PAI—Paid out (transactions by class)
POR—Portfolio
RES—Research
TRA—Transactions this month
USA—Usage tips
WHA—What's new

Other commands

F—Forward 1 page
Fn—Forward n pages
B—Backward 1 page
Bn—Backward n pages
M—Previous menu

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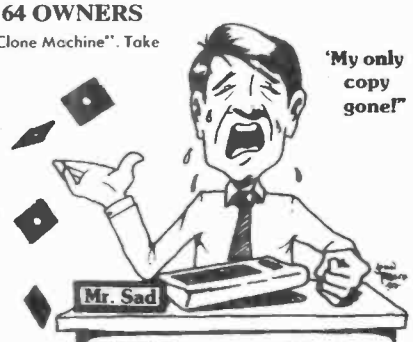

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Pointers

(Continued from page 69)

ed with parallel rows of transparent, conductive strips. The sheets are placed over the monitor at right angles to one another to provide an intersecting grid of switches that can be easily closed by finger pressure.

Capacitive sensing can also be used. Touch Technology, for example, has developed a touch sensitive screen of glass coated with a transparent array of tin oxide rectangles. Each rectangle senses the presence of a finger by the resulting capacitance change.

Touch sensitive tablets are good for the newcomer to computers

The company makes a touch sensitive screen having higher resolution by applying a uniform film of tin oxide over the entire surface of a glass sheet. Two terminals connected to the sides of the screen sense capacitance changes anywhere on its surface with a resolution of about 100 by 100 points.

Elographics, Inc. uses a resistive sensing method in which a glass sheet coated with a transparent, *resistive* film is covered by a flexible plastic sheet coated with a transparent, *conductive* film. A voltage is applied alternately across each axis of the resistive film. When the plastic cover is pressed against the resistive film, two alternating voltages are developed which, when digitized, enable the computer to determine where its screen has been touched.

All these touch screen sensors attenuate the brightness of the image on the monitor's screen. One sensing method that does *not* employs a grid of infrared beams on the screen. Infrared emitters along two adjacent sides of the screen project their beams to phototransistors along the opposite two sides of the screen. The result is an intersecting grid of infrared beams that permits a computer to determine where a finger has been placed.

Some companies make infrared touch sensor systems that can be mounted over the screen of a standard monitor. Others sell monitors with built-in infrared sensors. Hewlett-Packard's HP 150 personal computer, for example, features many menu driven operating modes that can be selected by touching the appropriate box or icon displayed on the screen.

Digitizing Tablets

Digitizing tablets, the largest family of pointing devices, have flat surfaces that can detect the presence of a special pen, stylus, or even a finger. In 1967, prior to the commercial development of either the mouse or the personal computer, a classic study concluded that the digitizing tablet was the best pointing device (W.K. English, D.C. Engelbart and M.L. Berman, *IEEE Transactions on Human Factors in Electronics,* HFE-8, 1, 21-31). Many experienced users of pointing devices still agree. After all, what could be more natural than a pointing device that's used like a pencil and paper? Until recently, however, digitizing tablets were far too expensive to be considered for use with personal computers. Now the price barrier has been penetrated by the introduction of several kinds of economical digitizer tablets. Some of them are supported by software having surprisingly high quality.

The tablets with the highest resolution, which also happen to be the most costly, use indirect sensing schemes. Typically, the table incorporates a crossed grid of conductors directly under its surface. As a special ballpoint pen or cursor fitted with crosshairs is moved across the tablet, electromagnetic radiation from oscillatory signals sent sequentially through the tablet's grid is detected by a small pickup coil in the pen or cursor. A properly programmed computer enables the position of the pen or cursor on the active surface to be detected with a resolution of 0.005" or less.

Electromagnetically scanned tablets cost from several hundred to several thousand dollars. And while they have better resolution than pressure-activated tablets, some low-cost units may exhibit pincushion distortion. This means the spacing between minimum resolution points may *increase* around the edges of the table's sensitive region.

This phenomenon may require the time consuming development of software correction factors or grid overlays with curved, rather than straight, lines.

Several new kinds of low-cost, pressure-sensitive digitizing tablets have appeared on the market in the past few years. Designed specifically for use with personal computers, these devices use innovative means to detect the pressure of a stylus or finger on their active surfaces.

The Koalapad by Koala Technologies Corporation is a book-sized table having a pressure-sensitive pad measuring 4¼" square. The base of the pad is an aluminum plate to which is attached a plastic

MANUFACTURERS OF POINTING DEVICES

Numerous companies make pointing devices as stand-alone products or as component parts of systems such as computers. Here is a representative listing of some of them:

Ampower Instrument Co. (26 Just Rd., Fairfield, NJ 07006)
Apple Computer (20525 Mariani Ave., Cupertino, CA 95014)
Atari Inc. (PO Box 427, Sunnyvale, CA 94086)
Bausch & Lomb (Houston Instrument Div., 8500 Cameron Rd., Austin, TX 78753)
CalComp (PO Box 3250, Anaheim, CA 92803)
Chalk Board, Inc. (3772 Pleasantville Rd., Atlanta, GA 30340)
Championship Electronics (U.S.A.) Inc. (1025 Grandview Dr., South San Francisco, CA 94080)
Elographics, Inc. (1976 Oak Ridge Turnpike, Oak Ridge, TN 37830)
General Digital Corp. (700 Burnside Ave., East Hartford, CT 06108)
GTCO Corp. (1055 First St., Rockville, MD 20850)
Hewlett-Packard (1820 Embarcadero Rd., Palo Alto, CA 94303)
Information Control Corp. (9610 Bellanca Ave., Los Angeles, CA 90045)
Inkwell Systems (PO Box 85152, MB290, San Diego, CA 92138)
Koala Technologies Corp. (3100 Patrick Henry Dr., Santa Clara, CA 95050)
Measurement Systems, Inc. (121 Water St., Norwalk, CT 06854)
Mouse System Corp. (2336H Walsh Ave., Santa Clara, CA 95051)
Numonics (418 Pierce St., Lansdale, PA 19446)
Pencept, Inc. (39 Green St., Waltham, MA 02154)
Preh-Werke (PO Box 1540, D-8740 Bad Neustadt, West Germany)
Radio Shack (1500 One Tandy Center, Fort Worth, TX 76102)
Science Accessories (970 Kings Highway W., Southport, CT 06490)
Summagraphics (35 Brentwood Ave., Fairfield, CT 06430)
Suncom, Inc. (650 E. Anthony Trail, Suite E, Northbrook, IL 60062)
Sun-Flex Co. (20 Pimentel Ct., Novato, CA 94947)
Tektronix (PO Box 1000, Wilsonville, OR 97070)
TG Products (1104 Summit Ave., Suite 110, Plano, TX 75074)
Touch Technology (111 Chinquapin Dr., Annapolis, MD 21041)
USI (71 Park Lane, Brisbane, CA 94005)
Wico Corp. (6400 W. Gross Point Rd., Niles, IL 60648)
Xerox Corp. (1341 W. Mockingbird Lane, Dallas, TX 75247)

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- Virtual segment procedures under UCSD Pascal.
- An in-depth look at MP/M-80 II.™
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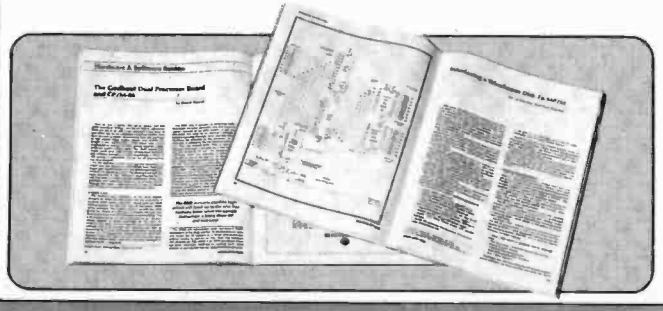

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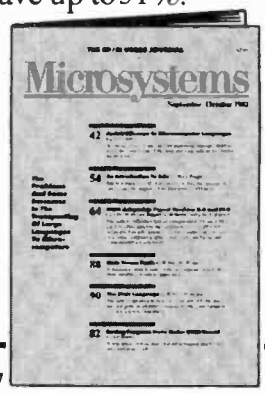

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layer coated with a thin resistive film. A plastic square with a second resistive film on its back and having an adhesive border is installed over the base.

An array of some 2000 tiny, nonconductive bumps in the first plastic layer separates the two resistive films by a few thousandths of an inch. A simple analog circuit alternately switches a current across first one resistive layer and then the other. When the two pads are pressed together, the circuit can detect both the presence of the pressure *and* its location.

The PowerPad by Chalk Board, Inc. is another innovative, yet affordable, digitizer tablet. Its large 12-inch-square active surface is backed by an array of 120 by 120 pressure-sensitive membrane switches. This provides a resolution of 100 switches per square inch.

The PowerPad's hardware scans all 14,400 switches twenty times each second. Since the device is purely digital, the scanning circuitry detects *all* switch closures. This means the PowerPad can respond virtually simultaneously to multiple data entries. For instance, it can display on a computer monitor the shape of a hand pressed down on the tablet's active surface.

Computers can be trained to remember words and act accordingly

Kaolapad and PowerPad are representative of the new generation of touch-sensitive digitizer tablets. Already other companies have introduced similar products and the prices for these devices, currently in the range of $100 or less, will likely decrease.

Touch sensitive tablets will play an important role in introducing computer novices of any age to personal computing. The icon-oriented software available for Koalapad, PowerPad and similar tablets is so "user-fiendly" even a beginner can perform sophisticated operations without referring to an operator's manual or learning to use a keyboard.

Miscellaneous Pointing Devices

The pointing device families described thus far are supplemented by a wide variety of related devices. Here are some of the more significant:

Joydisks and Cursor Disks. Identical in function to the rate joystick, joydisks and touch disks are circular control disks small enough to be installed directly on a keyboard. A typical joydisk is octagonal in shape and can be pressed along each of its eight sides to move a cursor in a desired direction. A cursor disk such as the one used on the Xerox 860 Word Processor senses finger capacity. The cursor of this machine moves in the direction indicated by finger movements on the cursor disk. The cursor speed is increased when the finger is moved closer to the edge of the disk.

Single-Axis Joysticks and Thumbwheels. A single potentiometer with an attached handle forms a single-axis joystick. It is used to move a cursor along only one axis. A thumbwheel is a potentiometer with a serrated knob whose edge emerges through a slot in a control

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11058	64	12.02	10.50	9.45

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22226	16	.29
22228	18-20	.29

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Stock No.	Description	1 Bag	5 Bags	10 Bags
11310	Bag of 100 solder tail pins	$ 4.95	$ 4.45	$3.95
11311	Bag of 100 wire wrap pins	11.95	10.75	9.50

WILD ROVER Touch switch capsule. Operating motion is .005" without the use of a levered arm. Extremely fast on and off with low noise. Normally open – rated 115 VAC, 1.6 amp-30 milliohm resistance – .615 radius by .160 thick.

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50076	062	25	4	2.39
50077	062	50	8	4.25
50078	032	33	1.5	1.31
50079	032	88.5	4	2.47
50080	032	175	8	4.57

TI WIRE WRAP SOCKETS Tin plated phosphor bronze contact – 3 wrap

Stock No.	No Pins	1-99	100-499	500
11301	8	$.40	$.36	$.30
11302	14	.59	.54	.45
11303	16	.64	.58	.48
11304	18	.73	.66	.55
11305	20	.99	.90	.75
11306	22	1.12	1.02	.85
11307	24	1.25	1.14	.95
11308	28	1.52	1.38	1.15
11309	40	2.05	1.86	1.55

TI LOW PROFILE SOCKETS Tin plated copper alloy 688 contact pins with gas tight seal.

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11202	14	.14	.13	.12
11203	16	.16	.15	.14
11204	18	.18	.17	.15
11205	20	.20	.18	.16
11206	22	.22	.20	.18
11207	24	.24	.22	.20
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The Battery Just Wrap™ Tool New battery powered tool wraps insulated wire around .025" square posts without need for pre-cutting and pre-stripping. Complete with bit and 100 ft. 30 AWG wire.

Stock No.	Description	Price
13340	Battery just-wrap tool with bit and 100 ft. 30 AWG wire	$59.95
13341	Replacement bit	10.35
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panel. A single thumbwheel moves a cursor along one axis. Usually two thumbwheels are mounted adjacent to one another but at right angles. This provides two-axis control.

The Track Pen. The Track Pen is a modified mouse. Developed by Ampower, it incorporates a rotating ball mounted in one end of a large stylus. It is claimed to be more natural to use than a mouse since it is held like a pen.

Sonic Digitizers. This device incorporates a stylus that emits a series of sonic pulses. Two microphones in a receiver system placed nearby detect the pulses and determine the exact distance between the pen and each microphone. With this information, the location of the pen can then be determined.

Pantograph Digitizers. Pantograph digitizers use cursor crosshairs attached to one end of a mechanical arm that slides up, down and through a slotted assembly placed to one side of the work area. Rows of conductive contacts along the arm and in the slotted assembly act as switches that enable the device to determine the position of the crosshairs. Though they are clumsy to use, they give very accurate results.

Voice Recognition Devices. Voice recognition hardware provides a fascinating new kind of pointing mechanism. Even a brief session with a Texas Instruments' Professional Computer equipped with a voice recognition capability is enough to convince a skeptic. This computer can be "trained" to remember words and respond accordingly when the words are used as commands. This permits menu options to be selected by simply stating the appropriate name.

Eye Position Detection. By detecting light reflected from the cornea or the retina of the eye, it is possible to determine where the eye is gazing. The military has used the former method to develop, among other things, automatic weapon-aiming devices for helicopter gunships. The same technology can be used to control the movement of a cursor on a monitor or to determine where on a monitor a user is staring.

Selecting a Pointing Device

As should be apparent by now, there is a plethora of pointing devices. Since each manufacturer claims its device is the most ergonomic and the easiest to use, remember that no single pointing device is the best for *all* applications.

Currently, the mouse and pressure-sensitive touch tablets are receiving the most attention, but neither provides the natural sensation of the light pen. The latter, however, has less resolution and is tiring to use with a conventional monitor.

The serious pointing-device user should keep *all* options open. For digitizing drawings, either original or traced, of circuit diagrams, floor plans, surveys and the like, a digitizing table is probably the best choice. For moving a cursor in word-processing applications, consider a cursor disk or a mouse. Trackballs are excellent for very fast cursor movements. And joysticks are good for tracking and in applications where precise pointing is not important.

As for selecting an actual device, nothing beats a hands-on trial with a variety of working pointing devices. Finally, no matter which device you select, be sure to keep other pointing devices in mind as your requirements expand. ◇

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7497N	3.77
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74109N	.56
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74126N	.70
74132N	.74
74141N	1.25
74145N	.99
74147N	1.63
74148N	1.14
74150N	1.48
74151N	.85
74153N	.55
74154N	1.32
74155N	.87
74156N	.73
74157N	.73
74160N	.78
74161N	.79
74162N	.79
74163N	.79
74164N	.94
74165N	.94
74166N	1.03
74170N	1.59
74173N	1.08
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74175N	.74
74176N	.95
74177N	.95
74180N	1.02
74181N	2.38
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74185N	3.06
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ADC0809CCN	5.92
ADC0811CCN	18.69
ADC0817CCN	11.28
ADC0833CCN	5.00
ADC1001CCN	32.00
ADC1021CCN	33.76
ADC0811CCN	8.27
ADC0711CCN	8.27
ADC0861CCN	8.30
ADC1021CCN	8.92
DAC0800LCN	2.77
DAC0807LCN	2.07
DAC0808LCN	2.27
DAC0830LCN	6.93
DAC0832LCN	4.95
DAC1001CCN	33.76
DAC0811CCN	8.27
DAC0711CCN	8.27
ADC0861CCN	8.30
ADC1021CCN	8.92
DAC0800LCN	2.77
DAC0807LCN	2.07
DAC0808LCN	2.27
DAC0830LCN	6.93
DAC0832LCN	4.95
DAC1020LCN	10.52
DAC1022LCN	8.77
MN5310A	3.89
MN5368A	2.80
MN5387A	2.30

Micro.

Part	Price
COP402N	7.17
COP404LSN-12/05	12.06
COP444LN	66.00
COP452N	8.17
COP470N	8.19
COP472N	8.19
COP498N	8.17
COP499N	8.17
COP800N	4.48
COP802N	5.50
COP804N	5.50
COP805N	7.44
COP820N	8.80
COP822N	8.83
COP840N	8.83
COP842N	8.83
COP888N	8.83
INS8035N-8	7.57
INS8035N-11	5.44
INS8039N-11	7.57
INS8039N-11	7.58
INS8060N	18.82
INS8073N	45.06
INS8080AN	4.65
INS8154N	15.81
INS8155N	6.59
INS8256N	6.10
INS8259N	9.24
INS8257N	9.76
INS8080AN	4.65
INS8154N	15.81
INS8155N	6.59
INS8256N	6.10
INS8259N	9.24
MC6809P	9.76
MC6809E	5.91
MC6821P	3.58
MC6840P	5.91
MC6850P	3.58
MC6852P	5.91
MC6854P	5.91
MC6860P	5.91
MC6862P	5.91
MC6875P	5.91
MC6880AP	3.58
MC6883P	5.91
MC6887P	5.91
MC6889P	5.91
MC6891P	5.91
MC6892P	5.91
MC6893P	5.91
MC6894P	5.91
MC6895P	5.91
MC6896P	5.91
MC6897P	5.91
MC6898P	5.91

DIGI-KEY CORPORATION 800-346-5144

In Mn., Ak., Hi. Call 218-681-6674

VISA

NATIONAL SEMICONDUCTOR • PANASONIC • AAVID • CHEMWIK • ATLANTIC DIODES • N ARIES • PLESSEY • MOLEX • AAVID • E. F. J OK MACHINE • UNGAR • GC CHEMICALS • A NATIONAL SEMICONDUCTOR • PANASONIC •

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The Big DIGI-KEY Discount makes a Big Price Difference (THE YELLOW)

SILICON RECTIFIERS ZENER DIODES

3 AMP SILICON RECTIFIER

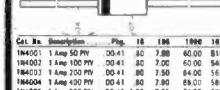
Part No.	PIV	Price 1	10	100	VF (Max)
PRS40	50V	100A			1.1V
		.35	3.00	27.50	250.00

RECTIFIERS

Typical Applications Include: Clock Radio Timers, Alarm Clock, Desk Clock, TV and Stereo Timer, Instrument Panel Clock, Digital Thermometer and much more.

Cat. No.	Description	Pkg.	1	10	100	1000
1N4001	1 Amp 50 PIV	.DO-41	.80	7.00	60.00	$50.00
1N4002	1 Amp 100 PIV	.DO-41	.80	7.00	60.00	540.00
1N4003	1 Amp 200 PIV	.DO-41	.80	7.50	64.00	563.00
1N4004	1 Amp 400 PIV	.DO-41	.80	7.80	69.00	588.00
1N4005	1 Amp 600 PIV	.DO-41	1.00	9.00	80.00	681.00
1N4006	1 Amp 800 PIV	.DO-41	1.50	12.00	100.00	710.00
1N4148	Ultra Fast Switching Diode (1N914 equiv.)	.DO-41	.50	5.00	32.00	278.00

SILICON ZENER DIODES



Catalog Number	Description	Price 1	10
1N5281	3.3 V 5% 500mW Zener (1N746A equiv.)	.24	1.80
1N5278	3.6 V 5% 500mW Zener (1N747A equiv.)	.24	1.80
1N5279	3.9 V 5% 500mW Zener (1N748A equiv.)	.24	1.80
1N5280	4.3 V 5% 500mW Zener (1N749A equiv.)	.24	1.80
1N5300	4.7 V 5% 500mW Zener (1N750A equiv.)	.24	1.80
1N5281B	5.1 V 5% 500mW Zener (1N751A equiv.)	.24	1.80
1N5282B	5.6 V 5% 500mW Zener (1N752A equiv.)	.24	1.80
1N5283B	6.0 V 5% 500mW Zener (1N753A equiv.)	.24	1.80
1N5284B	6.2 V 5% 500mW Zener (1N754A equiv.)	.24	1.80
1N5285B	6.8 V 5% 500mW Zener (1N4957B equiv.)	.24	1.80
1N5286B	7.5 V 5% 500mW Zener (1N958B equiv.)	.24	1.80
1N5287B	8.2 V 5% 500mW Zener (1N959B equiv.)	.24	1.80
1N5288B	8.7 V 5% 500mW Zener	.24	1.80
1N5289B	9.1 V 5% 500mW Zener (1N960B equiv.)	.24	1.80
1N5290B	10 V 5% 500mW Zener (1N961B equiv.)	.24	1.80
1N5291B	11 V 5% 500mW Zener (1N962B equiv.)	.24	1.80
1N5292B	12 V 5% 500mW Zener (1N963B equiv.)	.24	1.80
1N5293B	13 V 5% 500mW Zener (1N964B equiv.)	.24	1.80
1N5294B	14 V 5% 500mW Zener	.24	1.80
1N5295B	15 V 5% 500mW Zener (1N965B equiv.)	.24	1.80
1N5296B	16 V 5% 500mW Zener (1N966B equiv.)	.24	1.80
1N5297B	17 V 5% 500mW Zener	.24	1.80
1N5298B	18 V 5% 500mW Zener (1N967B equiv.)	.24	1.80
1N5299B	19 V 5% 500mW Zener (1N968B equiv.)	.24	1.80
1N5300B	20 V 5% 500mW Zener (1N969B equiv.)	.24	1.80
1N5251B	22 V 5% 500mW Zener (1N969B equiv.)	.24	1.80
1N5252B	24 V 5% 500mW Zener (1N970B equiv.)	.24	1.80
1N5253B	25 V 5% 500mW Zener	.24	1.80
1N5254B	27 V 5% 500mW Zener (1N971B equiv.)	.24	1.80
1N5255B	28 V 5% 500mW Zener	.24	1.80
1N5256B	30 V 5% 500mW Zener (1N975B equiv.)	.24	1.80
1N5257B	33 V 5% 500mW Zener (1N5738 equiv.)	.24	1.80

Littelfuse Fuses

3AG "NORMAL-BLO" FUSES

DIGI-KEY Part No.	Amp. Rtg.	%	1	100	1,000
F100-ND	.010	15 10	229.50	1900.00	1004.00/M
F101-ND	.031	11 85	178.00	788.00	292.00/M
F102-ND	.062	4 40	66.00	292.00/M	
F103-ND	.100	4 40	66.00	292.00/M	
F104-ND	.125	4 40	66.00	282.00/M	
F105-ND	.150	4 40	66.00	292.00/M	
F106-ND	.175	4 40	66.00	292.00/M	
F107-ND	.187	4 40	66.00	292.00/M	
F108-ND	.200	4 40	66.00	292.00/M	
F109-ND	.250	2 66	40.00	177.00/M	
F110-ND	.300	2 66	40.00	177.00/M	
F111-ND	.375	2 66	40.00	177.00/M	
F112-ND	.500	2 66	40.00	177.00/M	
F113-ND	.600	2 66	40.00	177.00/M	
F114-ND	.750	2 88	40.00	177.00/M	
F115-ND	1	1.32	20.00	88.00/M	
F116-ND	1.250	1.32	20.00	88.00/M	
F117-ND	1.800	1.32	20.00	88.00/M	
F118-ND	1.600	1.32	20.00	88.00/M	
F119-ND	2	1.32	20.00	88.00/M	
F120-ND	2.500	1.32	20.00	88.00/M	
F121-ND	3	1.32	20.00	88.00/M	
F122-ND	4	2.12	21.80	140.00/M	
F123-ND	5	2.12	21.80	140.00/M	
F124-ND	6	2.12	21.80	140.00/M	
F125-ND	7	2.28	23.80	150.00/M	
F126-ND	8	2.92	43.80	194.00/M	
F127-ND	10	2.92	43.80	194.00/M	

3AG SLO-BLO® FUSES

DIGI-KEY Part No.	Amp. Rtg.	%	1	100	1,000
F300-ND	.010	8.48	128.80	563.00/M	
F301-ND	.031	8.48	128.80	563.00/M	
F302-ND	.040	8.48	126.90	563.00/M	
F303-ND	.062	6.40	96.00	426.00/M	
F304-ND	.100	6.40	96.00	426.00/M	
F305-ND	.125	6.40	96.00	426.00/M	
F306-ND	.150	6.40	96.00	426.00/M	
F307-ND	.175	6.40	96.00	426.00/M	
F308-ND	.187	6.40	96.00	426.00/M	
F309-ND	.200	6.40	96.00	426.00/M	
F310-ND	.250	5.00	75.00	333.00/M	
F311-ND	.300	5.00	75.00	333.00/M	
F312-ND	.375	5.00	75.00	333.00/M	
F313-ND	.400	5.00	75.00	333.00/M	
F314-ND	.500	5.00	75.00	333.00/M	
F315-ND	.600	5.00	75.00	333.00/M	
F316-ND	.700	5.00	75.00	333.00/M	
F317-ND	.750	5.00	75.00	333.00/M	
F318-ND	.800	5.00	75.00	333.00/M	
F319-ND	1	5.00	75.00	333.00/M	
F320-ND	1.200	4.54	68.00	302.00/M	
F321-ND	1.250	4.54	68.00	302.00/M	
F322-ND	1.600	4.54	68.00	302.00/M	
F323-ND	1.800	4.54	68.00	302.00/M	
F324-ND	1.800	4.54	68.00	302.00/M	
F325-ND	2	4.54	68.00	302.00/M	
F326-ND	2.250	4.54	68.00	302.00/M	
F327-ND	2.500	3.62	54.00	241.00/M	
F328-ND	2.800	3.62	54.00	241.00/M	
F329-ND	3	3.62	54.00	241.00/M	
F330-ND	3.200	3.62	54.00	241.00/M	
F331-ND	4	3.62	54.00	241.00/M	
F332-ND	5	3.62	54.00	241.00/M	
F333-ND	6.250	3.62	54.00	241.00/M	
F334-ND	7	3.62	54.00	241.00/M	
F335-ND	8	3.62	54.00	241.00/M	
F336-ND	10	4.00	60.00	266.00/M	
F337-ND	12	4.00	60.00	266.00/M	
F338-ND	15	4.00	60.00	266.00/M	
F339-ND	20	4.00	60.00	266.00/M	
F340-ND	25	4.00	60.00	266.00/M	
F341-ND	30	4.00	60.00	266.00/M	

3AG Panel Fuseholder

Black phenolic conforming to MIL-M-14, type CFG. Rated to 20 amps for any voltage to 250. Includes neoprene washer, hex nut, and lock washer.

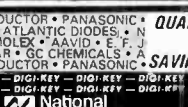
Part No.	Price 1	100
F004-ND	1.80	15.00	94.50

National Semiconductor

MA1026 Time-Temp. Clock Module

Giant .7 Inch 4-Digit LED Display

- °F and/or C° and virtually any number of sensors
- 50/60Hz line frequency operation
- 12 or 24 Hour Display



Typical Applications Include: Clock Radio Timers, Alarm Clock, Desk Clock, TV and Stereo Timer, Instrument Panel Clock, Digital Thermometer and much more.

Part No.	Description	Price
MA1026M	MA1026 clock module only	$30.60
MA1026P	Digi-Key switch panel kit (P.C. Board, 12 switches, two LM334Z temp. sensors, two KOA32 potentiometers, instructions).	11.95
MA1026T	110 VAC transformer for MA1026M	3.10
MA1026R	Alarm buzzer for MA1026M	3.36
MA1026K	MA1026M, P, T, R	45.95

For additional sensor units, you will need:

LM334Z	Temperature Sensor	1.51
K4A32	300 ohm Potentiometer	3.32
5001PB	Normally open push button switch	.55

Programmable Clock Modules

0.7" or 0.84" Red 4-Digit LED Display

User Programmable for:

- 12 or 24 hour display
- 50/60 Hz line frequency
- Fixed or flashing dot (colon indicator)
- Display: hours and minutes, minute and seconds, alarm time, and sleep time
- Battery back-up in case of power failure
- Typical applications include: clock radio timer, alarm clock, desk clock, instrument panel clock, and many more.

MA1020 — 0.84 INCH HIGH DIGITS

Cat. No.	Description	Price
MA1020M	MA1020 Clock Module only	$18.56
MA1020P	Digi-Key switching panel (includes P.C. board switches, hardware and instructions)	7.95
MA1020T	110 VAC Transformer for MA1020A	3.10
MA1020B	Buzzer for MA1020A alarm output	2.36
MA1020K	MA1020M, P, B and T	31.95

MA1023 — 0.7 INCH HIGH DIGITS

Cat. No.	Description	Price
MA1023M	MA1023 Clock Module only	$12.95
MA1023P	Digi-Key switching panel (includes P.C. board switches, hardware and instructions)	6.95
MA1023T	110 VAC Transformer for MA1023M	3.10
MA1023B	Buzzer for MA1023 alarm output	2.36
MA1023K	MA1023M, P, B and T	25.10

.5" 4-Digit LCD Clock

National Semiconductor MA1032 Clock Module

- One year warranty
- Buffered alarm and sleep outputs
- AC or DC alarm output
- Hold function

Cat. No.	Description	Price
MA1032M	MA1032 Clock Module only	$17.95
MA1032C	Switches for MA1032	2.85
MA1032K	MA1032M, C and AA battery holder	21.20

DIGI-CLOCK kit

- 12 VDC — Ideal for Car, Van or Boat!
- Includes Time Set Switch and Mounting Bracket
- Installs Easily — Just Solder Components to Board and Trim to Install
- Ideal for Car, Van or Boat
- 0.56" (14.2mm) Bright Red LED Digits
- Ideal for Home or Office

Part No. 5001K ONLY $17.95

LED's — Red, Green, Amber, Orange

3 mm, 4 mm, 5 mm, Round, Rectangular Arrow

Color	Part No.	Price 1	100	Size MM	Shape
Red Diffused	P300	2.20	19.50	5	Round
Red Clear	P301	2.20	19.50	5	Round
Green Clear	P307	2.20	19.50	5	Round
Green Diffused	P303	2.20	19.50	5	Round
Amber Clear	P304	2.20	19.50	5	Round
Orange Clear	P305	2.20	19.50	5	Round
Amber Diffused	P306	2.20	19.50	5	Round
Orange Diffused	P307	2.20	19.50	5	Round
Red Clear	P308	2.20	19.50	3	Round
Orange Clear	P309	2.20	19.50	3	Round
Amber Clear	P310	2.20	19.50	3	Round
Red Clear	P311	2.20	19.50	4	Round
Green Clear	P312	2.20	19.50	4	Round
Amber Diffused	P314	2.20	19.50	4	Round
Red Diffused	P315	2.20	19.50	3x5	Rectangle
Green Diffused	P316	2.20	19.50	3x5	Rectangle
Amber Diffused	P317	3.12	26.00	3x5	Rectangle
Red Diffused	P318	2.20	19.50	4x4.5	Arrow
Green Clear	P319	3.12	26.00	4x4.5	Arrow
Amber Diffused	P320	3.12	26.00	4x4.5	Arrow

Panasonic Numeric Displays

Red, Green, Amber and Orange Colors — Direct Drive

Comm. Anode	Comm. Cathode	Digits	Color	In.	1	10	100
P322	P343	8	Red	.3	1.25	11.50	105.00
P323	P344		Green	.3	1.58	14.50	132.00
P324	P345		Orange	.3	1.93	17.70	162.00
P325	P346		Orange	.3	1.80	17.70	162.00
P326	P347		Red	.43	1.45	13.30	122.00
P327	P348		Green	.43	1.78	16.30	149.00
P328	P349		Amber	.43	1.83	17.70	182.00
P329	P350		Orange	.43	2.10	19.32	176.00
P330	P351	8	Red	.57	1.56	14.50	132.00
P331	P352		Green	.57	1.90	17.50	159.00
P332	P353		Amber	.57	1.93	17.70	162.00
P333	P354		Orange	.57	2.25	20.70	188.00
P334	P356	8	Red	.43	2.10	19.30	175.00
P335	P357		Green	.43	2.45	22.50	205.00
P336	P357		Amber	.43	3.08	28.30	257.00
P337	P358		Red	.57	2.10	19.30	175.00
P338	P358		Green	.57	2.45	22.50	205.00
P339	P360		Amber	.57	3.58	32.90	299.00
P340*	P361*	8888	Red	.26	5.35	49.20	448.00
P341*	P362*		Orange	.28	6.15	56.60	515.00

*Multiplexed Display

Silicon Transistors

DIGI-KEY Part No.	1	10	100	1,000
2N3055	1.44	12.00	108.00	960.00
2N2904	.23	2.20	18.90	173.25
2N2905	.23	2.20	18.90	173.25
2N4124	.24	2.27	19.50	178.75
2N4126	.24	2.27	19.50	178.75
2N4401	.23	2.20	18.90	173.25
2N4403	.23	2.20	18.90	173.25
2N4410	.33	3.15	27.00	247.50
2N5087	.24	2.30	20.00	180.00
2N5089	.30	2.80	24.00	220.00
2N5210	.23	2.20	18.90	173.25
2N5457	.87	8.30	54.00	495.00
92PU01A	.45	4.20	36.00	330.00
92PU10	.45	4.20	36.00	330.00
92PU45A	.48	4.55	39.00	357.00
92PU91A	.45	4.20	36.00	330.00
MU2955	2.75	25.72	220.50	2021.25
MJE172	.67	6.30	54.00	495.00
MJE182	.71	6.65	57.00	522.50
MJE3439	.71	6.65	57.00	522.50
MJE344	.67	6.30	54.00	495.00
MJE370	.78	7.35	63.00	577.50
MJE371	.87	9.10	78.00	715.00
MJE520	.75	7.00	60.00	550.00
MJE521	.86	8.05	69.00	632.50
MJE703	.78	7.35	63.00	577.50
MJE717	.78	7.35	63.00	577.50
MJE722	.86	8.05	69.00	632.50
MJE803	.97	9.10	78.00	715.00
MPF102	.56	5.25	45.00	412.50
MPS2222A	.23	2.20	18.90	173.25
MPS2369A	.23	2.20	18.90	173.25
MPS2907A	.23	2.20	18.90	173.25
MPS3392	.23	2.20	18.90	173.25
MPS3393	.24	2.30	20.00	180.00
MPS3395	.24	2.20	20.00	180.00
MPS3563	.28	2.62	22.50	206.25
MPS3565	.23	2.20	18.90	173.25
MPS3638A	.23	2.20	18.90	173.25
MPS3641	.23	2.20	18.90	173.25
MPS3643	.23	2.20	18.90	173.25
MPS518	.28	2.62	22.50	206.25
MPSA13	.33	3.15	27.00	247.50
TIP112	1.08	10.15	87.00	797.50
TIP117	1.12	10.50	90.00	825.00
TIP120	1.01	9.45	81.00	742.50
TIP122	1.01	9.45	81.00	742.50
TIP127	1.09	10.80	84.00	770.00
TIP132	1.05	9.80	84.00	770.00
TIP135	1.35	9.80	84.00	770.00
TIP29C	.78	7.35	63.00	577.50
TIP30C	.78	7.35	63.00	577.50
TIP31C	.78	7.35	63.00	577.50
TIP32C	.78	7.00	60.00	550.00
TIP61C	.75	7.00	60.00	550.00
TIP62C	.75	7.00	60.00	550.00

1% Metal Film Resistors

½ Watt • Temperature Coefficient: ± 100 ppm/°C

Max. RC WV: 250V — Max. Voltage: 500V
Dielectric Withstanding Voltage: 500V

Standard Resistor Values from 10 to 1.00M ohms
STANDARD RESISTOR VALUE TABLE

10.0	13.3	17.8	23.7	31.6	42.2	56.2	75.0
10.2	13.7	18.2	24.3	32.4	43.2	57.6	76.8
10.5	14.0	18.7	24.9	33.2	44.2	59.0	78.7
10.7	14.3	19.1	25.5	34.0	45.3	60.4	80.6
11.0	14.7	19.6	26.1	34.8	46.4	61.9	82.5
11.3	15.0	20.0	26.7	35.7	47.5	63.4	84.5
11.5	15.4	20.5	27.4	36.5	48.7	64.9	86.6
11.8	15.8	21.0	28.0	37.4	49.9	66.5	88.7
12.1	16.2	21.5	28.7	38.3	51.1	68.1	90.9
12.4	16.5	22.1	29.4	39.2	52.3	69.8	93.1
12.7	16.9	22.6	30.1	40.2	53.6	71.5	95.3
13.0	17.4	23.2	30.9	41.2	54.9	73.2	97.6

How To Order: Take any standard resistor value (2.32K) and add an "X" (2.32KX), this is the DIGI-KEY part number. Order by quantity and price listed below.

¼ Watt 1% Metal Film	1 to 99	100 to 499	500 to 1000 for
	50¢	43.50	$30.00

For large quantities and prices as low as $9.25 M, contact DIGI-KEY

5% Carbon Film Resistors

Specifications:

	¼ W	½ W
Rated Working Voltage	250V	350V
Max. Overload Voltage	500V	700V
Operating Temp. Range	-55°C to +155°C	
Resistance Range	270 Ω to 1 MΩ	
Resistance Tolerance	±5%	
Series	E24	

Dimensions:

		¼ W	½ W
Body	Length (L)	6.8 - 9.4	9.5 - 11.5
	Diameter (D)	2.3 - 3.0	3.7 - 4.3
Lead Wire	Length (d)	28 - 32	28 - 32
	Diameter (d)	.6	.8

5% Carbon Film Resistor Values in Ohms

-1.0	-9.1	-82	-750	-6.8K	-62K	-560K
-1.1	-10	-91	-820	-7.5K	-68K	-620K
-1.2	-11	-100	-910	-8.2K	-75K	-680K
-1.3	-12	-110	-1.0K	-9.1K	-82K	-750K
-1.5	-13	-120	-1.1K	-10K	-91K	-820K
-1.6	-15	-130	-1.2K	-11K	-100K	-910K
-1.8	-16	-150	-1.3K	-12K	-110K	-1.0M
-2.0	-18	-160	-1.5K	-13K	-120K	-1.1M
-2.2	-20	-180	-1.6K	-15K	-130K	-1.2M
-2.4	-22	-200	-1.8K	-16K	-150K	-1.3M
-2.7	-24	-220	-2.0K	-18K	-160K	-1.5M
-3.0	-27	-240	-2.2K	-20K	-180K	-1.6M
-3.3	-30	-270	-2.4K	-22K	-200K	-1.8M
-3.6	-33	-300	-2.7K	-24K	-220K	-2.0M
-3.9	-36	-330	-3.0K	-27K	-240K	-2.2M
-4.3	-39	-360	-3.3K	-30K	-270K	-2.4M
-4.7	-43	-390	-3.6K	-33K	-300K	-2.7M
-5.1	-47	-430	-3.9K	-36K	-330K	-3.0M
-5.6	-51	-470	-4.3K	-39K	-360K	-3.3M
-6.2	-56	-510	-4.7K	-43K	-390K	-3.6M
-6.8	-62	-560	-5.1K	-47K	-430K	-3.9M
-7.5	-68	-620	-5.6K	-51K	-470K	-4.3M
-8.2	-75	-680	-6.2K	-56K	-510K	-4.7M

When ordering individual resistors, place a "Q" after the value shown for 5% and an "R" for 1% resistors.

¼ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS125	5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2 ohms, to 1M ohms or the 5% resistor for a total of 365 pieces.	89.90
RS226	5 each of 72 values in the series 1, 1.1, 1.3, 1.6, 2.0, 2.4 ohms to 810K ohms of the 5% resistor for a total of 360 pieces.	89.90

½ WATT 5% CARBON FILM RESISTOR ASSORTMENT

RS150	5 each of 73 values in the series 1.0, 1.2, 1.5, 1.8, 2.2, 2.4 etc. to 1M ohms of the 5% resistor for a total of 365 pieces.	89.90
RS250	5 each of 72 values in the series 1, 1.1, 1.3, 1.6, 2.0, 2.4 etc. to 810K ohms of the ½W 5% resistor for a total of 360 pieces.	89.90

Remember a "Q" after the resistance value indicates a ¼ watt, "R" indicates a ½ watt (i.e., 10KΩ or 10KR). Prices are for single values.

¼ Watt	5 for 25¢; 200 for $3.40; 1000 for 13.00
½ Watt	5 for 25¢; 200 for $3.60; 1000 for 15.00

In order to receive the pricing below, the resistor part number must be followed by a "+NO" (i.e., 10KΩ-NO) and ordered in multiples of 1,000 only.

Type	1M	10M	50M	100M	500M	1000M
¼W	9.00	8.00	6.50	6.00	5.00	4.50
½W	13.60	11.40	10.60	9.50	8.25	7.40

M

RN ROBINSON NUGENT, INC.

Termination Jumpers

P = PCB CONNECTOR TERMINATION

X = CARD EDGE CONNECTOR TERMINATION

Number After Dash Is Cable Length in Feet

Con-tacts	DIGI-KEY Style Part No.	Pricing 1	10	100	1,000
10	S	R300-NO	8.15	10.25	94.90	872.10
10	S	R301-NO	1.40	12.52	115.81	1064.20
10	S	R302-NO	1.81	14.32	132.45	1217.20
10	S	R303-NO	1.88	14.85	137.38	1262.80
26	S	R304-NO	2.43	21.50	159.80	1836.00
34	S	R305-NO	3.15	28.00	258.00	2380.00
40	S	R306-NO	3.73	33.00	307.10	2822.00
50	S	R307-NO	4.65	41.40	382.95	3518.00
10	P	R400-NO	1.81	8.00	83.25	765.00
20	P	R401-NO	1.21	10.84	100.27	921.40
26	P	R402-NO	1.53	13.55	125.06	1148.20
34	P	R403-NO	1.86	16.56	153.18	1407.60
40	P	R404-NO	2.11	18.82	174.08	1599.70
50	P	R405-NO	2.65	23.60	218.30	2006.00
20	X	R500-NO	2.39	21.00	194.25	1785.00
26	X	R501-NO	2.85	23.60	218.30	2006.00
34	X	R502-NO	3.26	29.00	268.25	2465.00
40	X	R503-NO	3.63	33.00	312.85	2873.00
50	X	R504-NO	4.74	42.20	380.35	3587.00

1A — SOCKET CONNECTOR

Con-tacts	DIGI-KEY Style Part No.	Pricing 1	10	100	1,000
10	1A	R209-36-NO	2.13	19.01	179.67	1616.19
14	1A	R310-36-NO	2.78	24.79	228.80	2102.95
16	1A	R311-36-NO	3.18	28.36	262.05	2408.05
20	1A	R312-36-NO	3.83	34.06	315.12	2895.78
24	1A	R313-36-NO	4.93	44.38	410.36	3770.84
30	1A	R314-36-NO	5.94	53.44	494.33	4541.91
40	1A	R316-36-NO	7.87	68.21	630.89	5798.20
50	1A	R317-36-NO	8.56	85.17	787.82	7239.43

2A — SOCKET CONNECTOR

Con-tacts	DIGI-KEY Style Part No.	Pricing 1	10	100	1,000
10	2A	R408-36-NO	1.99	17.76	164.22	1509.09
20	2A	R407-36-NO	3.18	28.34	262.21	2409.58
24	2A	R408-36-NO	4.08	36.26	335.87	3084.15
30	2A	R409-36-NO	5.21	46.32	428.51	3937.71
40	2A	R410-36-NO	6.05	53.83	492.98	4575.08
50	2A	R411-36-NO	7.87	87.37	683.17	5726.61

3A — SOCKET CONNECTOR

Con-tacts	DIGI-KEY Style Part No.	Pricing 1	10	100	1,000
10	3A	R505-36-NO	4.32	38.50	353.15	3273.10
26	3A	R506-36-NO	5.21	46.32	428.51	3948.94
34	3A	R507-36-NO	6.91	58.76	543.56	4994.94
40	3A	R509-36-NO	7.74	68.81	636.94	5848.28
50	3A	R510-36-NO	8.61	85.97	795.22	7307.45

1B — SOCKET CONNECTOR

Con-tacts	DIGI-KEY Style Part No.	Pricing 1	10	100	1,000
10	1B	R318-36-NO	2.47	21.97	203.79	1888.13
14	1B	R319-36-NO	2.82	24.89	230.29	2118.24
16	1B	R320-36-NO	3.23	28.36	262.21	2408.05
20	1B	R370-36-NO	3.04	27.06	250.50	2301.87
24	1B	R320-18-NO	3.50	31.16	288.28	2649.11
30	1B	R320-36-NO	4.16	37.37	344.81	3168.78
40	1B	R321-6-NO	5.21	46.32	428.51	3937.71
50	1B	R321-36-NO	6.79	42.85	394.51	3625.25
10	1B	R322-6-NO	4.85	43.03	398.25	3659.70
20	1B	R322-18-NO	4.97	41.87	387.33	3558.29
30	1B	R322-36-NO	5.89	50.52	458.30	4303.38
40	1B	R323-6-NO	6.91	58.76	543.56	4994.94
50	1B	R323-18-NO	6.84	54.58	504.88	4639.47
10	1B	R323-36-NO	7.62	65.98	610.18	5606.94
20	1B	R324-6-NO	8.85	60.94	563.88	5180.66
30	1B	R324-18-NO	7.87	70.88	655.66	6025.05
40	1B	R324-36-NO	7.39	65.75	608.33	5590.11
50	1B	R325-6-NO	8.12	72.23	668.18	6140.06
10	1B	R325-18-NO	8.43	83.50	772.38

4164 64K DYNAMIC 200 NS $5.95 TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
TC5514	1024 x 4	(650ns) (cmos)	2.49
TC5516	2048 x 8	(250ns) (cmos)	9.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95
HM6264	8192 x 8	(150ns) (cmos)	49.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/7.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	8.95

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
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)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2732A-4	4096 x 8	(450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8	(250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8	(200ns) (5v) (21vPGM)	13.95
2764	8192 x 8	(450ns) (5v)	6.95
2764-250	8192 x 8	(250ns) (5v)	7.95
2764-200	8192 x 8	(200ns) (5v)	19.95
TMS2564	8192 x 8	(450ns) (5v)	14.95
MCM68764	8192 x 8	(450ns) (5v) (24 pin)	39.95
MCM68766	8192 x 8	(350ns) (5v) (24 pin)(pwr dn.)	42.95
27128	16384 x 8	(300ns) (5v)	29.95

5v = Single 5 Volt Supply 21vPGM = Program at 21 Volts

EPROM ERASERS
SPECTRONICS CORPORATION

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	93.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

★ Computer managed inventory — virtually no back orders!
★ Very competitive prices!
★ Friendly staff!
★ Fast service — most orders shipped within 24 hours!

CRYSTALS

32.768 khz	1.95
1.0 mhz	3.95
1.8432	3.95
2.0	2.95
2.097152	2.95
2.4576	2.95
3.2768	2.95
3.579545	2.95
4.0	2.95
5.0	2.95
5.0688	2.95
5.185	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
18.0	2.95
18.432	2.95
20.0	2.95
22.1184	2.95
32.0	2.95

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
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

FUNCTION

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

MISC.

UPD7201	29.95
TMS99532	29.95
ULN2003	2.49
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

CLOCK CIRCUITS

MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	12.95
MM58174	11.95
MSM5832	3.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
AY5-3600 PRO	11.95

CMOS

4000	.29	4528	1.19
4001	.25	4531	.95
4002	.25	4532	1.95
4006	.89	4538	1.95
4007	.29	4539	1.95
4008	.95	4541	2.64
4009	.39	4543	1.19
4010	.45	4553	5.79
4011	.25	4555	.95
4012	.25	4556	.95
4013	.38	4581	1.95
4014	.79	4582	1.95
4015	.39	4584	.75
4016	.39	4585	.75
4017	.69	4702	12.95
4018	.79	74C00	.35
4019	.39	74C02	.35
4020	.75	74C04	.35
4021	.79	74C08	.35
4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
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	14.95	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
4527	1.95	74C929	19.95

6800

68000	49.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809E	14.95
6809	11.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	37.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	9.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	29.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

8000

8035	5.95
8039	5.95
INS-8060	17.95
INS-8073	49.95
8080	3.95
8085	4.95
8085A-2	11.95
8086	24.95
8087	CALL
8088	29.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	29.95
8748	24.95
8755	24.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	19.95
CRT5037	24.95
TMS9918A	39.95
DP8350	49.95

8200

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74LS09	.29	74LS192	.79		
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74LS11	.35	74LS194	.69		
74LS12	.35	74LS195	.69		
74LS13	.45	74LS196	.79		
74LS14	.59	74LS197	.79		
74LS15	.35	74LS221	.89		
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74LS28	.35	74LS245	1.49		
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74LS33	.55	74LS249	.99		
74LS37	.35	74LS251	.59		
74LS38	.35	74LS253	.59		
74LS40	.25	74LS257	.59		
74LS42	.49	74LS258	.59		
74LS47	.75	74LS259	2.75		
74LS48	.75	74LS260	.59		
74LS49	.75	74LS266	.55		
74LS51	.25	74LS273	1.49		
74LS54	.29	74LS275	3.35		
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7407	.29	74147	1.75		
7408	.24	74148	1.20		
7409	.19	74150	1.35		
7410	.19	74151	.55		
7411	.25	74153	.55		
7413	.35	74154	1.25		
7414	.49	74155	.75		
7416	.25	74157	.55		
7417	.25	74159	1.65		
7420	.19	74160	.85		
7421	.35	74161	.69		
7425	.29	74163	.69		
7427	.29	74164	.85		
7430	.19	74165	.85		
7432	.29	74166	1.00		
7437	.29	74167	2.95		
7438	.29	74170	1.65		
7442	.49	74173	.75		
7445	.69	74174	.89		
7446	.69	74175	.89		
7447	.69	74177	.75		
7448	.69	74181	2.25		
7451	.23	74184	2.00		
7473	.34	74185	2.00		
7474	.33	74191	1.15		
7475	.45	74192	.79		
7476	.35	74193	.79		
7482	.95	74194	.85		
7483	.50	74195	.85		
7485	.59	74197	.75		
7486	.35	74198	1.35		
7489	2.15	74221	1.35		
7490	.35	74246	1.35		
7492	.50	74247	1.25		
7493	.35	74259	2.25		
7495	.55	74273	1.95		
7497	2.75	74276	1.25		
74100	1.75	74279	.75		
74107	.30	74366	.65		
74109	.45	74367	.65		
74116	1.55	74368	.65		
74121	.29	74393	1.35		
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CA 3065	1.75	CA 3130	1.30
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75107	1.49	75452	.39
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75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
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TL074	2.19	LF351	.60
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SN7425N	14	.29
SN7426N	14	.29
SN7427N	14	.29
SN7428N	14	.59
SN7430N	14	.25
SN7432N	14	.29
SN7437N	14	.25
SN7438N	14	.29
SN7439N	14	.59
SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.65
SN7443N	16	1.25
SN7444N	16	1.25
SN7445N	16	.69
SN7446N	16	.69
SN7447N	16	.69
SN7448N	16	.69
SN7450N	14	.19
SN7451N	14	.19
SN7453N	14	.19
SN7454N	14	.19
SN7459N	14	.25
SN7460N	14	.39
SN7470N	14	.29
SN7472N	14	.29
SN7473N	14	.35
SN7474N	14	.35
SN7475N	16	.45
SN7476N	16	.35
SN7479N	14	4.95
SN7480N	14	.89
SN7482N	14	1.49
SN7483N	16	.59
SN7485N	16	.79
SN7486N	14	.35
SN7489N	16	2.25
SN7490N	14	.39
SN7491N	14	.79
SN7492N	14	.39
SN7493N	14	.39
SN7494N	14	.89
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	3.25
SN74100N	24	1.95
SN74104N	14	1.19
SN74105N	14	1.19
SN74107N	14	.29
SN74109N	16	.39
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.69
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.89
SN74142N	16	3.95
SN74143N	24	3.95
SN74144N	24	3.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74153N	16	.59
SN74154N	24	1.25
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SN74156N	16	.59
SN74157N	16	.59
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SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.95
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	1.19
SN74184N	16	2.49
SN74185N	16	2.49
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	2.49
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

74LS00	14	.25
74LS01	14	.25
74LS02	14	.29
74LS03	14	.25
74LS04	14	.35
74LS05	14	.29
74LS06	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	14	.29
74LS26	14	.29
74LS27	14	.29
74LS28	14	.35
74LS30	14	.29
74LS32	14	.39
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	14	.75
74LS51	14	.25
74LS54	14	.25
74LS55	14	.29
74LS73	14	.39
74LS74	14	.49
74LS75	16	.39
74LS76	16	.39
74LS78	14	.39
74LS83	16	.65
74LS85	16	.89
74LS86	14	.39
74LS90	14	.55
74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.89
74LS125	14	.59
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.89
74LS139	16	.79
74LS151	16	.59
74LS153	16	.59
74LS154	24	1.29
74LS155	16	.59
74LS156	16	.69
74LS157	16	.69
74LS158	16	.69
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	.69
74LS168	16	.69
74LS169	16	.69
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.69
74LS175	16	.69
74LS181	24	2.95
74LS190	16	.89
74LS191	16	.89
74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.49
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.49
74LS374	20	1.49
74LS375	16	.69
74LS378	16	1.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.45
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S85	16	2.49
74S86	14	.55
74S112	16	.55
74S113	14	.55
74S114	14	.55
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S162	16	2.49
74S174	16	1.19
74S175	16	1.19
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49
74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	1.19
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	16	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

CA3010H		1.35
CA3039H		1.35
CA3046N	14	1.35
CA3059N	14	2.95
CA3060N	16	2.95
CA3065E	14	1.49
CA3080E	8	.89
CA3081N	16	.99
CA3082N	16	1.19
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.49
CA3130E	8	.89
CA3140E	8	.79
CA3160H		1.95
CA3161E	16	2.95
CA3162E	16	6.95
CA3189E	16	1.95
CA3401N	14	.59

CD—CMOS

CD4000	14	.29
CD4001	14	.29
CD4002	14	.29
CD4006	14	1.19
CD4007	14	.29
CD4009	16	.59
CD4010	16	.59
CD4011	14	.29
CD4012	14	.29
CD4013	14	.39
CD4014	16	1.19
CD4015	16	.39
CD4016	14	.49
CD4017	16	1.19
CD4018	16	.99
CD4019	16	.59
CD4020	16	1.19
CD4021	16	1.19
CD4022	16	1.19
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	1.29
CD4030	14	.39
CD4034	24	2.49
CD4035	16	1.49
(More In Catalog)		
CD4040	16	1.19
CD4041	14	1.19
CD4042	16	.89
CD4043	16	1.19
CD4044	16	.79
CD4046	16	1.19
CD4047	14	1.29
CD4048	16	.59
CD4049	16	.39
CD4050	16	.39
CD4051	16	.99
CD4052	16	.99
CD4053	16	.99
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	1.49
CD4066	14	.59
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	1.19
CD4078	14	.49
CD4081	14	.29
CD4082	14	.29
CD4093	14	.49
CD4098	16	1.95
CD4505	16	1.19
CD4507	14	1.19
CD4508	24	3.95
CD4510	16	1.29
CD4511	16	1.19
CD4512	16	1.19
CD4514	24	2.49
CD4515	24	2.49
CD4516	16	1.19
CD4518	16	1.19
CD4519	16	.59
CD4520	16	1.19
CD4526	16	1.49
CD4528	16	1.19
CD4529	16	1.69
CD4543	16	1.95
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.69
CD4723	16	1.19
CD4724	16	1.19
MC14409	24	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$2.95
2650	40	MPU (2MHz)	9.95
MCS6502	40	MPU w/Clock	5.95
MCS6502B	40	MPU w/Clock at 3MHz	9.95
6809	40	CPU—8-bit (External Clock) 1MHz	14.95
6809E	40	CPU—8-bit (External Clock) 1MHz	14.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N	40	CPU-Sgl chip 8-bit(128bits, Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	9.95
INS8070N	40	CPU (64 bytes RAM)	29.95
INS8073N	40	CPU w/Basic Micro Interpreter	29.95
P8085A	40	CPU	4.95
8086	40	CPU 16-bit 5MHz	24.95
8088	40	CPU 8/16-bit	29.95
8155	40	HMOS RAM I/O Port-Timer	6.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N-4/780C) 2MHz	$3.95
Z80-CTC	28	Counter Timer Circuit	3.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	10.95
Z80-DMA	40	Direct Memory Access Circuit	9.95
Z80-PIO	40	Parallel I/O Interface Controller	3.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	12.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80-S10/9	40	Serial I/O	12.95
Z80A	40	CPU (MK3880N-4)(Z80C-1) 4MHz	4.49
Z80A-CTC	28	Counter Timer Circuit	4.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-PIO	40	Parallel I/O Interface Controller	3.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	12.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80A-S10/9	40	Serial I/O	12.95
Z80B	40	CPU (MK3880N-6) 6MHz	9.95
Z80B-CTC	28	Counter Timer Circuit	12.95
Z80B-DART	40	Dual Asynch. Receiver/Transmitter	19.95
Z80B-PIO	40	Parallel I/O Interface Controller	12.95
Z8001	48	CPU Segmented	44.95
Z8002	40	CPU Non-Segmented	34.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6500/6800/68000 SERIES

MC6502A	40	MPU with clock and RAM (2MHz)	6.95
MC6520	40	Peripheral Inter. Adapter	4.95
MC6800	40	MPU	2.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6809E	40	CPU (1MHz) External (Locking)	14.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	2.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC6BA30-8)	9.95
MC6850	24	Asynchronous Comm. Adapter	3.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	7.95
MC68000L8	64	MPU 16-Bit (8MHz)	49.95
MC6843IPP	40	General Purpose Int. Adapter	9.95
MC6845P2	40	Multi Protocol Comm. Controller	24.95
MC68561PB	28	Enhanced Prog. Comm. Int.	9.95
MCM68764	24	64K EPROM (450ns)	24.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8080A	40	CPU	2.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
8156	40	RAM with I/O Port and Timer	6.95
INS82C06	20	Octal O Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	2.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	3.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	5.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.95
DP8307	20	8-bit Bi-Directional Receiver	2.95
DP8308	20	8-bit Bi-Directional Receiver	2.95
DP8310	20	Octal Latched Peripheral Driver	4.95
8741	40	8-bit Univ. Peripheral Interface	29.95
8755	40	16K EPROM with I/O	24.95

DISK CONTROLLERS

INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	29.95
FD1792	40	Single/Double Density (True)	29.95
FD1795	40	Dual Density/Side Select (Inv.)	29.95
FD1797	40	Dual Density/Side Select True	29.95

SPECIAL FUNCTION

DS0025CN	8	Dual MOS Clock Driver (SMIZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (SMZ)	2.49
INS2651	28	Communication Chip	8.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM5816TAN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcomputer w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N	20	3½ Digit VAC Fluor. Dvr. (20-pin pkg.)	3.25
MM5369AA/N	8	Prog. Oscillator/Divider (50Hz)	1.79
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

DYNAMIC RAMS

Part No.	**Pins	Function	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	6.95 - 8/49.95
4164N-200	16	65,536x1 (200ns)	5.95 - 8/44.95
MM5261	18	1024x1 (300ns)	.49 - 8/1.95
MM5262	22	2048x1 (365ns)	1.10
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	18	1024x1 (350ns)	.89
21L02	18	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	1.95
2114	18	1024x4 (450ns)	1.49 - 8/9.95
2114L	18	1024x4 (450ns) L.P.	1.95 - 8/13.95
2114-2	18	1024x4 (200ns)	1.75 - 8/11.95
2114L-2	18	1024x4 (200ns) L.P.	2.25 - 8/14.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	4.95
TMS4045	18	1024x4 (450ns)	3.95
TMS40L47-45	20	1024x4 (450ns)	2.95
5101	22	256x4 (450ns) CMOS	2.95
MM5257	18	4096x1 (250ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	5.95
HM6116P-4	24	2048x8 (200ns) CMOS	4.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	5.49
HM6264P-15	28	8192x8 (150ns) CMOS	39.95
2TL509	16	256x1 (40ns) L.P.	9.95
7489	16	16x4 (50ns) 3101	2.25
TMS4044	22	256x4 (250ns)	3.95
TMS4036	24	4096x1 (150ns)	9.95
TMS4060	24	4096x1 (200ns)	7.95
TMS4061	24	4096x1 (250ns)	6.95
TMS4062	24	4096x1 (300ns)	5.95
TMS4063	24	4096x1 (350ns)	5.95
TMS4064	24	4096x1 (450ns)	4.95
TMS4065	24	4096x1 (550ns)	5.95
TMS4066	24	4096x1 (650ns)	2.95
TMS4067	24	4096x1 (450ns) 5 voltage	9.95
TMS4164	24	65,536x1 (150ns)	9.95
TMS4165	24	65,536x1 (200ns)	8.95
TMS4167	24	65,536x1 (250ns)	7.95
TMS4416	24	16,384x4 (150ns)	19.95
TMS4464	24	65,536x4 (150ns)	29.95
TMS4500	40	4096x8 (450ns)	19.95
TMS4501	40	4096x8 (450ns)	19.95
TMS4502	40	4096x8 (450ns)	19.95
TMS4732	24	4096x8 (450ns)	19.95
TMS4733	24	4096x8 (450ns)	19.95
TMS4764	24	8192x8 (450ns)	19.95
TMS4864	24	8192x8 (450ns)	19.95
TMS4932	24	16,384x8 (450ns)	19.95
TMS4964	24	65,536x8 (450ns)	19.95
TMS4972	24	65,536x8 (450ns)	19.95
TMS4980	24	65,536x8 (450ns)	19.95
TMS4981	24	65,536x8 (450ns)	19.95
TMS4982	24	65,536x8 (450ns)	19.95
TMS4983	24	65,536x8 (450ns)	19.95
TMS4984	24	65,536x8 (450ns)	19.95
TMS4985	24	65,536x8 (450ns)	19.95
TMS4986	24	65,536x8 (450ns)	19.95
TMS4987	24	65,536x8 (450ns)	19.95
TMS4988	24	65,536x8 (450ns)	19.95
TMS4989	24	65,536x8 (450ns)	19.95
TMS4990	24	65,536x8 (450ns)	19.95
TMS4991	24	65,536x8 (450ns)	19.95
TMS4992	24	65,536x8 (450ns)	19.95
TMS4993	24	65,536x8 (450ns)	19.95
TMS4994	24	65,536x8 (450ns)	19.95
TMS4995	24	65,536x8 (450ns)	19.95
TMS4996	24	65,536x8 (450ns)	19.95
TMS4997	24	65,536x8 (450ns)	19.95
TMS4998	24	65,536x8 (450ns)	19.95
TMS4999	24	65,536x8 (450ns)	19.95

PROMS/EPROMS

1702A	24	256x8 (1µs)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SMQ0246	3.95
TMS2516	24	2048x8 (450ns) 2716	5.95
TMS2532	24	4096x8 (450ns) NMC2532	6.95
TMS2564	28	8192x8 (450ns)	14.95
TMS2716	24	2048x8 (450ns) 5 voltage	7.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	5.95
2716Q-5	24	2048x8 (550ns)	4.49
2732	24	4096x8 (450ns)	6.95
2732A-3	24	4096x8 (300ns)	7.95
2732A-4	24	4096x8 (450ns) 21V	6.95
2732Q-4	24	4096x8 (550ns)	5.95
2758Q-A	24	1024x8 (450ns)	2.95
2764-4	28	8192x8 (450ns)	9.95
2764-3	28	8192x8 (300ns)	14.95
MM5204Q	24	512x8 (1µs)	4.95
MCM68764	24	8192x8 (450ns)	24.95
27128	28	16,384x8 (450ns) 128K EPROM	59.95
74S188	16	32x8 PROM T.S. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S476	18	1024x4 PROM T.S	6.95
74S478	24	1024x8 PROM T.S.	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
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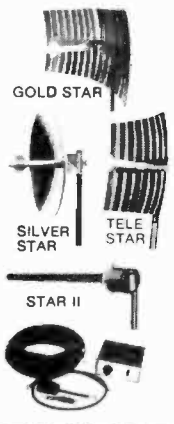

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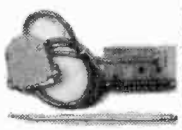

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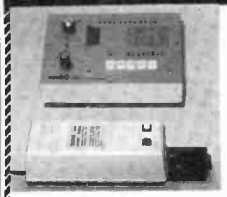

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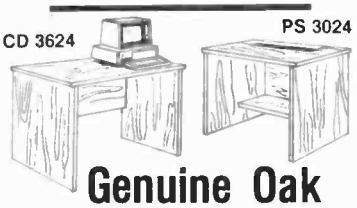

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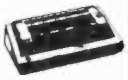

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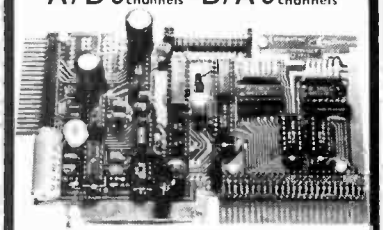

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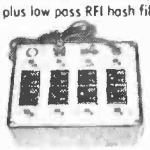

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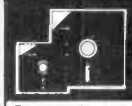

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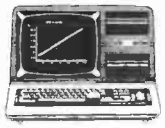

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Leading Edge Personal Computer

(Continued from page 37)

screen prompts are concerned, all the Leading Edge MS-DOS programs follow the IBM conventions. So if you're an experienced user, there is virtually nothing new to learn.

As mentioned, Leading Edge includes Microsoft's GW Basic programming language in the purchase price of the machine. This is very important since the IBM, or PC-DOS, version of BASIC will most definitely not work on the Leading Edge PC. My first, and only attempt to load IBM BASIC resulted in the disks whirring a lot; but nothing actually happened. The problem has to do with inevitable code differences in the IBM and Mitsubishi ROM chips.

Is this a problem? No, not really. According to Leadiing Edge, this version of BASIC will correctly execute any IBM BASIC program. Of course, if you want a machine that will run all IBM programs and IBM BASIC with absolutely no surprises, then you'd better buy an IBM PC, because that's the only street-legal 100% compatible product around. If you want to run some IBM programs and are willing to load Microsoft BASIC from disk, then the Leading Edge PC is not a bad choice.

Like many of its peers, the Leading Edge PC is a bit noisy since it uses an electric fan to keep the system cool. Again, this is just a small point, but it could be bothersome in an office where two or three machines are in constant use. Certainly, the fan works since there were no signs of overheating during the time I used the machine. The main air vents are along the back of the system unit, near the power sockets.

Documentation

If there is one thing that really makes life hard for the user it's poor documentation. Leading Edge, however, has managed to avoid a lot of the common traps and provide a well-designed set of manuals for its personal computer customers. These manuals are quite well-written, professionally printed, and have a number of high-quality illustrations wherever relevant.

The technical specification sections provide very detailed information for all interested users, and an index of contents is supplied. (It's amazing how many other document writers for this type of equipment have failed to include indexes with manuals.)

Conclusion

The Leading Edge PC is not an especially pretty machine. But what it lacks in design it makes up for in terms of price and performance. There are other IBM compatibles on the market that are less expensive than this machine—the Tava and the Sanyo PCs for example. But I liked the Leading Edge idea of supplying a machine that comes standard with almost everything a user might immediately need.

You can use the Leading Edge PC to write BASIC programs, run MS-DOS and PC-DOS software, and see it all on the monitor supplied within the purchase price. You can then print out hard copies of documents using either the serial or parallel communications port. Plus, at the flick of a microswitch, you can make the machine do lots of processing tasks at a speed that is anywhere up to twice as fast as an ordinary Intel 8088-based computer.

If you've already decided to buy an MS-DOS machine, but don't want to pay the full price for an IBM PC, the $3000 Leading Edge PC should be a serious contender for your business. ◇

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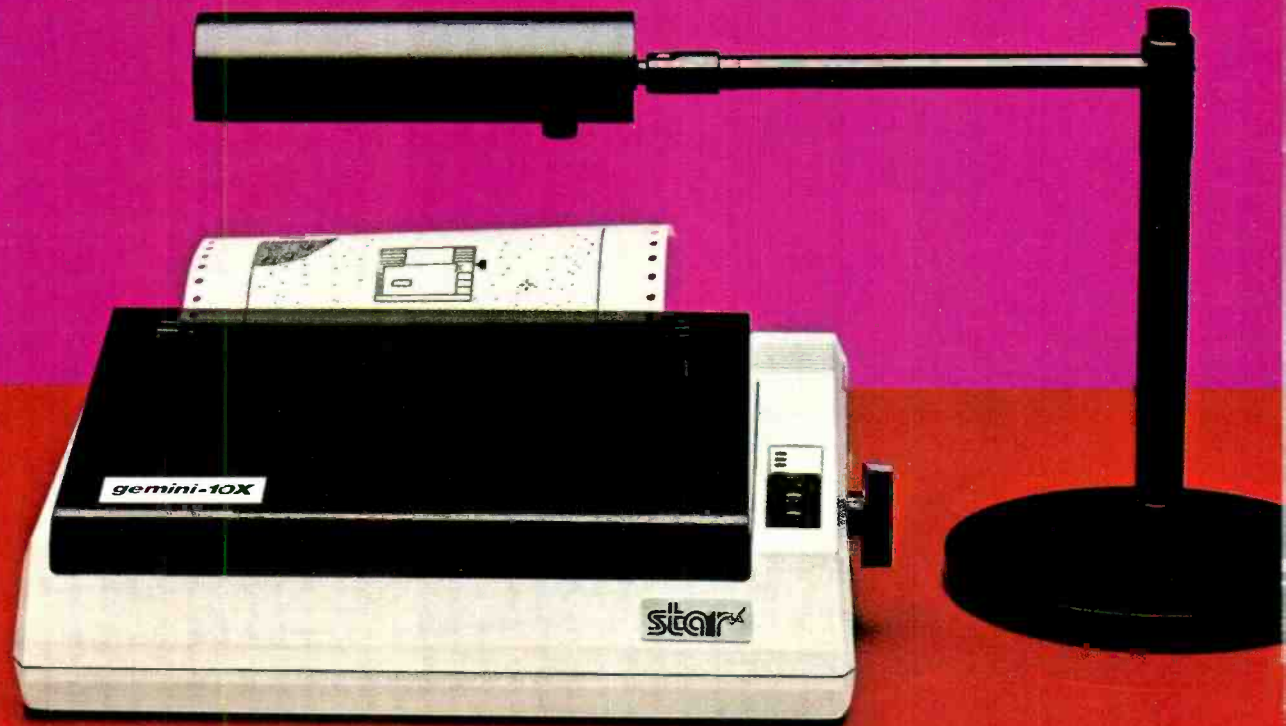

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