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BYTE

JANUARY 1989

A McGRAW-HILL PUBLICATION

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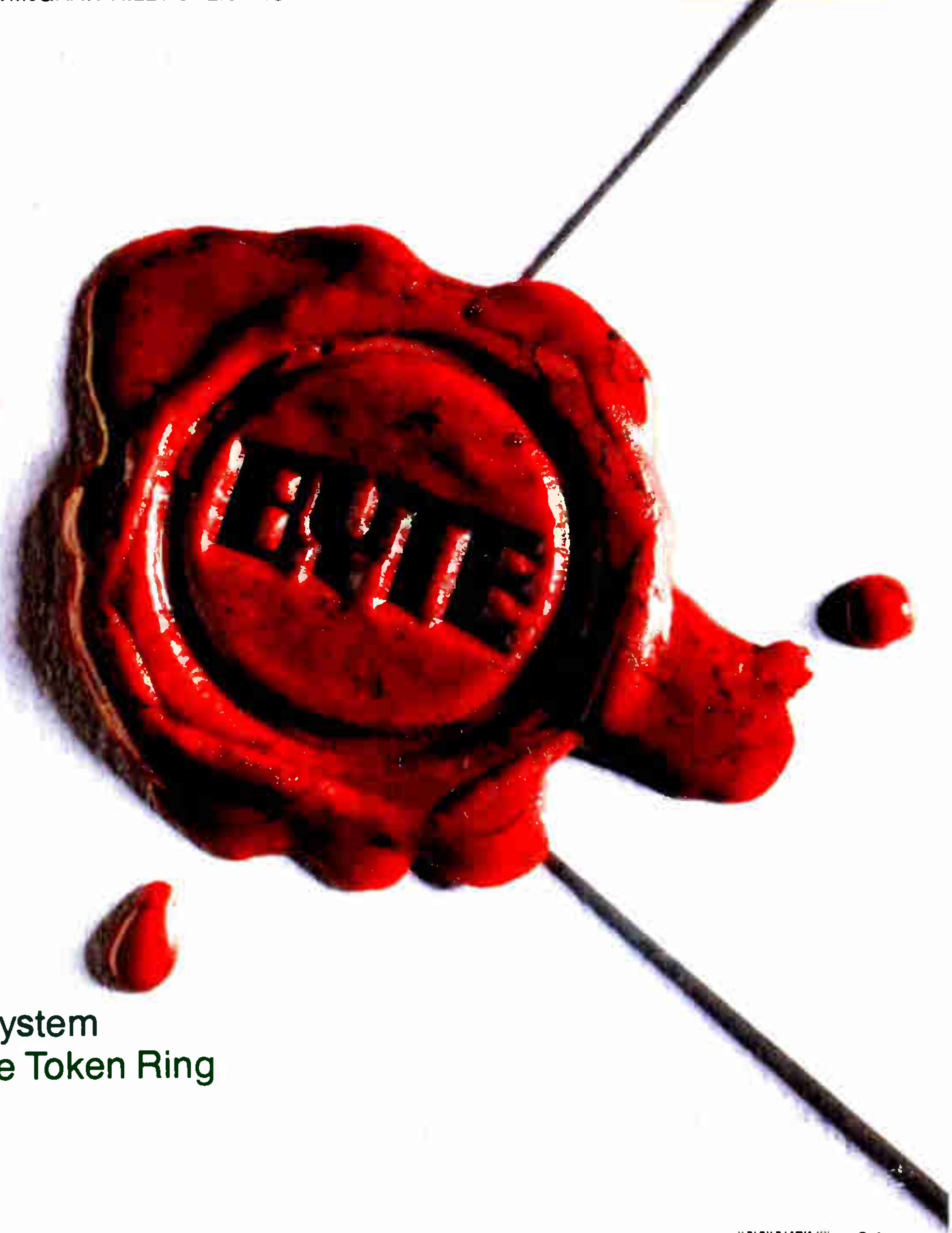

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- VGA systems include a high performance 16-bit video adapter.
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- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
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Options:

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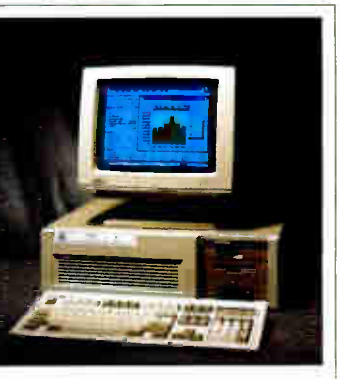
The Dell System 325 is an FCC Class A device, intended for business use only.



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Standard Features:

- Intel 80386 microprocessor running at 20 MHz.
- 1 MB of RAM* expandable to 16 MB using a dedicated high speed 32-bit memory slot.
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 20 MHz Intel 80387 or 20 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots.

Options:

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- 1 MB or 4 MB memory upgrade kit.
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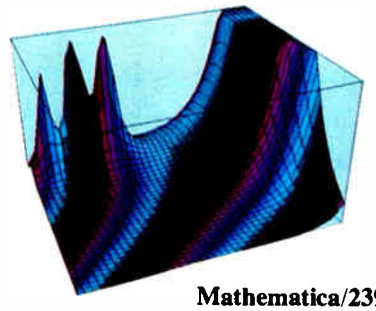

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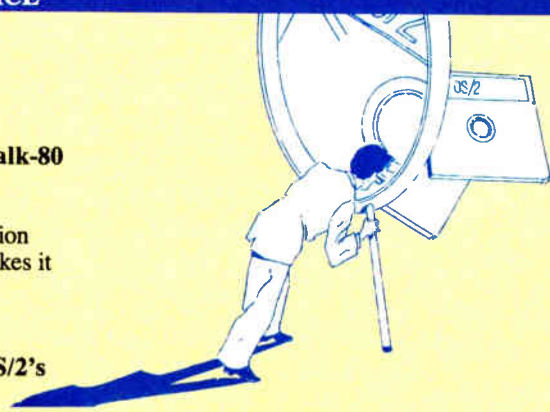

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PM, SunView, and the Mac

Our early benchmarks show some interesting similarities and some surprising differences

I am writing this in my hotel room at COMDEX in Las Vegas. It's just a week after the formal release of Presentation Manager (PM). All around the show, signs dangle from the ceilings: "OS/2," they say, pointing to the booths displaying OS/2-related hardware or software. From a distance, it's impressive.

But when you follow the signs and actually go into the booths, you find more promises than products. The expected flood of OS/2 applications still is not materializing.

In a way it's a shame, because our early benchmarks of PM show that it's a very nice product: BYTE Lab's preliminary figures on text and graphics performance indicate that PM is marginally faster than either of its two chief rivals—the Macintosh and SunView (Sun's graphical interface for Unix).

What's the holdup? Senior Testing Editor Rick Grehan thinks it's in part due to "a whopping amount of starting friction," as he puts it. Programmers are facing a body of documentation that rivals (if not surpasses) the gigantic *Inside Macintosh*. "Remember how long it took decent programs to show up on the Mac? We'll probably see the same phenomenon on PM," Rick warns.

Here's a very cursory summary of some of the interesting ways that Rick and the BYTE Lab have found that PM differs from the Mac and SunView.

Macintosh Windowing

On the Macintosh, a window is a data structure that holds all the information the Mac needs to make the window appear on-screen: The window definition function knows how to draw the window's frame, how to determine if the pointer is in the window when the mouse button is clicked, and so forth. Mac windows are more or less independent.

PM Windowing

A PM "window" is actually a bundle of separate windows, including the frame, the titlebar, and the client window (where the actual drawing/text display occurs). All are windows in their own right. This bundle is arranged in a hierarchy, the head of which is the frame.

Since windows in PM are hierarchical, a window can have children. The children's positions are relative to the parent's; when the parent is moved, its children also move. Also, when the parent window is closed, its children are also closed. PM's hierarchical approach allows applications to create an arbitrarily complex system of windows.

SunView Windowing

The Sun window system is constructed around the idea of multiple panes. A window is built as a bundle of other windows; these subwindows are akin to the PM client windows. Such subwindows can be canvases (for graphics), text subwindows (for text entry and editing), panels (that typically hold static text and buttons), or TTY subwindows (that act as a port to a command prompt).

Programming Hassles

In many ways, the Sun system takes care of many details that Mac or PM programmers have to handle explicitly. For example, because of the way user-triggered "events" are processed and the ease with which a programmer can "attach" specified actions to events, Rick has written a demonstration program on the Sun that creates and labels a button that you can click on to initiate some predefined action: It's only about four lines of C code.

In a similar program on the Mac, a mouse-down event would be detected by the program's event loop, but the application program would have to determine where the mouse was when its button was pressed, figure out what was supposed to happen next, and act accordingly.

A PM program would need a procedure for responding to a WM_BUTTONDOWN message, then would have to call a position function to determine the location of the pointer on the screen, examine the location to see if the pointer was in the button to begin with, and initiate the desired process.

Text Handling

There are also variances in the way the three systems handle text. The Mac supports a structure called TextEdit. This is basically a string, but the Mac Toolbox contains a pile of routines that let a program manipulate that string for performing text editing-type functions. The Mac's TextEdit routines handle a lot of the work programmers would ordinarily have to do on their own.

Rick reports a parallel to the TextEdit structure on the Sun system: the text subwindow, which is a window to which you attach a memory- or file-based string. Text subwindow routines let you display and manipulate text by means of simple function calls.

However, using beta software and documentation, Rick has found no TextEdit counterpart to this structure in the PM environment.

Complexities such as these (and there are many more) add up to a steep learning curve. And that's what's taking so long.

On the other hand, our preliminary benchmarks indicate that when applications do arrive—for both PM and SunView—we'll probably feel it was well worth the wait.

—Fred Langa
Editor in Chief
(BIX name "flanga")

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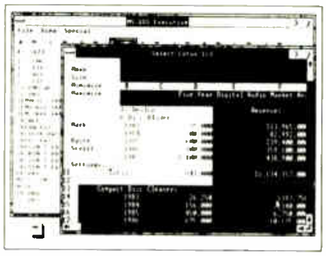

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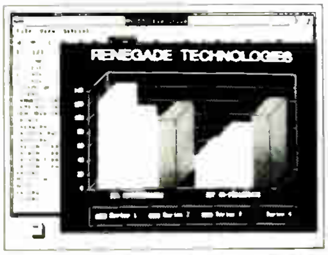

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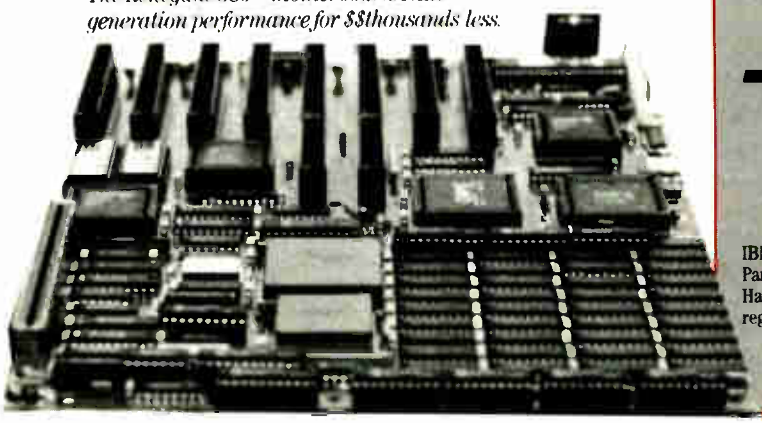

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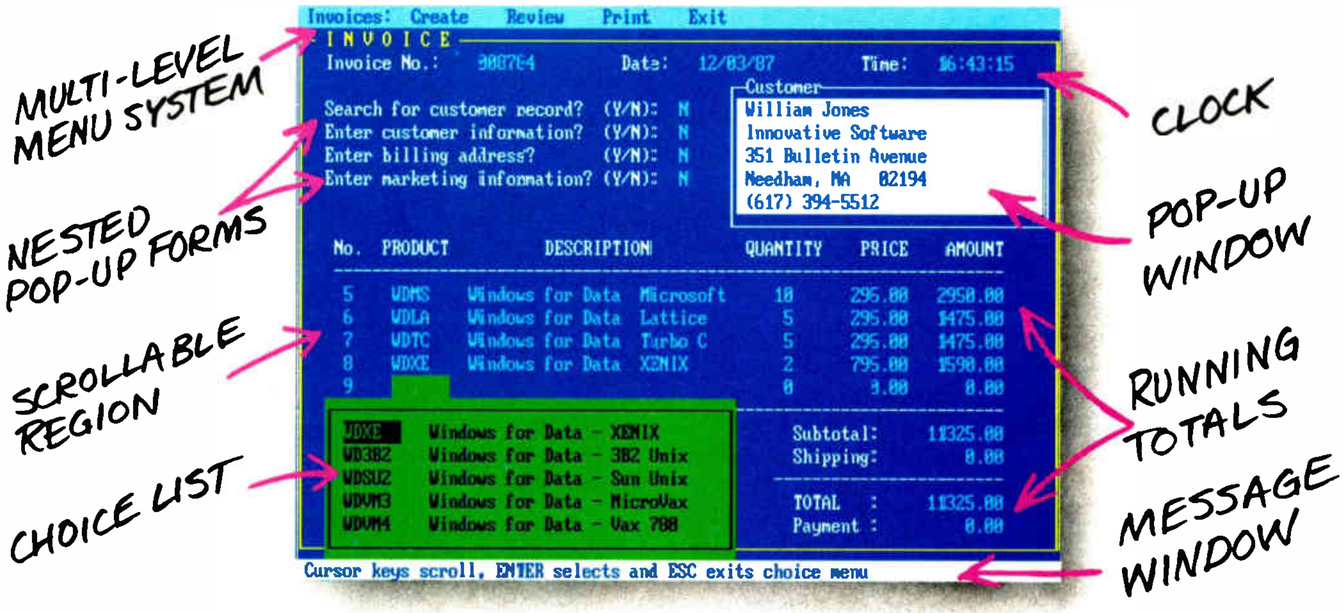

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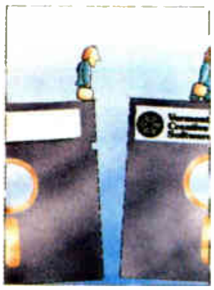

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Staff-written highlights of developments in technology and the microcomputer industry

Voice-System Researchers Hope to Rise Above Noise

Although great progress has been made in the quality and accuracy of systems using voice recognition and voice synthesis, there is still much work to be done in both recognizing and synthesizing the acoustic variations of speech. That was the consensus at the annual meeting of the American Voice Input/Output Society (AVIOS), held recently in San Francisco.

The biggest problem in voice recognition is being able to accurately interpret various accents, intonations, word ambiguities, and different pitches of the male and female voice. Some progress has been made by using a technique called the Hidden Markoff Model, in which each word is broken up into syllables and each syllable's frequency response is analyzed separately. Although this method has promise, it requires a totally quiet environment and has yielded only 70 percent accuracy for vocabularies of up to 1000 words.

The main objectives of researchers working in voice recognition in the next few years are achieving a 90 percent semantic accuracy rate, real-time performance, and being able to maintain accuracy in normal, noisy environments. Another challenge facing researchers is getting voice recognition systems to sample sounds faster than once every 10 milliseconds.

Voice synthesis systems have achieved a high degree of accuracy in converting text to talk, but they don't sound natural. Part of the problem is that single phonemes, like the letter *a*, for example, produce a wide range of frequencies depending on the word. For example, "The fat man ate jam in the Cadillac" can yield variations in frequencies of up to 300 Hz in the formant frequencies for the phoneme *a*.

The trick is to develop a parser that can determine the frequency of the phoneme depending on the adjacent letters. For example, the phrases "Sally" and "sassy" yield different frequencies because of the letters immediately following *a*.

Another major challenge facing voice synthesists is creating different voice qualities in text-to-speech synthesis. For example, there's no method for expressing breathiness, creakiness, falsetto, loud and soft intonations, and variations in stress on different syllables.

The challenge is to develop methods for quantifying the acoustic variations in speech and to develop parsers that can resolve semantic ambiguities to help assign the proper intonation to a phrase. Work in this area is being conducted at Stanford Research Institute, Speech Plus (Palo Alto, CA), and at a number of other research institutes and speech-recognition companies. AVIOS can be contacted at P.O. Box 60940, Palo Alto, CA 94306, (408) 742-2539.

C++ Users Await Next Release

As the future of software engineering looks more and more object-oriented, C++ looks more and more significant. Addressing the question of how to make the programming environment more productive, Sun Microsystems' cofounder Bill Joy said recently, "The name of the answer is C++."

C++, invented by Bjarne Stroustrup at AT&T Bell Labs in the early 1980s, is an extended version of ANSI Standard C that adds the constructs necessary for object-oriented programming. Users and researchers at a recent Usenix-sponsored conference agreed that the next major release of C++ from AT&T, version 2.0, will resolve many portability concerns and add functionality to the object-oriented paradigm, including type-safe linkage, multiple inheritance, and member-wise assignment and initialization semantics. Version 2.0, which should be released during the first quarter of this year, should coincide roughly with the release of a document that will comprehensively describe the current state of standard C++.

The AT&T C++ compiler has been considered the standard since its release in 1985. Unlike C, for which companies have written variations on the original, incompletely specified AT&T C compiler, developers writing their own C++ compilers have been careful to

continued

NANOBYTES

• Since Lotus Development founder **Mitch Kapor** can get pages of publicity for a product that isn't even a product yet, we'll give him just a paragraph. Kapor has said that his company, **On Technology**, will develop products that make computers **easier to use** and that they'll consist of "building blocks" that will run under different operating systems. He hasn't specified how these products will make computers better, but we can bet the first On product will implement **object-oriented** principles. At a recent conference on object-oriented programming, 14 of On's 23 employees were there. Kapor, a speaker at the conference, said OOPS methodology will prompt "a different ecology of applications . . .more modular, more like kits that users assemble."

• Mighty mouse: **Marq Technologies** (San Diego, CA) has a new **mouse** that you can transform into an image scanner or an optical character reader by outfitting it with special cartridges that plug into the front of the input/pointing device. The Marq-Mouse, which is compatible with mice from Logitech, has a resolution of 600 pixels per inch. With the scanning module attached, the device can capture images at 300 dots per inch and with

continued

NANOBYTES

16 levels of gray. It works with the IBM PC, PS/2s, and compatibles. The basic mouse is $199; the scanner module and OCR module will each sell for $799.

• The pact between **Tandy** and **Digital Equipment Corp.**, whereby Tandy will build personal computers that DEC will then sell under its own name, has advantages for both companies. DEC gets a production line run by one of the most experienced electronics manufacturers in the world. Tandy, as a result of a "technology exchange," gets, among other things, DEC's DECnet networking technology. DEC's outreach to personal computer companies like Tandy and Apple indicates an awareness that you can't plan to survive in a proprietary VMS world. DEC also signed a pact with Ashton-Tate to put dBASE on the VAX.

• **DEC** is "well along" in making the transition from proprietary DECnet communications protocols to **Open Systems Interconnect** protocols, said DEC vice president William Strecker at Patricia Seybold's Executive Forum recently. The move to OSI will take a couple of years, but it's at least the right direction, as OSI provides guidelines for networks of computers from different manufacturers. As Strecker agreed, the language of networks has to be open and international. "We believe everybody else will come to that conclusion," he said.

• **Metaphor** (College Place, WA) has a new li-

continued

stick closely to the example set by AT&T's own evolving version of C++. "The main players have all deferred to us [on compatibility issues]," said Jonathan Shapiro, a member of the Bell Labs technical staff.

Programmers and academics at the Usenix conference disagreed on how to implement several object-oriented constructs, but all agreed that compatibility with the AT&T C++ compiler is essential.

Not everyone is a fan of C++; some programmers think it is too unstructured, an "anarchist" in Shapiro's terms (as opposed to a "fascist"). "What he's saying is: Either programmers can do what they want, or programmers can do what the language designers think they should do," explained Andrew Koenig of the Bell Labs staff. Bill Joy says, "C++ gives you enough rope to hang yourself."

Technical staffers at Bell Labs point out that C++ is evolving and that version 2.0 will not be driven by market concerns. "It has taken so much more time to get things working reliably that we want to wait and make sure that it's reliable when released," said Koenig. Noting that input from the user community and consultation with vendors is vital, Stroustrup said, "We must have delays in this process [the release of 2.0]; otherwise, we may have to live with gross mistakes."

The presence at the C++ conference in Denver of representatives from major computer companies, including IBM, Hewlett-Packard, Apple, AT&T, and Sun, makes the language's future look good. (Notably absent was Stepstone, which makes Objective C, the object-oriented programming language bundled with the NeXT machine. Objective C is not compatible with C++.) "As far as I can tell, we've had a much bigger impact than any current language, if you look at languages introduced in the last 15 years. It is no longer controversial to say C++ is the next generation of C," Shapiro said.

Prototype Big LCD Can Display 16 Colors

Liquid crystal displays will be one of the hottest potential markets heading into the 1990s. And they'll come in all flavors, sizes, colors, and resolutions. LCDs with resolutions of 640 by 480 pixels will be common on laptops in the next decade, and as the market grows, so will the size of the displays.

And now, IBM Japan and Toshiba have produced a prototype of what they say is "the world's largest color LCD." Hitachi recently announced a 2-meter-square LCD that can display eight different colors, but a Toshiba spokesperson said, "Ours is the largest one capable of displaying 16 colors."

The prototype, developed jointly by IBM's Yamamoto Laboratory and Toshiba's Electron Technology Labs, measures almost 15 inches square. It took 2 years to develop, a Toshiba representative told Microbytes Daily. The LCD uses an "active-matrix-type thin film transistor" for each pixel. The display can switch between color and monochrome mode; in monochrome mode, the resolution is 1440 by 1000 pixels, for a total of 1.58 million pixels. Color mode is somewhat less, providing a matrix of 720 by 550 pixels. Each pixel in color mode is made up of four colors: red, green, blue, and white. You can reproduce up to 16 colors on the LCD at the same time.

A Toshiba official said that the "pitch between pixels is about 200 microns," producing the high density required for the LCD's high-resolution images. The official wouldn't speculate on when the LCD would reach production levels, nor would he provide any details on what the display might cost or when it might appear in products.

NeXTStep Won't Affect OS/2 Plans, IBM Says

IBM's deal with NeXT to license the NeXTStep Unix-based graphical interface prompted speculation that IBM might be veering from its proclaimed commitment to OS/2. But IBM claims that its use of NeXTStep will have absolutely no impact on its plans for OS/2. IBM spokesperson Scott Brooks said that NeXTStep and OS/2 are "intended for different areas. OS/2 is a strategic system for PS/2s and Systems Application Architecture host environments. NeXTStep is purely for Unix-based environments." Brooks said users can expect a "steady stream of enhancements to both our OS/2 and Unix-based systems. We want to offer leadership in both areas over time."

Brooks declined to comment on planned products for the NeXTStep environment

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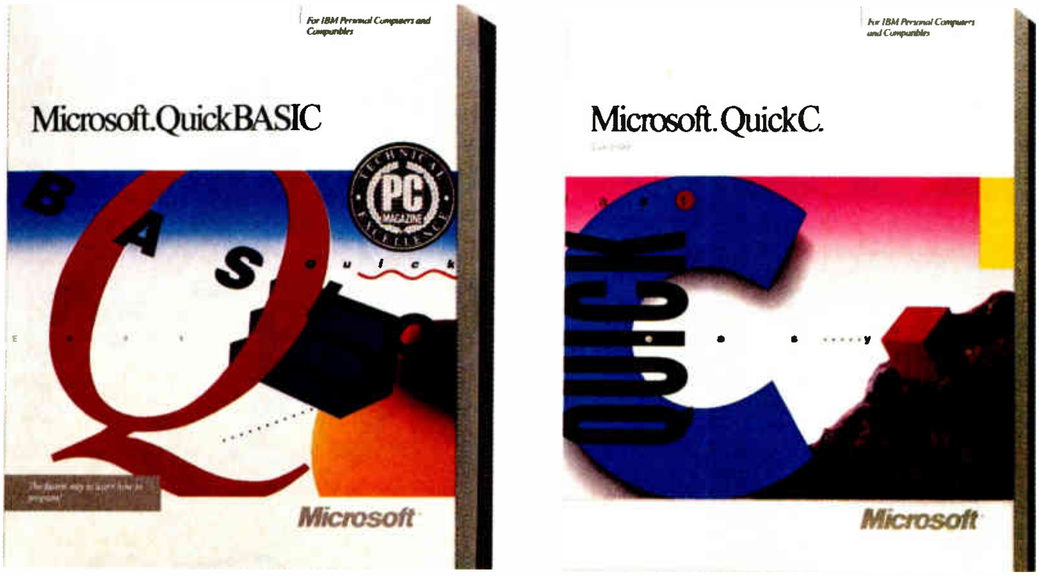
If anyone tries to tell you that one language fits all, turn the page.

To each



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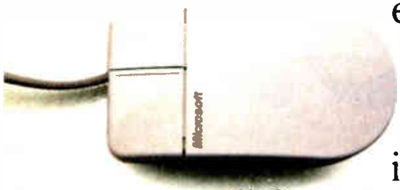

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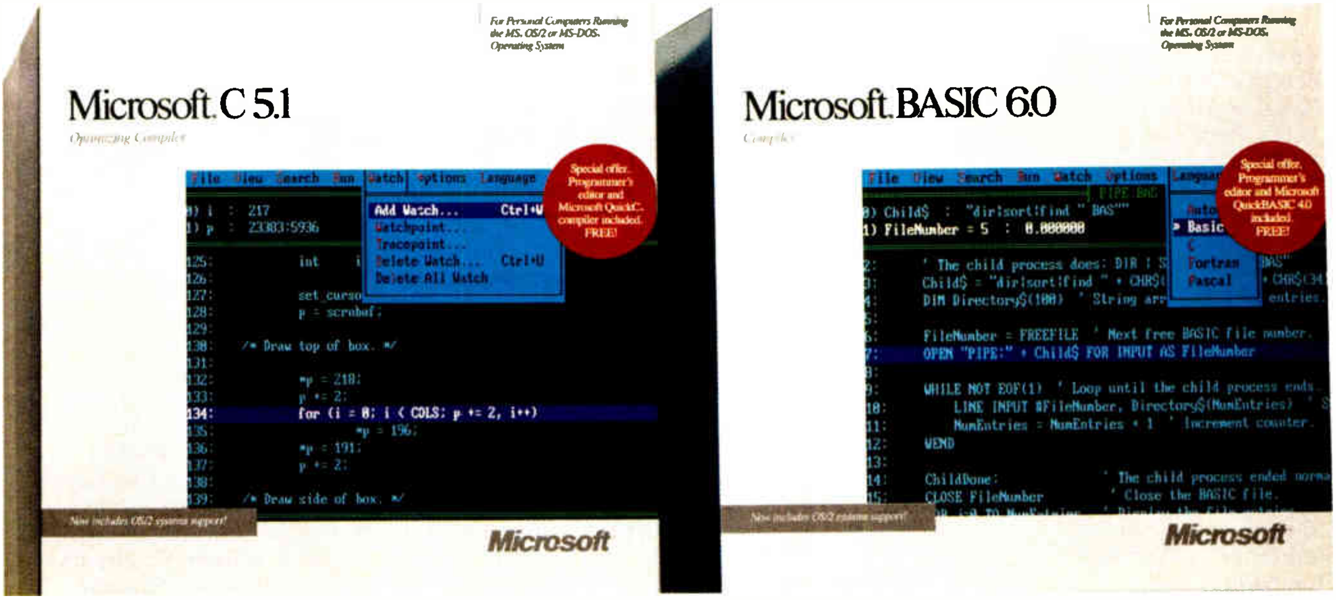

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brary of numerical methods for Think's Lightspeed C for the Macintosh. **NuTools** contains 350 numerical routines and 50 I/O routines and sells for $125. Metaphor said it plans similar libraries for Lightspeed Pascal and Borland's Turbo Pascal.

- **Mitsubishi** Electronics America (Torrance, CA) is offering a new line of **optical storage** devices to system builders. The MW-5D1 WORM (write once, read many) drive can hold 300 megabytes on each side of a 5¼-inch removable disk cartridge and has an average random access time of 80 milliseconds; track-to-track seek time is rated at 1 ms. The company's two new optical jukeboxes, primarily for document management systems, can hold as much as 90 gigabytes on 152 WORM cartridges or 34 gigabytes on 56 cartridges. Each cartridge is good for about 300,000 pages, Mitsubishi said.
- **Mitsubishi** researchers in Japan have been doing overtime in the **optical technology** department. The company says it has come up with a process that greatly increases the writing density on optical media.
- **Drexler Technology** (Mountain View, CA) says it will start marketing LaserCard-based workstations next month. The systems, designed for record keeping, security, and electronic publishing applications, use Drexler's credit-card-size **optical memory cards** for storing data; the cards can now hold as much as 2 megabytes. A

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but said that IBM products would follow "closely behind" the rollout of NeXTStep 1.0 on the NeXT computer, which is scheduled to be available during the second quarter of this year. Brooks said IBM is "bound by the schedule that NeXT has." IBM will have to wait until early or mid-1989 for a bug-free version of NeXTStep.

Regarding the Open Software Foundation consortium of Unix vendors, which includes IBM and is working on a new interface for Unix, Brooks said that IBM "does not have a product to present to OSF at this time." Steve Jobs said that NeXT has not offered any products to OSF, either. So far, NeXTStep will be limited to the NeXT computer and IBM's AIX platforms. After paying a reported $10 million for the license with NeXT, IBM may not be too anxious to share this interface with other companies, and NeXT might feel the same way.

NeXT has a lot to gain from IBM's acceptance of NeXTStep. NeXT knows that the key to its success is widespread support from innovative applications developers. With IBM providing another major market for NeXTStep software applications, NeXT could attract developers who otherwise might have been hesitant to commit themselves to NeXTStep.

With DVI Technology, Intel Could Be Key to PC Video

Intel (Santa Clara, CA) has joined the race to commercialize interactive digital video. The company's surprising purchase of Digital Video Interactive technology from GE/RCA gives it the chance to establish a technical standard for microcomputer-based digital video, much as it has done with microprocessors. Developed by RCA, DVI consists of hardware and software that enables microcomputers to play long videos stored on conventional digital compact disks.

DVI uses a proprietary data-compression algorithm to squeeze up to an hour of full-screen, digitized video onto a standard CD-ROM disk. Without compaction, only 30 seconds of normal video could be stored on a disk, yet the quality of DVI images is not significantly different from those generated by a VCR. Half-screen or smaller images can run for more than 2 hours, and moving pictures can be combined with computer text and graphics, high-resolution still photographs, and stereo audio. The digitized video is played back through an IBM PC AT or equivalent configured with a high-resolution monitor and three plug-in boards to be supplied by Intel.

First demonstrated in March 1987, DVI is now in beta test at more than 20 sites. Intel plans a commercial release of the system in the second quarter of this year to software developers and OEMs. The company said it intends to improve the quality and performance of DVI over the next 2 years and reduce its cost through miniaturization and volume production. By 1990, Intel aims to package DVI in a set of chips.

Beta-site applications will include interactive education and training, simulation, and entertainment.

Japanese Giants Offer New Unix Systems

Unix workstations have been the province of American computer makers, and they got a glamour boost last year when Steve Jobs rolled out the NeXT cube, but Japanese companies aren't neglecting this growing market. Two industrial giants are showing a considerable interest.

Sony last year began offering its NeWS Unix systems in the U.S. and now will ship them with an erasable optical disk drive (594 megabytes) as a $4650 option. The newest models are built around Motorola 25-MHz 68030s and come with as much as 16 megabytes of main memory, room for three 286-megabyte hard disk drives, a 125-megabyte tape drive, and a 64K-byte memory cache. The prices for the NeWS series range from $3995 (diskless) to $54,900.

Matsushita Electric Industrial has developed four new Unix workstations it plans to start marketing this spring. The four new BE series models are a diskless machine with an Ethernet interface; a desktop machine that can be used as an MS-DOS computer; a desktop publishing system, equipped with a 1312- by 1312-pixel display; and a deskside machine that can hold up to 1.5 gigabytes of hard disk storage internally. All four new models use 80386 CPUs and have 32K-byte memory caches. They will run Unix System V release 3.2, including X Windows and Sun's NFS. Up to four 80386s can be installed in a single machine.

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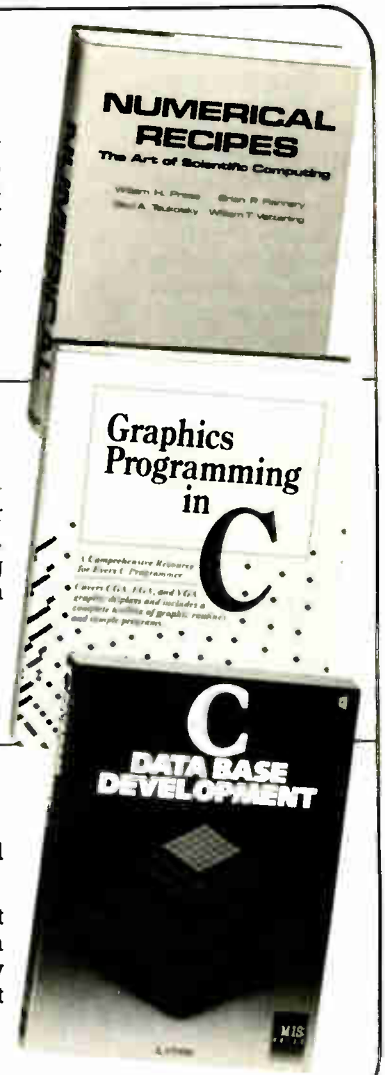

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Byte 1/89

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new device driver card will enable the systems to run MS-DOS software. Drexler has been one of the pioneering forces behind these optical memory cards.

• NorthBank Corp. recently issued a statement saying it will offer a $1000 reward to "the first person to write a program that will modify, erase, or otherwise write to a hard disk partition protected by the Guard Card. The program may be in the form of a virus, Trojan [Horse], or any other executable program." If you're feeling contagious, contact Richard Bronson at NorthBank, 10811 North Bank Dr.,

continued

A-T Won't Put dB into PD

Ashton-Tate (Torrance, CA) has no intention of putting its dBASE language into the public domain as a standard computer language, company chairman Ed Esber told a group of users recently. "Beware of Greeks bearing standards," Esber told the Boston Computer Society IBM group at one of its meetings.

"If you're talking about putting dBASE into the realm of an ANSI standard, I'm not ready to do that yet," Esber said. "If you're suggesting that I do that, it's an issue that I've thought a lot about. . . but I'm not willing to put the dBASE language into the public domain."

On the much-publicized late shipment of the dBASE IV package, which finally came out in late October, Esber said, "We know we screwed up."

"If you have some input to make on our products, and the first level or two you try don't work, don't assume that I don't want to hear it," Esber said. "Write to me. You'd be surprised what can happen if I get a letter, draw an arrow to so-and-so, and add a note that says 'Please make this happen.'"

Newspaper Designers Putting Desktop Systems to the Test

Although newspapers still use a delivery system that often depends on school-age children as the last link between producer and customer, they are in many ways technological leaders in production. At a recent meeting of the Society of Newspaper Design (SND), attended by page designers from around the world, 90 percent of the members said they use personal computers in their newsrooms, and 92 percent of those computers are Macintoshes. Those Macs are often used to create graphics relating to local news stories. Several companies now provide a national service of daily graphics

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Circle 259 on Reader Service Card

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Richmond, VA 23233, (804) 741-7591.

• Now that the grease has settled from the election of 1988, let's look back at a truly interesting race. **Eastgate Systems** (134 Main St., Watertown, MA 02172, (617) 924-9044) has a new **hypertext package** for the Macintosh that explores and simulates the **1912 presidential election**. Remember that one? Rough-and-ready upstart Theodore Roosevelt went up against Taft and Wilson. Eastgate describes this $45 program, appropriately called The Election of 1912, as a hypertext book and says it doesn't have even one "next page" button.

that subscribing newspapers receive either by telephone lines and modems or by direct satellite link.

These graphics directors have become more demanding of software and hardware vendors for the tools of their trade, but they have found that they can create good-looking print publications with personal computers and off-the-shelf parts. Karl Gude of the Associated Press, for example, uses MacDraw II despite what he says are several drawbacks. What he doesn't like is that text presentation isn't what newspaper graphics designers demand; kerning capabilities are not satisfactory; the ability to have a continuous-tone screen is lacking; and when doing color separations, text cannot be overprinted.

Bill Campbell, president of Claris (Mountain View, CA), said feedback from AP members is affecting version 1.04. "You are the pushers of the limits of technology," he told the SND.

Fred Ebrahimi of Quark (Denver), whose Quark XPress has proved of particular interest to the newspaper market, agreed that users such as the SND members can play an important role in the growth of his product.

Quark XPress 2.0 was used to produce the 24-page color newspaper done during the meeting. About half of the full-page output was produced on a Varityper 600-dot-per-inch laser printer, and the rest was done on a Linotronic 500 with 1250 dpi. Several designers said they could not tell which pages were produced on which device in the final product. "It shows that both of these machines are good enough for production on newsprint, although I am not sure I would want to produce halftones and screens at 600 dpi for a newspaper," explained one of the designers.

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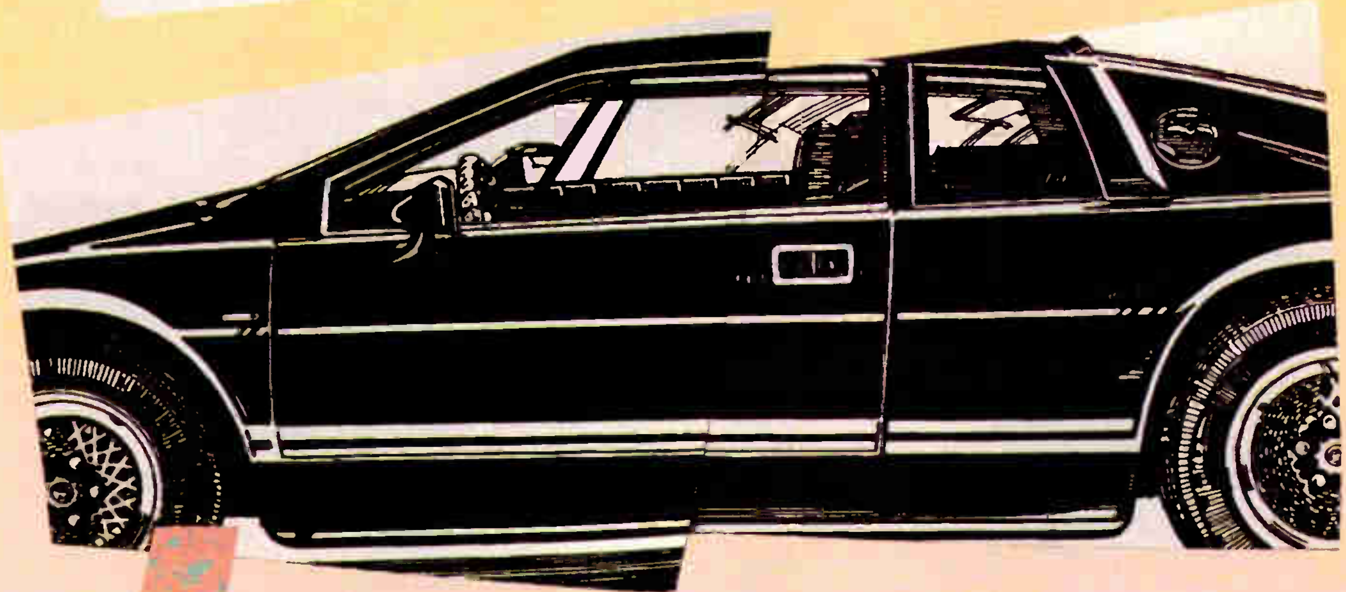
These unretouched print samples show the superior print quality of QMS-PS 810 over printers using first-generation print engines.



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LETTERS

Power Reading

Congratulations on "PC Power, Part 1: Power Protection" by Mark Waller (October 1988), a much-needed article. There is altogether too much misinformation being cast about by those who pretend to know. Specifications that may sound impressive in a peddling contest often have little to do with the real issues. The problem is compounded by oft-quoted mavens and other self-proclaimed pundits who still speak from the "landmark" studies of the 1970s that have long since been determined to be invalid.

Mr. Waller described many of the shortcomings of surge suppressors and ferroresonant transformers with respect to the needs of modern electronic loads. All I want to add to his comments is that not only are these approaches less good than alternatives, they are actually harmful when misapplied. This point could have been made stronger. All in all, though, Waller's article should go a long way toward broadening the respect for the subject.

Having said all that, one technical point should be clarified. On page 280, Waller says, ". . . a couple of capacitors and a MOV across the secondary. . . ." In actuality, the clamping circuit (MOV or otherwise) belongs on the primary side of the transformer.

AC power is a very complex phenomenon. But, like music, it has been made so readily available that nearly everyone takes it for granted.

David Fencl
Libertyville, IL

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the page and include your name and address. We can print listings and tables along with a letter if they are short and legible. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

Because of space limitations, we reserve the right to edit letters. Generally, it takes four months from the time we receive a letter until we publish it.

Cleaning Up Piracy in Hong Kong

The note in Nanobytes (October 1988) that software piracy in Hong Kong is getting worse is out of date. From late July to mid-August, the Hong Kong police and courts shut down all pirated-software shops and publishers in the colony. These raids were far larger and more widespread than previous halfhearted attempts, and the results have been criminal convictions, not just seizures of a few dollars' worth of disks.

No doubt some form of software piracy by private individuals will continue to exist, just as it does in the U.S. and elsewhere, but the software piracy industry is broken. There will never again be mass marketing of low-cost copies of famous packages or stores openly selling racks full of counterfeit manuals. I have been in the Hong Kong/Macao computer industry for several years, and I am certain that the changes are dramatic and permanent.

Keith Gross
Exton, PA

October Inventory

I'm not normally given to spending time writing letters to magazines, but I thought I had to offer high praise for the October 1988 issue. Here's why:

The article entitled "80386s for the Masses" by Steve Apiki and Stanford Diehl gives me a good benchmark for judging such systems, as I am considering the investment myself. As usual, your comparison covered all the major points well.

I am a heavy Borland product user. I'm not attached to Borland in any fashion, but I usually wind up buying Borland products because of the company's combination of features, price, and the excellent customer support available through the company's upgrades and technical-support staff. So I found "Borland Beefs Up Its Languages" by Rick Grehan and Tom Thompson, on the new Borland Pascal/C/Assembler packages, of interest, and I was gratified to read of the recommendation.

continued

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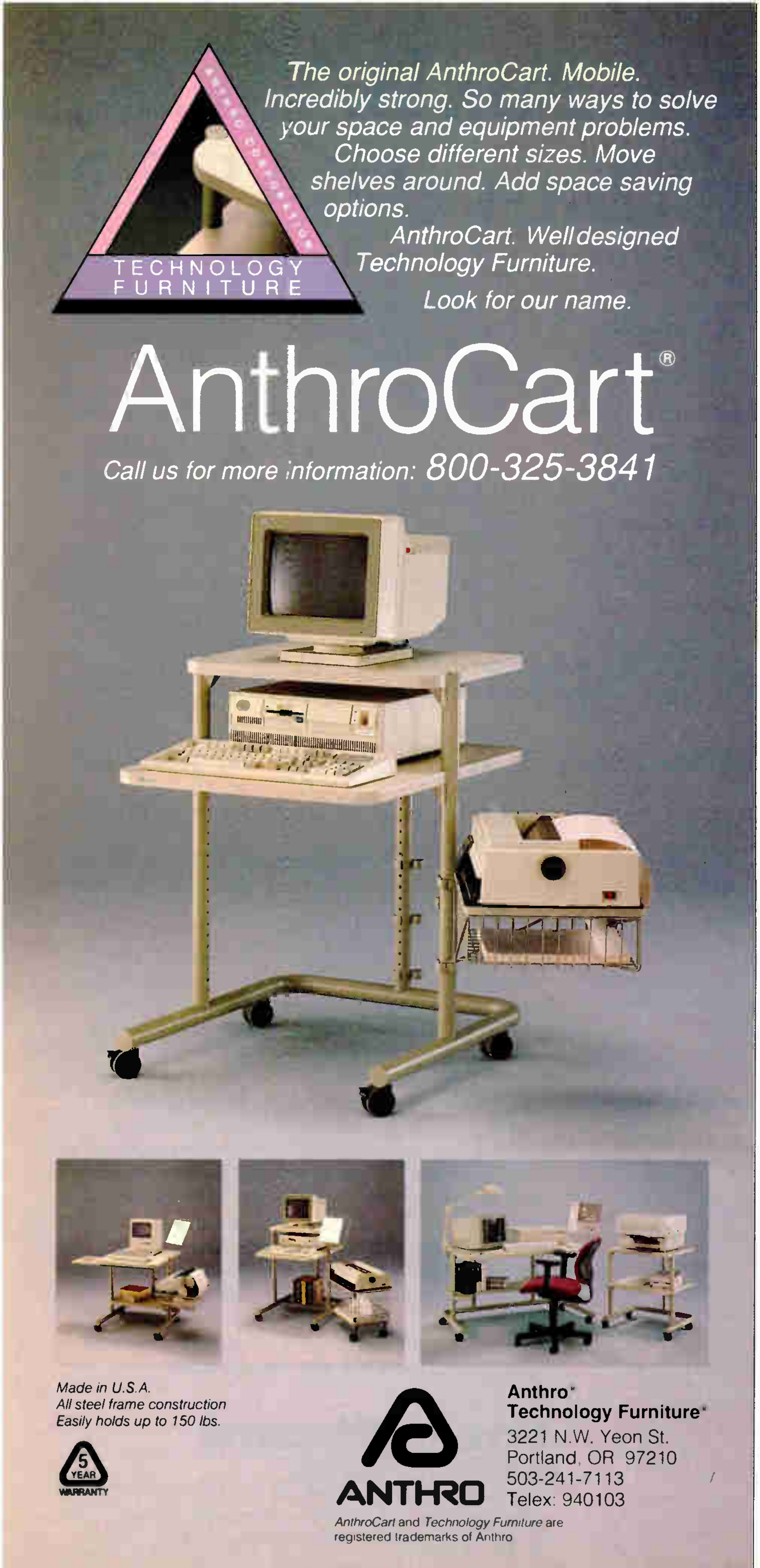

I am also impressed by the exhaustive reviewing of Sprint in no less than three articles, giving it the broadest possible treatment. Coincidentally, I bought Sprint the day before my magazine arrived and used it for the first time that day. So I think my own impressions are not influenced by the articles. Nevertheless, the articles echo many of my own sentiments.

The In Depth articles on hypertext were both informative and appreciated. Thanks for defining things for me.

Finally, I thought "PC Power, Part 1: Power Protection" by Mark Waller was very useful. Everybody I know uses a surge protector, but not a one can explain what it does, and the article was on exactly the right technical level to clarify matters. Instruction like this is easily worth the price of a subscription.

Paul E. Tichy Jr.
Houston, TX

Hypertext Update

Your In Depth section on hypertext (October 1988) was a valuable contribution to this emerging technology. As an update to your "Hyper Activity" resource guide, I would like to inform you that Hyperties, listed as an R&D project of the University of Maryland, is available from Cognetics Corp. (55 Princeton-Hightstown Rd., Princeton Junction, NJ 08550, (609) 799-5005). It costs $249.

Hyperties runs on the IBM PC. It uses the metaphor of an interactive encyclopedia, or "hyperbook." The nodes consist of articles (text, graphics, and videodisk) linked together. Retrieval is by browsing, an alphabetical index, a topical table of contents, or string search on article content. Path history and article printing are provided. You construct databases with the Author Tool and read them with the Browser.

Hyperties continues to be an active research project of the Human-Computer Interaction Laboratory at the University of Maryland.

Charles B. Kreitzberg, Ph.D.
President, Cognetics Corp.
Princeton Junction, NJ

Missing Points

It is not easy to find in your magazine an article that is not well written, informed, and correct. If I have any criticisms, it is invariably because a specialist tends to look at particular aspects of a problem or product only. omitting, without saying so, other important aspects and sometimes drawing conclusions not warranted by his or her necessarily limited scope.

continued

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EVEREX STEP

Take, for instance, the article entitled "The BASIC Revival" by Namir Clement Shammas (September 1988), which compares Turbo BASIC and QuickBASIC 4.0 on the one hand to Pascal and C on the other. I am professionally familiar with three of these, and I find the article correct in every detail, yet it's missing some very important points.

At least as important as all the points mentioned taken together is the advent of the "Integrated Programming Environment" in QuickBASIC: the immediate syntax checking, the very fast compilation, and the possibility to watch and modify variables during debugging and to even edit a program while it is running. Sure, the CodeView debugger is nice, but the QuickBASIC 4.0 environment is even better. In my experience, programming takes only a little bit of actual programming—the rest is debugging. That's why these developments are so very important to the practical programmer.

BASIC has now caught up with Pascal in that it can be linked to other languages. The BASIC interlanguage calls are even more powerful than Pascal's. The CodeView debugger now handles mixed-language programs, including BASIC modules.

Analogous to, for instance, C, the new BASICs introduced structures (called subprograms and functions in QuickBASIC) that allow you to add homemade functions to the language. These functions are subsequently used in exactly the same way as if they were part of the BASIC programming language. This opened the way to the commercial offering of ready-made libraries, more often called toolboxes. They give you windowing, fast communications, and so on—just like a real programming language.

Moreover, language extensions for BASIC are now available that give the programmer database structures (e.g., dBASE, dbVista, and B-tree) that are readily available in a few commands and very adaptable to boot.

Of course, there's nothing new here for C programmers—it just means that, one by one, the disadvantages of BASIC disappear, while the advantages stay with us. Incidentally, I sometimes hear BASIC being criticized because it can handle only a limited amount of data. This may indeed be a handicap for some applications, but on the whole this point seems to me rather academic. How many professional programmers nowadays would practically consider building a structure that handles large amounts of data, from scratch?

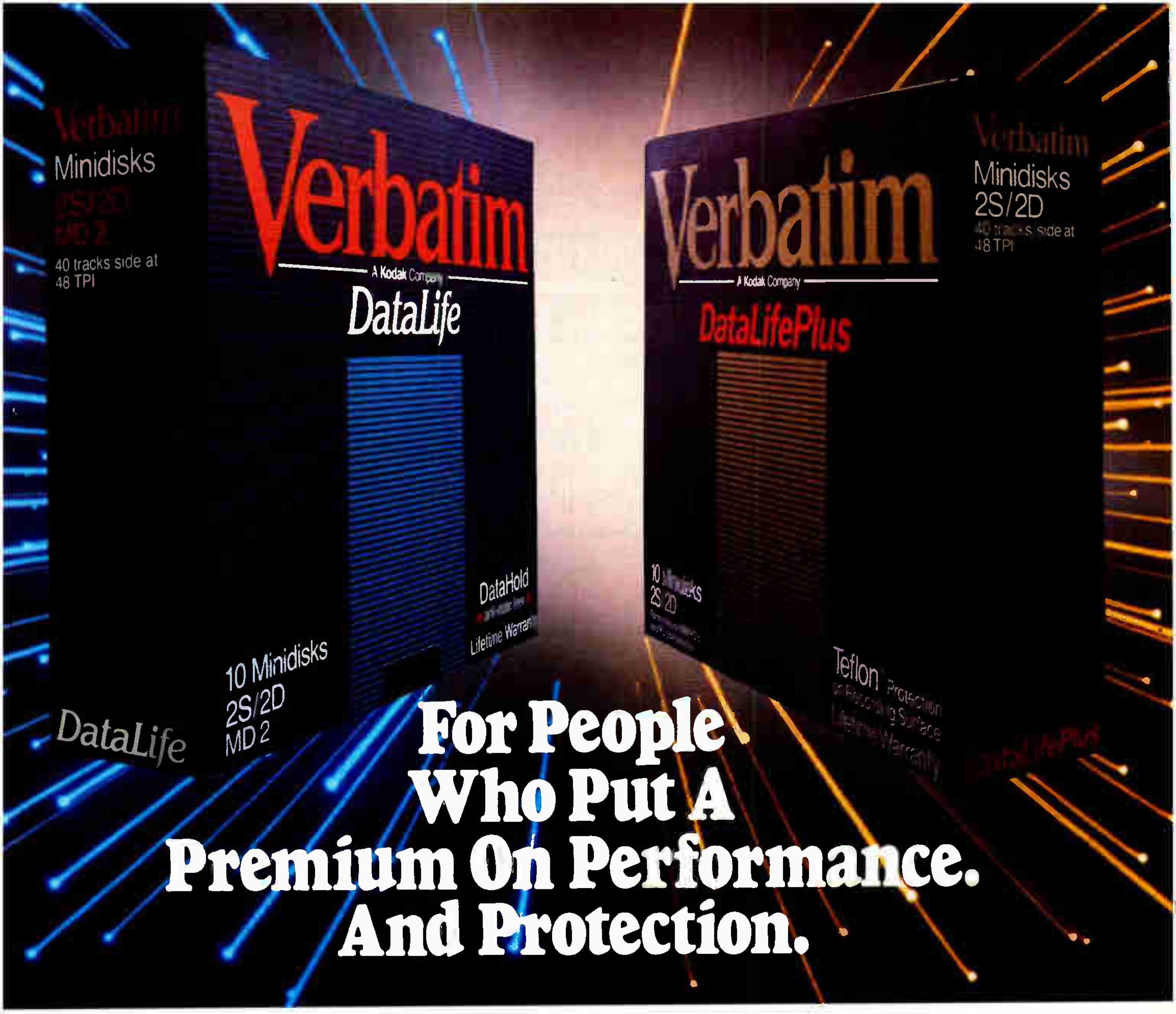
Of course I use toolboxes and language extensions where available. It's only the few people developing these tools who have to worry about this shortcoming of BASIC—but they don't write in BASIC, anyway.

If it's all so wonderful, why don't I write commercial programs in QuickBASIC 4.0? Good question. Here are some reasons:

1. A QuickBASIC program cannot be larger than 256K bytes, a limitation discussed nowhere in the manual but mentioned on the back of the packing. And 256K bytes is not enough. Were it 640K bytes, it still would not be enough. Since the beginning of computer times, this dilemma has been resolved by means of overlays—the technique of keeping the most often used functions in memory and reserving space to load less often used functions from disk as needed.

QuickBASIC 3.0 was capable of using

continued



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overlays, albeit in a nonstandard way. This idiosyncrasy has disappeared in version 4.0. But do you think Microsoft gave us the standard way of making overlays in return? Not at all. Version 4.0 cannot use overlays (nor can Bascom 6.0, for that matter). Worse, if the linker finds one BASIC module in the row, it refuses to make correct overlays even when these have nothing to do with the BASIC module—and it doesn't even give you an error message. This limitation is not mentioned in the documentation.

Exit QuickBASIC 4.0 for two-thirds of professional programming. BASIC users, unite! Let's all write a letter to Microsoft about this, and let's do it now!

2. BASIC is not portable to, say, Xenix. Why not? Because it is not a professional programming language. At least that's what I suspect, since I cannot find any technical reason for this.

3. Intel's way of addressing—and, consequently, memory models—are the bitter fruit of the need for compatibility, way back when it all started. Yet we in microcomputerworld are stuck with them and will be for some time to come. BASIC knows only one memory model (medium). For many applications, that's no problem: We just buy a database toolkit or language extension. But sometimes it just isn't enough.

Sorry, I'll have to stick to C for the time being. But, OK, let's drop Pascal—it has more than served its function.

Hans Mabelis
Amsterdam, The Netherlands

Getting Real

In the September 1988 issue, Daniel J. Bernstein states in his letter ("Recursion vs. Iteration") that "any recursive routine can be written iteratively."

This statement is highly misleading. It is true that it follows from a theorem of Kleene that every computable function can be programmed using a single WHILE loop, together with some more elementary aids, such as substitutions, but there is no known practical way of doing this in general. The method used for proving this theorem is unbelievably inefficient and totally impractical. Let Mr. Bernstein write an iterative program for the well-known Ackerman function! This has, in fact, been done, and the solution was sufficiently interesting to have been published.

There is, of course, another way to avoid recursive function calls, and that is by mimicking this whole apparatus, using stacks, but this cannot be regarded as an iterative solution.

In practice, therefore, the ability to call functions recursively is one of the most essential and powerful methods available to the programmer.

Ivan Danicic
London, U.K.

Old Hoc

Jud McCranie (Letters, October 1988) suggested that the acronym spool (standing for "simultaneous peripheral operation on-line") was a recent ad hoc creation. Since I remember this acronym being in use when IBM introduced the original System 360, I decided to check my now-ancient manuals.

It seems the acronym was first used by IBM for its 7070 computer, the predecessor of the more famous 7090/7094 machines. The date was 1962 or 1963. So, for the record, the term is certainly not recent, though it may well be ad hoc.

Robert L. Milton
Agoura Hills, CA ■


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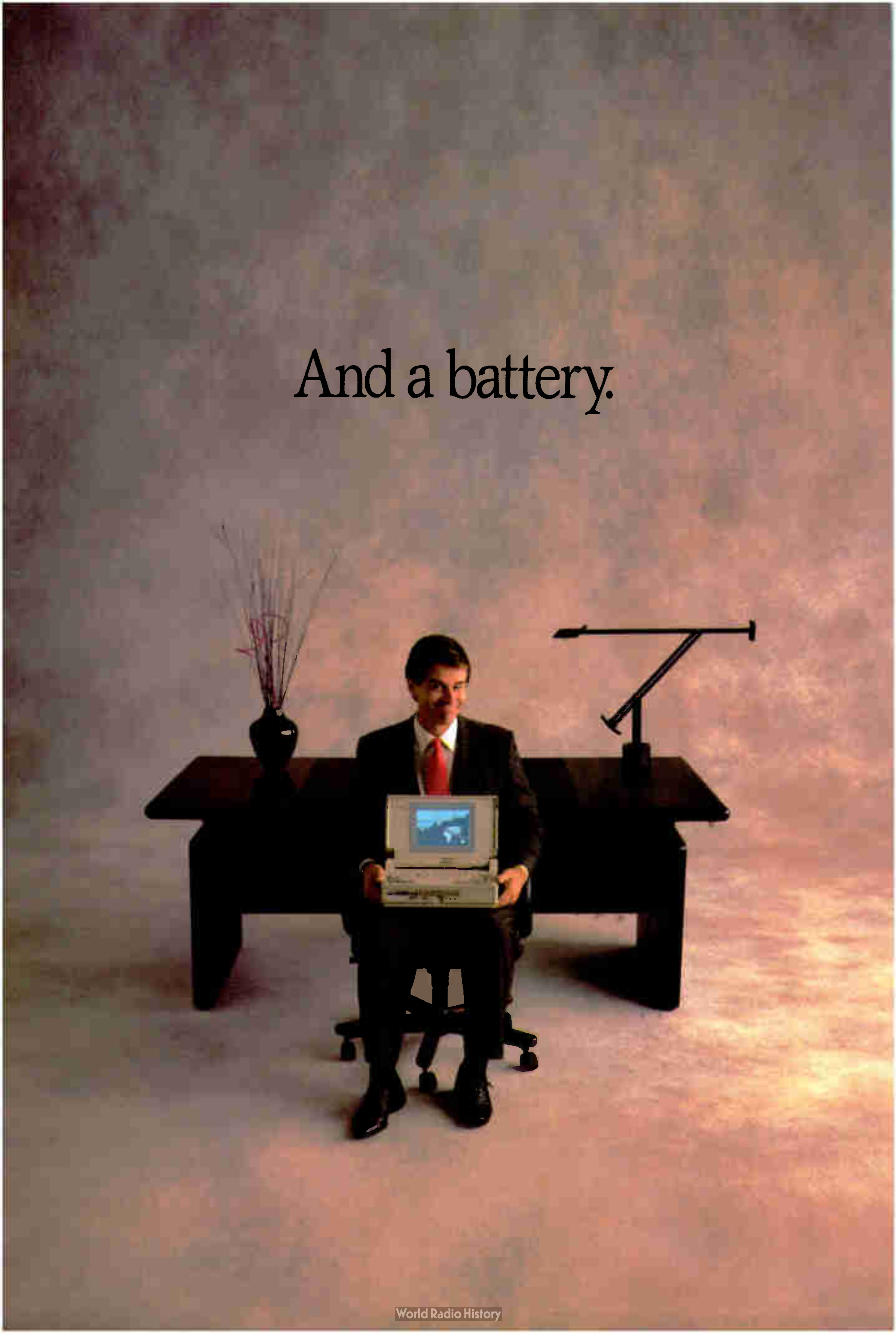
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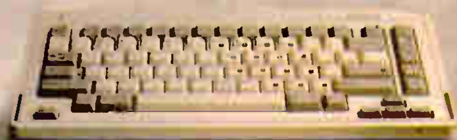

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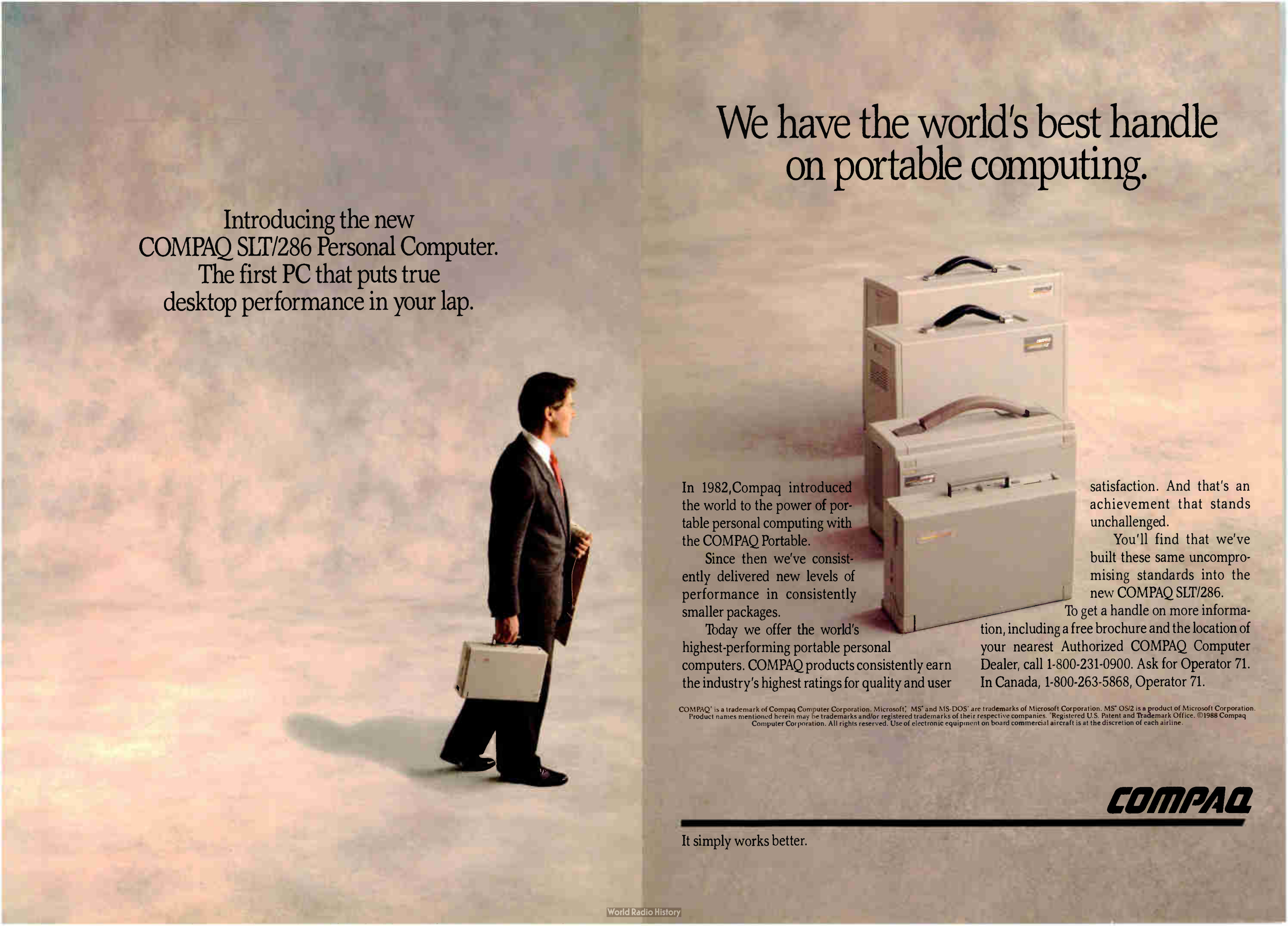
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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

The Care and Feeding of Dinosaurs

Dear Jerry,

I couldn't help but chuckle when I read the letter from John Boddie (June 1988). As a dinosaur keeper myself (a "thecodont" system 36 rather than a "sauropod" mainframe), I will agree that many corporate MIS departments are ponderous. I am amused, though, at all the squealing little proto-rats from sales, accounting, and everywhere else who think they can do a better job.

I've dined many times on these mammals that have spent weeks "developing applications" in Lotus 1-2-3 that still have a few bugs in them when the president wants the information, so they rush to the MIS department and I write a quick RPG (excuse my language) program and get the answer in 2 minutes.

I'm not completely heartless, though. Many times I've lent my shoulder to a whimpering mammal that didn't want to be locked into a daily routine like backing up his spreadsheets until after they were accidentally deleted. And then there's always the problem of negotiating the "cretaceous swamp" of information. Little mammals tend to squeal when their data doesn't match the data in the dinosaur—usually because they "don't have time" to follow standard procedure and verify what they've punched.

In short, mammals are cute and they make nice pets. I think every sales department should have one out in West Fencepost. But when it comes down to devouring the volume of information that most companies generate on a daily basis, give me a good old tyrannosaurus any day. Perhaps this sounds a little cold-blooded, but when it comes down to it, "survival of the fittest" is the order of the day, and barring an asteroid striking the earth, I doubt that dinosaurs will become extinct again soon. But keep the mammals coming: They make great meals for newly hatched dinosaurs.

Don Varney
New Bedford, MA

Well, I'm glad things work out well in your shop. Some of us have had different experiences; as you say, survival of the fittest will determine who's right.

I'm sure there are lots of good reasons to keep dinosaurs. I'm also certain there are lots of people who can't afford to feed *a tyrannosaurus.* —Jerry

Beware of Cheap Clones

Dear Jerry,

Since you get lots of high-quality hardware direct from high-end vendors, you probably don't realize how bad the cheapest stuff being sold is nowadays. I didn't, either. I bought my Taiwan special IBM PC XT clone a few years ago, use it a lot, and haven't had any problems beyond what I consider to be normal wear and tear. It even came with documentation that included schematics that weren't too wrong for most of the components.

However, we bought some clone kits for work recently. Wow! Two out of five motherboards failed. One video card literally exploded (it wasn't dangerous, but it was showy). Three keyboards failed within 2 months. It took six hard disk drives to come up with three that worked reliably. One monitor was too jittery to work with. We even got one case with the card slot bracket mounted at enough of an angle that the cards don't sit securely in the left-hand slots.

The only things we haven't had trouble with are the power supplies and the floppy disk drives. I won't even talk about the quality of the documentation, and lots of parts didn't come with any documentation at all. Clearly, some of the cost reduction in hardware lately has come at the cost of product quality.

To their credit, the dealers involved have been very responsive. We finally got everything working. But it took time

continued

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

and a fair number of trips to the shops to do it.

Until this experience, I would have told anybody looking for low-end equipment to buy from the cheapest supplier. Now I'm not so sure. I guess my advice would be, "buy cheap, but remember that it may not work." All other things being equal, you may be better off buying from a supplier 3 blocks away than from one 15 miles away who is $20 cheaper and buying from just one supplier at a time.

Donald Kenney
San Diego, CA

I have noticed the problem, and one day I ought to do a larger treatment of the subject. There was a time when all clones were nearly equal, and all pretty good. No longer.

Pournelle's Rule still applies: "If you don't know what you're doing, deal only with people who do."—Jerry

Don't Trash That Software!

Dear Jerry,

I read with great dismay that you have so much software that you're forced to throw away a great deal of it unopened. This is indeed a terrible situation. I'd like to suggest that instead of throwing away this valuable resource, you send it to some poor computer user. I think I qualify for such a donation, since I have a Corona IBM PC-compatible but only four pieces of software—one is a utility, two are languages that I need for school, and the last is Electric Desk, an integrated word processor. Unfortunately, I don't have the resources to purchase any more software. If you decide to make any donations, I'll be happy to pay for the shipping and handling.

I'm writing this letter somewhat tongue-in-cheek. While I would appreciate any software you could spare, you might suggest in your column that any institution or large user group donate its older software to organizations trying to spread computer literacy. As our knowledge base grows, those outside the mainstream of education will fall further and further behind until a new class emerges, the functionally computer illiterate.

Imagine how much good all those old Osbornes, Kaypros, and Tandys could do in inner-city or nonaffluent areas, both in and outside the U.S. In teaching the people of undeveloped nations to use microcomputers for such basic needs as civic and resource planning, health care, education, government and police record keeping, and even cultural preservation, we would be providing a program that could far exceed the limited success of programs like the Peace Corps.

James Carroll
North Lauderdale, FL

Yours is one of many letters suggesting that I donate unwanted software to clubs, educational institutions, or other worthy causes.

I completely agree—that would be a good idea, and I'd really like to do it. Alas, I don't own the software sent to me for review, and unless it's accompanied by a letter specifically authorizing me to donate it to a good cause—or unless, like Borland, the publisher has given me blanket permission to do so—I have no ethical alternative to destroying it.

I do like your notion that user groups and other publishers help expand the computer literacy base.—Jerry

Manipulating Turbo C

Dear Jerry,

After I finished reading Walter K. MacAdam's letter (June 1988), I couldn't help but reply. Screen manipulation is indeed possible in Turbo C, though it's a bit esoteric.

I have no intention of coming to Turbo C's defense. In fact, I prefer QuickC to it—primarily for the larger number of run-time routines QuickC comes with. However, there is a simple way of getting around some of Turbo C's shortcomings in this area without resorting to assembly language. I find it ludicrous that, rather than pointing these methods out to Mr. MacAdam, Borland suggested he buy such routines from another dealer.

Turbo C has several routines that let the user generate ROM BIOS interrupts. Int86, the least complex, can be used for scrolling, clearing the screen, and getting and setting the cursor position, among other things.

Int86 utilizes three parameters, commonly denoted INTNUM, INREGS, and OUTREGS. INTNUM is the number of the interrupt to be used. INREGS and OUTREGS are unions of type REGS, defined in the DOS.H include file, which describes the system registers.

When a call to INTDOS is made, an interrupt 0x21 is generated; the contents of INREGS are copied to the registers; the value of INTNUM invokes the interrupt; the function, defined in INREGS.H.AL, is executed; and the (new) register values are copied to OUTREGS. This entire, mind-boggling process is described in detail in the *Turbo C Reference Guide* on page 131.

The only catch is that you must know what to put in which registers before you call Int86. (The Turbo C books assume the user already has knowledge of the subject. Not for beginners, eh?) However, a partial list can be found in the wonderful book *C: The Complete Reference* by Herbert Schildt (Osborne-McGraw-Hill, 1987).

A clear-screen interrupt is generated by doing the following:

```
INREGS.H.AH = 6;
    /*screen scrolling function*/
INREGS.H.AL = 0;
    /*number of lines to scroll;'0'
clears screen*/
INREGS.H.CH = 0;
    /*row starting position*/
INREGS.H.CL = 0;
    /*column starting position*/
INREGS.H.DH = 24;
    /*row ending position*/
INREGS.H.DL = 79;
    /*column ending position*/
INREGS.H.BH = 7;
    /*blank line's color*/
INT86 (0x10, &INREGS, &OUTREGS);
```

Determining the cursor position is even simpler. Generate the cursor location interrupt, and the *x* value (row) comes back in OUTREGS.H.DH, while the *y* value (column) is in OUTREGS.H.DL. Here's an example:

```
INREGS.H.AH = 3;
    /*cursor location function*/
INREGS.H.BH = 0;
    /*video page*/
INT86 (0x10, &INREGS, &OUTREGS);
PRINTF ("Cursor was just at %d, %d\n",
    OUTREGS.H.DH, OUTREGS.H.DL);
```

As for setting the cursor location, that's a given; it's illustrated in the Int86 example in the *Turbo C Reference Guide* on page 132.

Granted, Turbo C doesn't exactly roll over, play dead, and fetch the newspaper in the morning. But screen manipulation is available, and even easy to use, once you've done it a few times. By making a procedure out of such processes, as well as other useful screen functions executed similarly, you could make a custom user library. This would obviate the need for purchasing a separate C library, as Borland suggested.

S. Y. Walters
Tempe, AZ

Thank you. I'm no expert on any kind of C, so I have to depend on reports from readers.—Jerry ■

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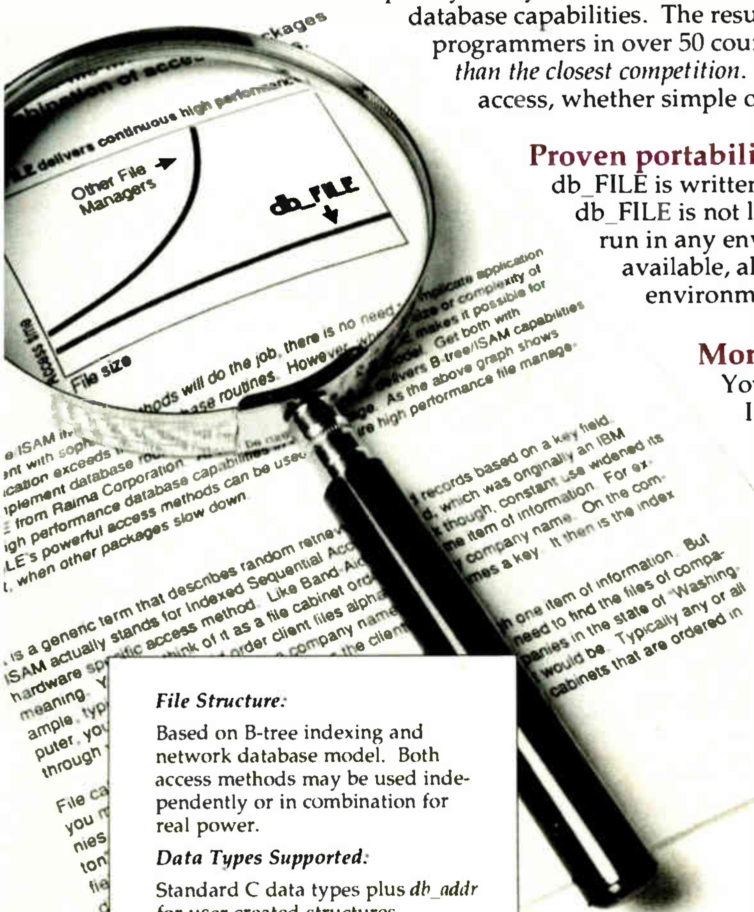

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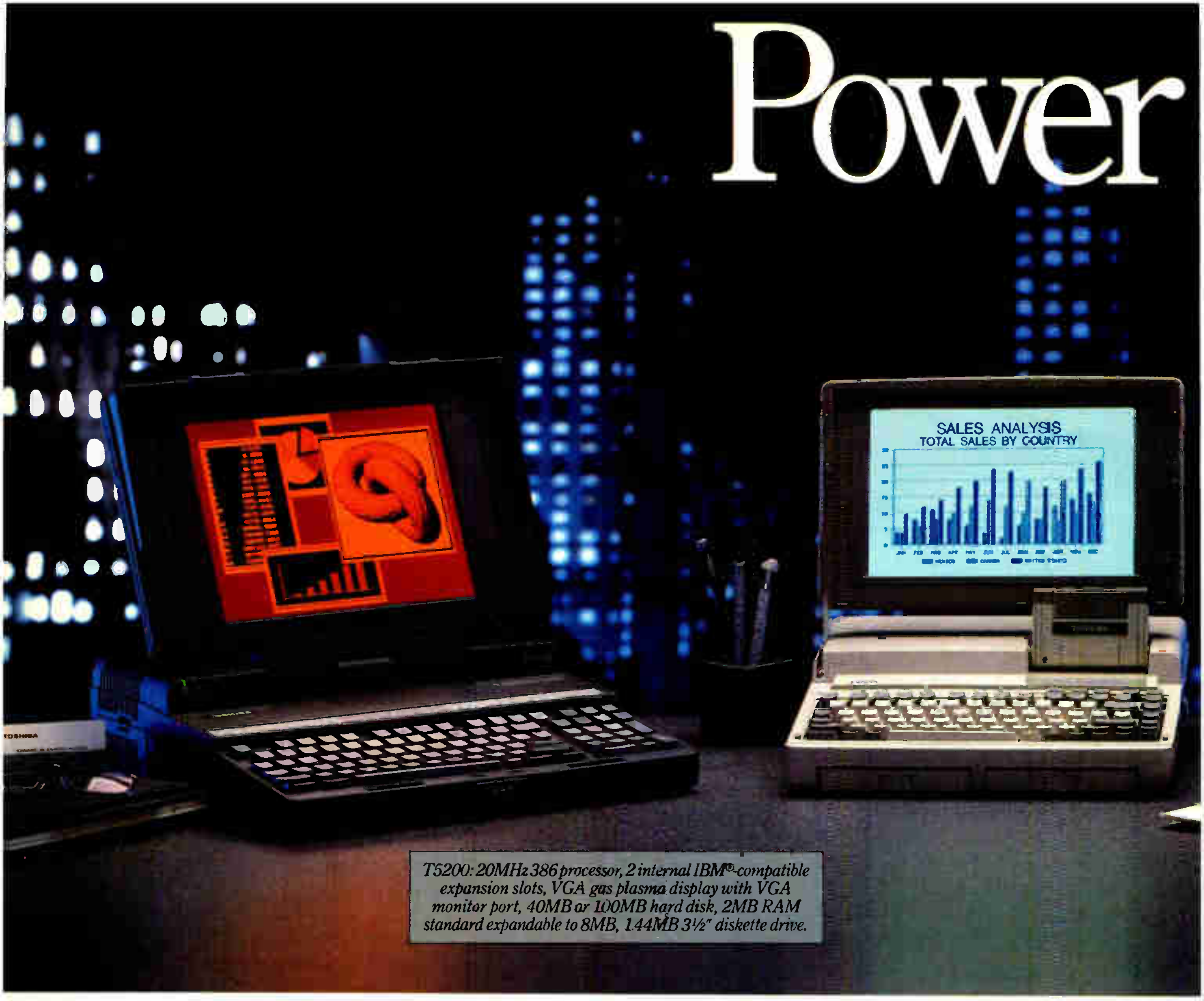

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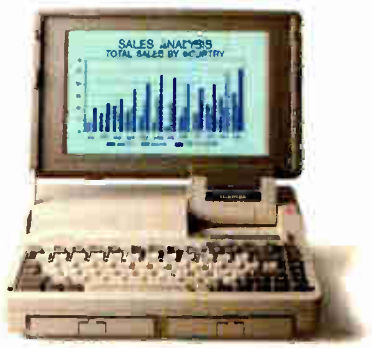

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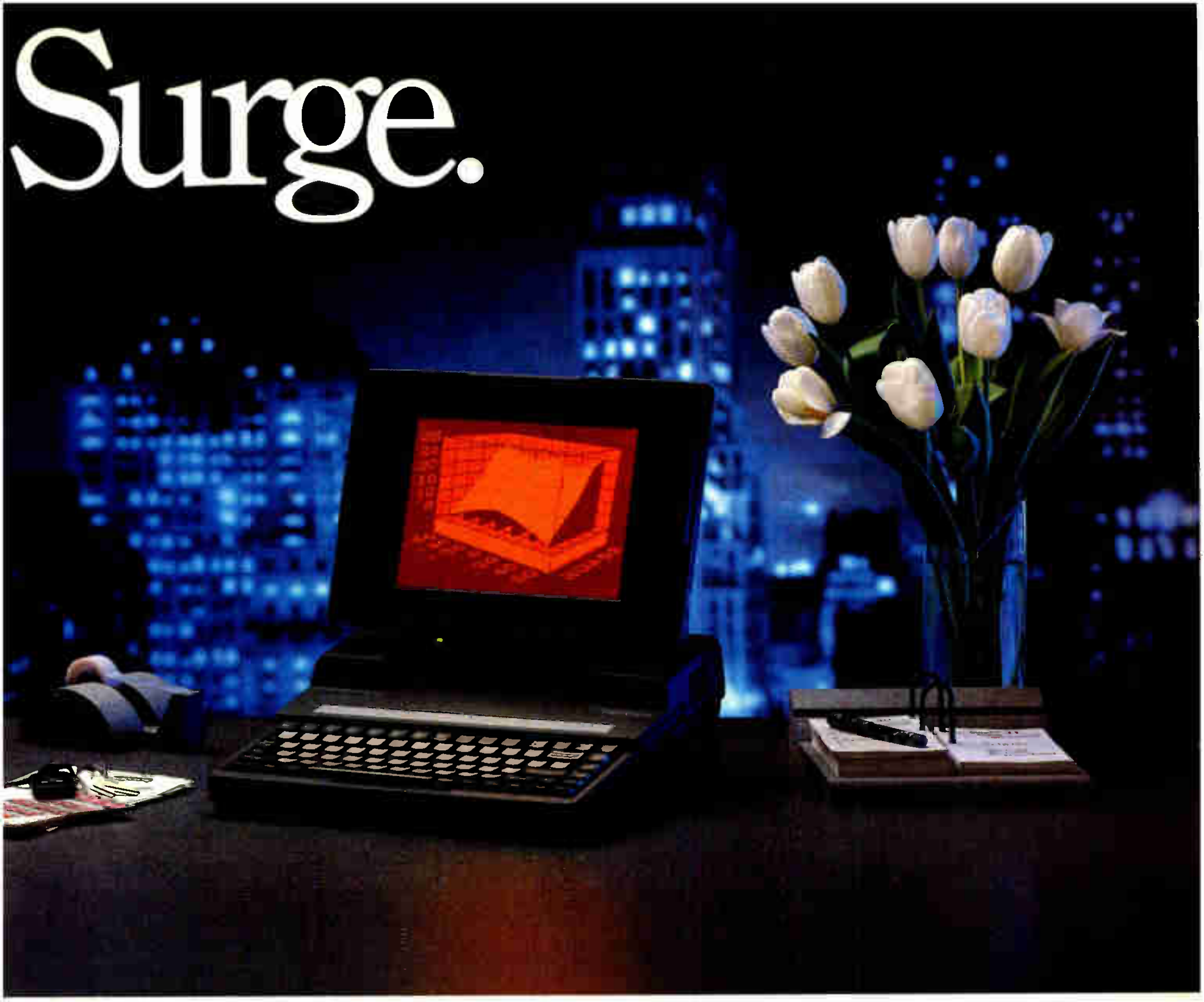

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ASK BYTE

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Turning Apples to Oranges

I have a Compaq Deskpro 286 in my office for business.

My son, who is 8 years old, is learning about Apple computers at school. Rather than buy two computers, I would like to know what hardware and software are required to make the Compaq Deskpro or IBM PC AT series act like and look like the Apple computers.

Lee Rose
Deerfield, IL

I assume that by "Apple computers" you mean the Apple II series of computers, which have become popular in the classroom. Though I can understand your desire to make your work machine compatible with your child's school machine, such an effort borders on the impossible. Even if you are successful, you might not be acting in your son's best interest.

First, not only are the CPUs different in both machines, the disk formats are also incompatible, as are the video systems and operating-system software. That just about covers it, doesn't it? The best you could do would be to locate one of the peripheral boards that allow a PC to interface to an Apple disk drive, but all that buys you is the ability to transfer data files from one system to another.

Also, it probably wouldn't be a good idea to keep your son tied to the Apple II. Not that I'm passing judgment on that machine, but the situation in the real world today doesn't point to the Apple II as being a major player. Realistically, your son would probably benefit from exposure to the AT computer.

With luck, your son's computer class will focus on languages that are more or less common across all computers. Even if the language of choice is Applesoft BASIC, your son will pick up enough fundamentals to allow him to operate PC BASIC with ease.—R. G.

The Hacker's Mac

A couple of years ago, I heard about Lee Felsenstein's "Hacker's Mac" project, a proposal for the development of an open, Macintosh-like homebrew system for the hobbyist. I contacted him at Golemics and received a preliminary specification in the mail. I have been unable to contact him again or learn any more about the project. Do you know if this project is ongoing and, if so, how I can get current information?

David Lanznar
Boston, MA

You might check out Max Stax's recent columns in Computer Shopper *magazine (beginning in August 1988). His "Hackintosh" may be the answer to your prayers.—R. G.*

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Do Get Me Started

Do you have any suggestions for someone who wants to get started designing circuits or putting together a portable IBM PC from parts? Where could I order parts that are found in a Toshiba or Zenith laptop (e.g., a screen, a power supply, a 3½-inch hard disk drive, and a 3½-inch floppy disk drive)?

Walter George
San Francisco, CA

For getting started in digital circuit design, I've always liked Don Lancaster's Cookbook series (this includes The CMOS Cookbook *and* The TTL Cookbook, *both published by Howard W. Sams, Indianapolis, IN), as well as the BugBook series from Blacksburg books. Though they may be difficult to find, a search through a used technical bookstore would be worth it if you turned them up.*

If you want to put together your own personal computer from parts, you should try one of the many computer flea markets that take place monthly around the country. Computer Shopper *magazine publishes a schedule of these swap meets in its "Coming Events" section. You should also pick up a copy of one of the following books:*

How to Build Your Own IBM PC-Compatible Computer *(Comprehensive Guides, 7507 Oakdale Ave., Canoga Park, CA 91306, 1987)*

Build Your Own IBM Compatible and Save a Bundle *by Aubrey Pilgrim (Tab Books, Blue Ridge Summit, PA 17214, 1987)*

Build Your Own 80286 IBM Compatible and Save a Bundle *by Aubrey Pilgrim (Tab Books, 1988)*

As far as putting together a laptop goes, I suggest you regulate your enthusiasm. You may be able to put together a portable, but the engineering gauntlet you'll have to run to stick a laptop together might be more than you've bargained for.—R. G./S. W.

Who Needs All Those Bits?

Someone once suggested to me that IBM has ever had only one successful personal computer, the original PC. The XT, AT, and PS/2 models are only faster or larger versions of the PC. This is not strictly true, of course, but it fits my understanding of how microcomputers have been used so far and exactly describes what I want: my own computer with a lot of memory and a lot of speed and software that I understand.

The only arguments that I remember hearing (7 years ago) in favor of purchasing an IBM PC instead of an Apple II were the IBM name and increased speed. Speed isn't the only issue, of course, or we might still be using CP/M.

Why doesn't anyone make a fast 8088

continued

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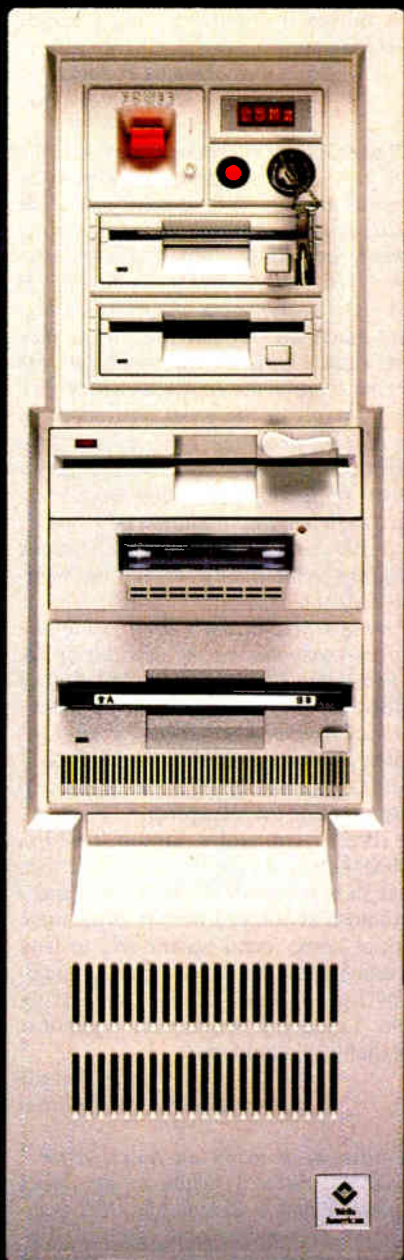

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or 8086 computer? Why do we need an 80286 or 80386 to get above 10 MHz? Aren't 8 bits plenty for word processing? We haven't been using the extra memory-addressing abilities of 16-bit and 32-bit buses, so what have we been using? Is there some reason why the 8088 and 8086 are limited in speed?

Perhaps the answer lies in the economics of designing and building computers or is buried in the history of computer developments.

Dennis P. McGuire
Minneapolis, MN

If people used microcomputers only for word processing, 8 bits might be enough. (Even so, a large cut-and-paste operation involves moving blocks of memory around, and if the move can be performed 16 bits [2 bytes] or 32 bits [4 bytes] at a time, the cut and paste will execute much faster.) But the fact is that more than character manipulation occurs out there in the computer world. For example, one of the great attractions of the Macintosh is the alloy of text and graphics it provides, making yesterday's dreams of desktop publishing today's reality. Efficient manipulation of graphics on a par with those of the Macintosh would be prohibitively slow on an 8-bit-wide machine.

Perhaps you haven't been using the extra memory-addressing abilities of 32-bit buses, but I'll wager that a number of 80386-based Unix users have. I submit that they would be rather cool to any suggestion to return to an 8-bit bus.—R. G.

Imagewriter on a Laptop

I'd like to connect a laptop Toshiba T1200 with an Apple Imagewriter I. Because I am using MS-DOS at work and a Macintosh at home, I want to print some work at home, but I wasn't able to find documentation on proper pin arrangement for the ends of the connecting cable. Could you recommend a publication that would help me?

Serge Amoos
Geneva, Switzerland

I have been using an Imagewriter I connected via a T-switch to an Apple Macintosh and a Zenith MS-DOS computer for over a year now with no problem, so you should encounter none. All the documentation you need is in the Imagewriter user's manual (pin-outs for the serial port are in appendix F). Also, there have been a number of replies to letters in recent Ask BYTE *columns with detailed connection diagrams for RS-232 products and how to handle the infamous "crossover" problem.*

Table 1: *Pin-out for AT-compatible serial port.*

Pin	Description
1	Carrier detect
2	Receive data
3	Transmit data
4	Data terminal ready
5	Signal ground
6	Data set ready
7	Request to send
8	Clear to send
9	Ring indicator

Keep in mind that you should use the Toshiba's serial port to connect to your Imagewriter, not the parallel port. The Toshiba's 9-pin serial port should be IBM PC AT-compatible; refer to table 1 for a pin-out of the AT's serial connector. And remember to use MS-DOS's MODE.

—R. G.

Laptop Expansion

For the past year, I have been looking (in vain, it seems) for an external 3½-inch floppy or hard disk drive for my Toshiba T1000. Do you know of such a unit that I could connect to the external drive port on the back of the T1000?

Gary Ridley
Ottawa, Ontario, Canada

I have looked in vain as well. It seems that the only external drive currently available for the T1000 is a 5¼-inch model. I suggest you contact your nearest Toshiba dealer for price and ordering information.—R. G.

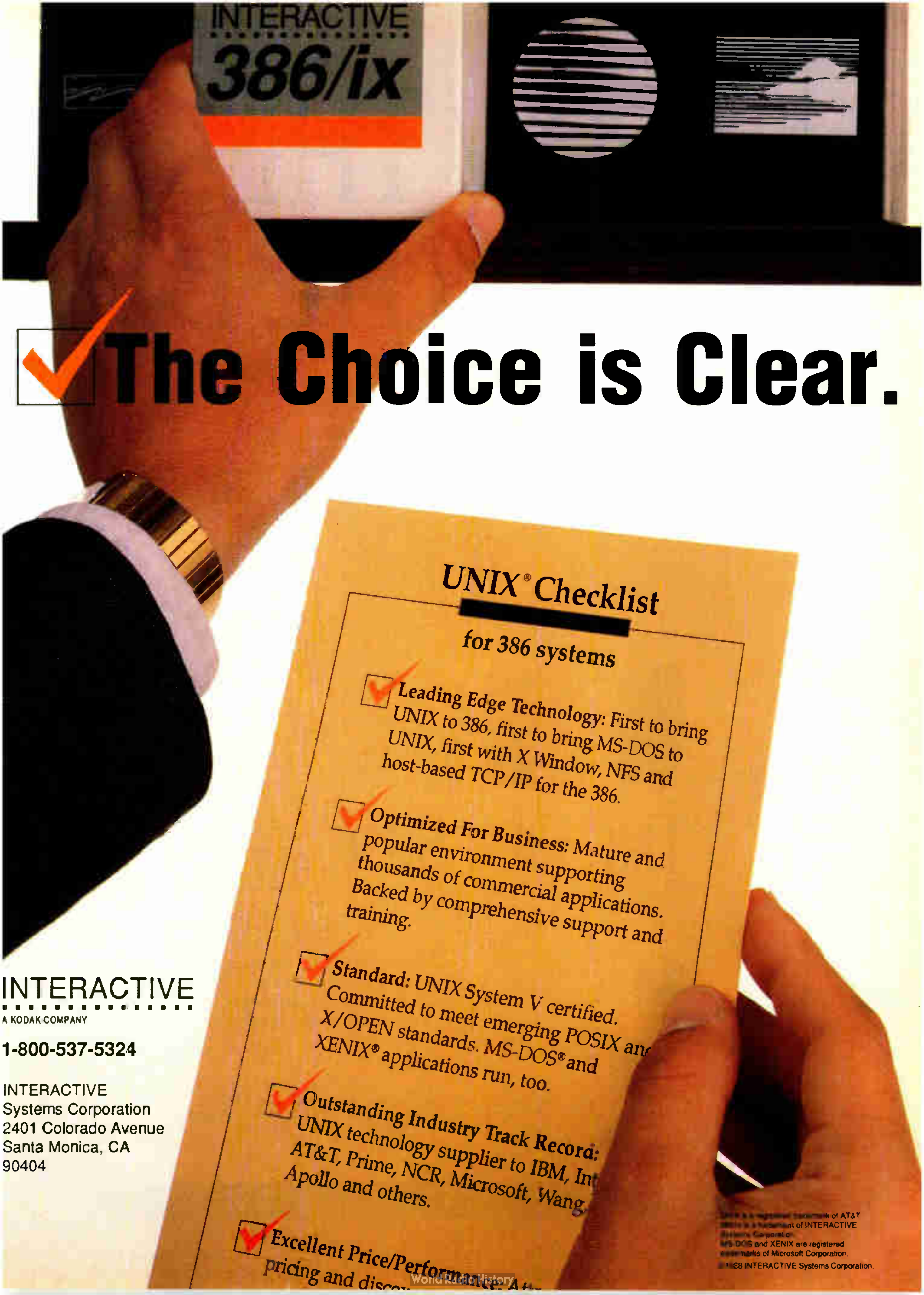
Permutations

I have an Apple IIe with 128K bytes of memory. I want to find a program (preferably in the public domain) that will compute and print all possible combinations of any entered group of numbers, letters, or words. For example, I want to find all possible combinations of "Compute with Apple." If I enter the three words in any order, I would like the computer to print out the following:

```
Compute with Apple
Compute Apple with
with Apple Compute
with Compute Apple
Apple Compute with
Apple with Compute
```

This appears to be a simple task for a competent programmer. Alas, I am not

continued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one. I would use such a program as a code breaker; I could set it up to keep searching until it found a certain code combination.

Roderick I. McNeil
Warner, NH

How do you write a program that can generate all possible permutations of an array of tokens (where the tokens are strings, as in your example)? Thinking about how to solve that problem without the help of a computer is one good way to discover an algorithm that you can then translate into a program. Consider how to permute all the digits in a number. Start with an easy case—the two-digit number 34. Clearly, there are just two permutations:

34
43

What if you're working with the three-digit number 234? Well, there have to be combinations that begin with 2, 3, and 4. How many of each? Two, since when you "freeze" each first digit, what's left is a two-digit number that—like 34—has two permutations. Working step-by-step for each of three possible initial digits, there are two permutations; the total yield is six permutations. A template of the solution looks like this:

2
2
3
3
4
4

When the first digit is 2, the remaining digits are 3 and 4. You know how to permute 3 and 4, so you get

234
243
3
3
4
4

When the first digit is 3, 2 and 4 remain. So you get

234
243
342
324
4
4

You get the idea. Now, what about the

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four-digit number 1234? You know that there are six permutations of a three-digit number and that you have to solve the three-digit problem four times—once for each possible first digit. Taking it step-by-step, the four-digit template looks like the array in table 2a. Each column now reduces to a three-digit problem, and you can add the appropriate three-digit templates; see table 2b. Now you're back to the degenerate two-digit problem. To complete each number, permute the two unused digits, and you have table 2c.

It's a classic recursive problem. To solve it for n *tokens, find the solution for* n-*1 tokens; keep decomposing the problem until you get to the trivial case of 2 tokens; then let the results percolate back up to the top level.*

Now you can express the method in algorithmic terms. A first draft (in pseudocode) is shown in listing 1. For a second draft, use two variable-length arrays called `prefix` *and* `suffix`*. The prefix is the part that's fixed, and the suffix is the part that's variable. For example, when permuting the digits 1234, 1, 2, 3, and 4 will in turn be the top-level prefixes, and 234, 134, 124, and 123 will be the corresponding suffixes. At the next level, the prefixes (for solutions starting with 1) will be 12, 13, and 14, and the suffixes will be 34, 24, and 23. See listing 2.*

To start, you need a main program that initializes the prefix to be an empty token array (since nothing is fixed yet) and a suffix that is the array of tokens you want to permute (since at first the whole thing is variable). The pseudocode for the main program is shown in listing 3.

To translate this algorithm into a program, you'll need a language that supports recursion, such as Pascal or one of the more modern dialects of BASIC. If the tokens you're interested in permuting are letters or digits, you can use strings to represent arrays of them. It's best if the language you choose provides intrinsic support for variable-length strings; that

continued

Table 2: *Templates for permuting a 4-token entity:* **(a)** *The first step (leftmost token),* **(b)** *the next step, and* **(c)** *the final array.*

(a)			
1	2	3	4
1	2	3	4
1	2	3	4
1	2	3	4
1	2	3	4
1	2	3	4
(b)			
12	21	31	41
12	21	31	41
13	23	32	42
13	23	32	42
14	24	34	43
14	24	34	43
(c)			
1234	2134	3124	4123
1243	2143	3142	4132
1324	2314	3214	4213
1342	2341	3241	4231
1423	2413	3412	4312
1432	2431	3421	4321

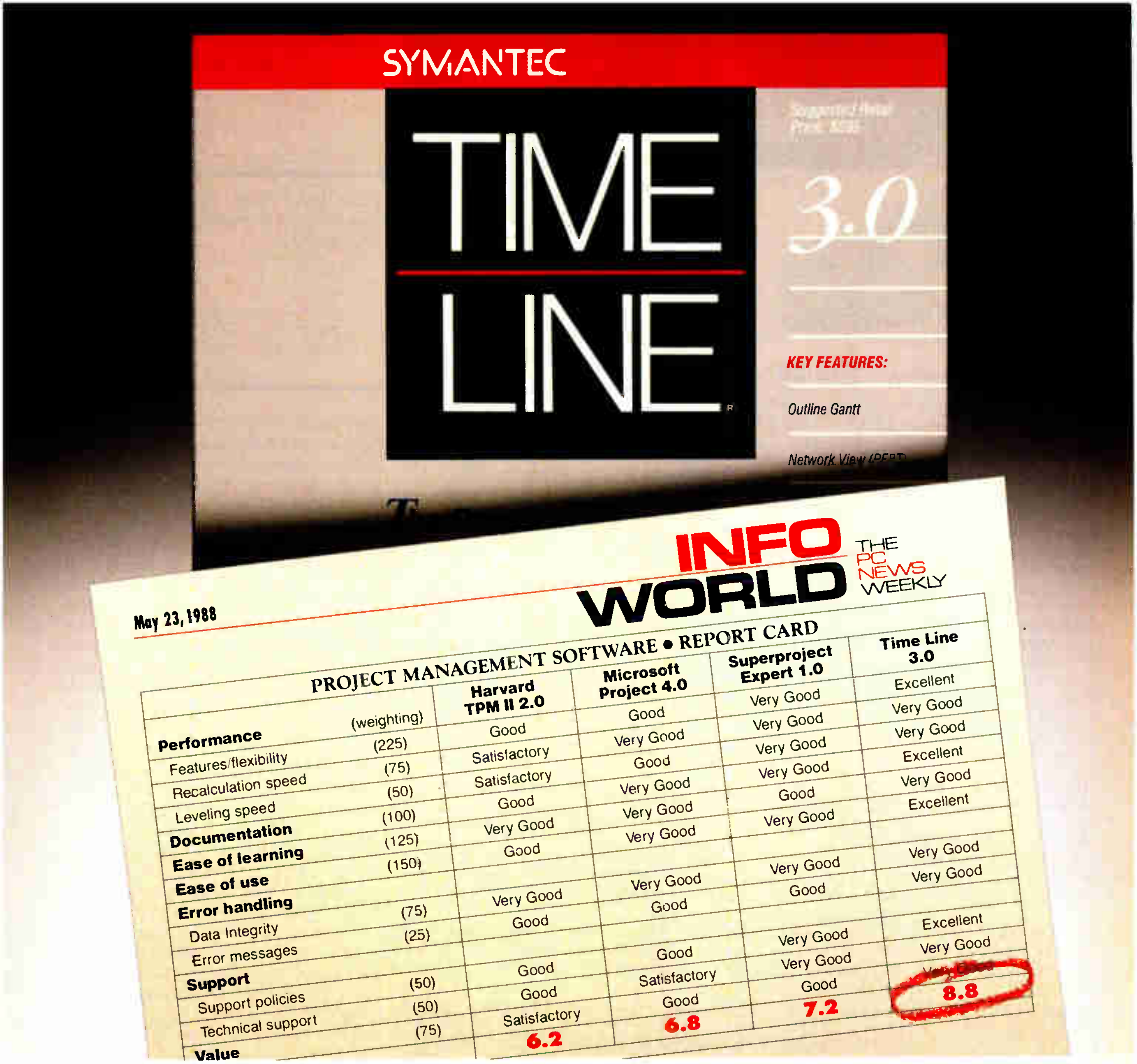
Listing 1: *First step in casting the technique shown in table 2 into an algorithm.*

```
For each token of an n-token
    array, append to that
    token all permutations of
    the remaining n-1 tokens.
```

Listing 2: *Algorithm of listing 1, shown now in greater detail.*

```
permute_n(prefix,suffix)
 {
 n := count_of_tokens_in
                (suffix)
 for d := 1 to n
  {
  if 2_token(suffix)
   {
   permute_2_and_print
       (prefix,suffix)
   }
  else
   {
   new_prefix := (prefix +
     dth_token_of(suffix))
   new_suffix := (suffix -
     dth_token_of(suffix))
   permute (new_prefix,
           new_suffix)
   }
  }
 }

permute_2_and_print(prefix,
                 suffix)
 {
 print ( prefix +
        1st_token_of(suffix) +
        2nd_token_of(suffix) )
 print ( prefix +
        2nd_token_of(suffix) +
        1st_token_of(suffix) )
 }
```



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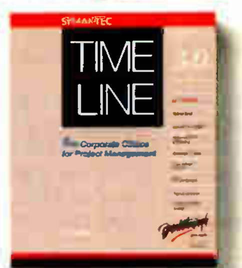

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PC MAGAZINE *Editor's Choice, '86 and '87*

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Listing 3: *Main routine for calling the permutation function of listing 2.*

```
permute
  (
  prefix := new_array
  suffix := 1234
  permute_n(prefix, suffix)
  )
```

way, you don't have to explicitly manage their length when you append prefixes to suffixes, append tokens to prefixes, and delete tokens from suffixes.—J. U.

Help with Hercules

I have an Epson Equity II IBM PC XT clone with a monochrome monitor. It came with a built-in video board that supports both regular monochrome text mode and Hercules graphics. The GWBASIC that came with it supports monochrome text (mode 7) and Hercules graphics modes. However, my customary programming language is Lahey FORTRAN 77, which provides a convenient subroutine that can be used to perform BIOS or DOS function calls. I have used it to set up my screen I/O, menus, and so on, in text mode.

Now, however, I would like to perform graphics from FORTRAN. I thought mode 6 might support Hercules graphics via the BIOS video services, but it didn't work when I tried it. Perhaps it will be necessary for me to write an assembly language subprogram to do Hercules graphics. Lahey includes a sample that shows how to interface assembly language with his FORTRAN, and I have programmed in assembly language on several machines (although not on an 8086). I expect I can handle it, but I need to know the protocol for manipulating Hercules graphics. Can you tell me where to look? I tried Peter Norton's *Programming Guide to the IBM PC*, but I couldn't find the information I needed.

James C. Wilcox
Palos Verdes Estates, CA

None of the standard IBM video modes will work with Hercules graphics. Writing graphics routines for the Hercules cards requires programming the 6845 graphics controller, but it's not difficult, especially with the proper sources. Two good references are Richard Wilton's Programmer's Guide to PC and PS/2 Video Systems *(Microsoft Press, 1987) and David Doty's* Programmer's Guide to the Hercules Graphics Cards *(Addison-Wesley, 1988).—S.A.* ■

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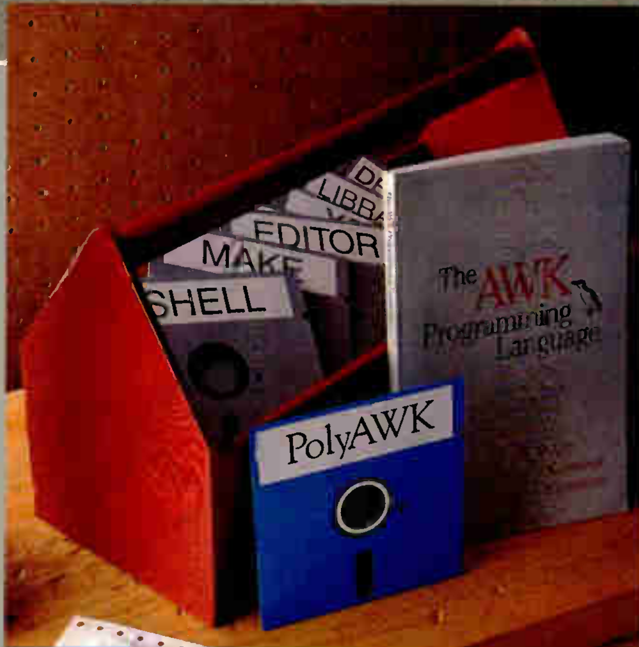

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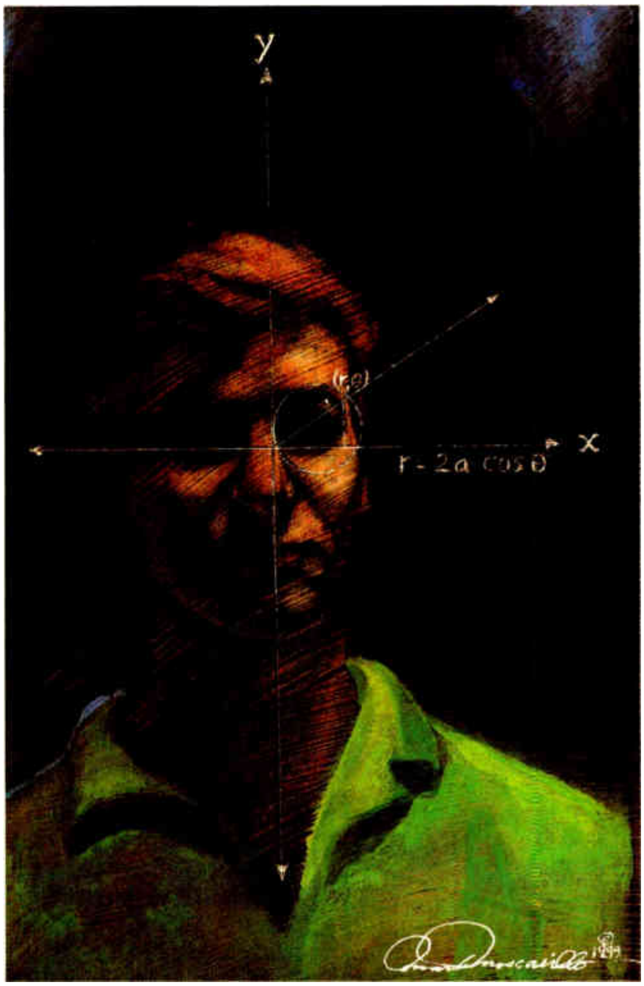
Descartes' Dream

by Philip J. Davis
and Reuben Hersh

Houghton Mifflin Co., Boston, MA: 1986, 320 pages, $12.95

Reviewed by Mark Bridger



In their first book, *The Mathematical Experience* (Birkhauser, 1981), Philip J. Davis and Reuben Hersh tried to explain, for the nonmathematician, what mathematicians do for a living and what they think about what they do. In addition to providing some interesting descriptions of contemporary research, the authors let everyone in on a secret of which many mathematicians seem to be unaware: Not all mathematicians agree on the scope, validity, or relevance of their field. In *Descartes' Dream*, the authors turn their attention to a fact that is no secret at all: Not everyone is entirely happy with the way mathematics seems to be applied in the modern world.

The year 1987 marked the 350th anniversary of the publication of René Descartes' celebrated *Discourse*, in which he introduced many of the ideas of what has come to be called Cartesian or analytic geometry. Of equal importance, Descartes also described a way to determine "truth" in the sciences. Loosely speaking, this method consists of 1) assuming only what is intuitively self-evident, 2) arguing from the simple to the complex, by dividing a problem into small enough steps, and 3) carefully checking one's work for correctness. Hardly anyone nowadays would dispute this as a generally reasonable procedure to follow in scientific research (although what is intuitive in quantum mechanics, for example, is open to argument). What Descartes provided that was unique was the vision that *this could always be made to work*; in other words, that you could unravel *any* problem, pure or applied, by following this method. This "revelation" seems to have dated from a series of mystical dreams that Descartes experienced in 1619 and that provide Davis and Hersh's title.

Descartes had more than a dream to support his optimism. His own research had shown him ways in which problems in geometry could be translated into problems in algebra, hence into numerical calculations. By using geometry to model the physical world, by applying "analytic geometry" to derive algebraic equations, and by solving these equations, you could learn whatever you wanted to know.

The *Discourse* had a very powerful effect on philosophy, logic, science, and mathematics. Fifty years after its appearance came an event that seemed to justify without a doubt Descartes' dream: the publication in 1685 of Newton's *Principia*. Physics and mathematics research, from Newton through Einstein and from Euclid through Hilbert, promised the eventual knowledge of everything. Only in this century, with Godel's theorem and quantum mechanics, have we awakened from this dream of certainty.

The theme for *Descartes' Dream*, then, is the "mathetization" of the modern world, the attempt to apply the tools of mathematics to every facet of our existence. And these tools are not to be taken lightly: algebra, geometry, logic, calculus, probability and statistics, numerical analysis, topology, and...computer science. Hersh and Davis devote the first few chapters of their book to a discussion of how and why these techniques came to play roles in our lives. They discuss topics ranging from social structuring to computer dating, from computer art to IQ testing. Their tale is a cautionary one. We

continued

ALSO REVIEWED

Structured Programming Using Turbo BASIC

Programming in ANSI C

Macintosh Family Hardware Reference

Computer Cryptology: Beyond Decoder Rings

Program Design for Knowledge-Based Systems

Expert Systems in Data Processing: A Professional's Guide

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do not? Computers can be used for Star Wars, or they can be used for agriculture. Davis and Hersh perform the admirable task of showing us that mathematics is a human activity, performed by very fallible humans. However, they don't go far enough in pointing out that mathematics doesn't just *happen*, or happen *to* us. The whole issue of the economics and politics of science and technology, unfortunately, is left undiscussed.

Whatever its deficiencies in certain areas, *Descartes' Dream* provides a framework for discourse and argument, and it raises, in some form, most of the important issues that we must confront when we apply technology and mathematics to human beings.

BRIEFLY NOTED

Structured Programming Using Turbo BASIC *by Wade Ellis Jr. and Ed Lodi, Academic Press, San Diego, CA: 1988, 337 pages, $23.95.* The Educational Testing Service was recently petitioned by a group including the inventors of BASIC to provide BASIC as well as Pascal versions of the Computer Programming Aptitude Test. The group believes that BASIC is as well-suited a language for students to learn proper programming technique as Pascal.

Authors Ellis and Lodi prove the point that BASIC programs can be well structured, readable, and maintainable. Their book serves as an introduction to BASIC programming but follows the tenets of structured programming technique from beginning to end.

An educated layperson or a student in a formal classroom setting can use *Structured Programming Using Turbo BASIC*. It is liberally sprinkled with exercises for the reader to solve; the solutions can be found in an appendix if you get stuck. An optional companion disk contains all the book's sample code.

After an introductory chapter to familiarize readers with the Turbo BASIC environment, the authors move into lessons describing how to place text and graphics on the computer's screen. This is a refreshingly logical beginning to learning how to write programs. Before they tackle sophisticated algorithms, most programmers just want to be able to see the results of their efforts on-screen. Why more books don't start this way is a mystery.

From learning to master the screen, the lessons move into a discussion of top-down programming using the example of a graphical house. First, you learn to draw the frame, then the roof, and finally the doors and windows. Using graphical examples reinforces the lesson concept visually.

The book continues in this style, using visual examples where possible to illustrate a programming concept.

Structured Programming Using Turbo BASIC is not a comprehensive guide to either BASIC programming or Turbo BASIC. But for the beginning BASIC programmer, it provides a solid foundation on which to build.

—*G. Michael Vose*

Programming in ANSI C *by Stephen G. Kochan, Hayden Books/Howard W. Sams & Co., Indianapolis, IN: 1988, 468 pages, $24.95.* Now that an ANSI standard for the C programming language is imminent, books on C will need to follow the standard conventions in describing C programming technique. Stephen G. Kochan vaults to the head of the ANSI-conforming pack with this revision of his 1984 book, *Programming in C*.

With 17 chapters roughly corresponding to the earlier volume, Kochan's book is suitable for a beginning programmer or someone new to C. Kochan thoroughly explains every C operation needed to write a nontrivial program, along with an easy-

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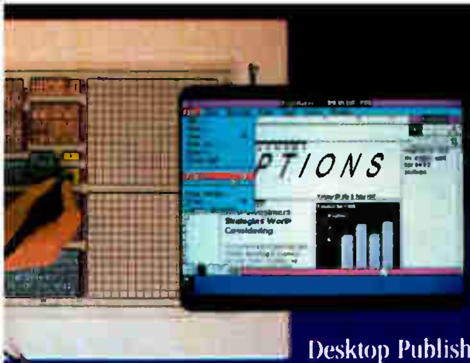

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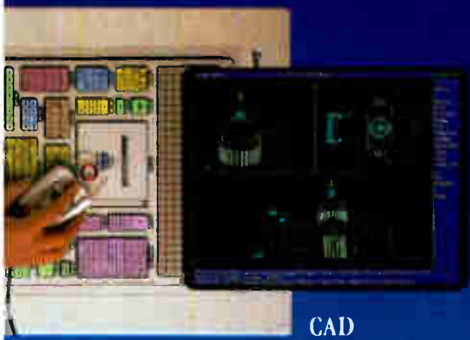

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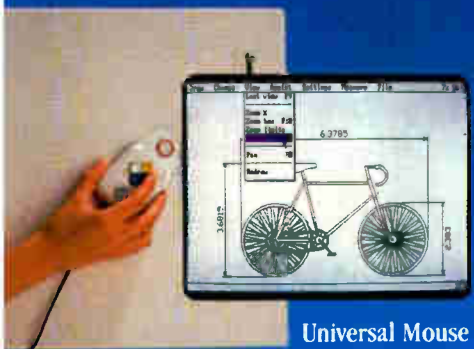

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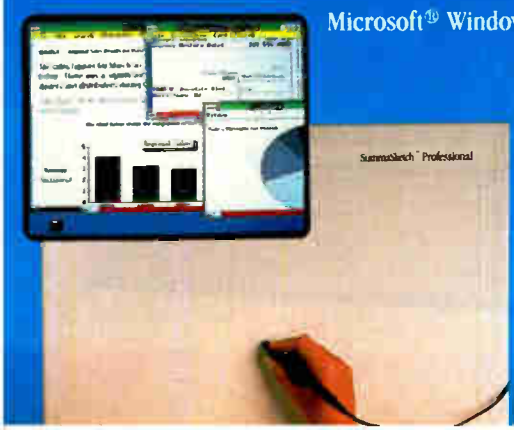

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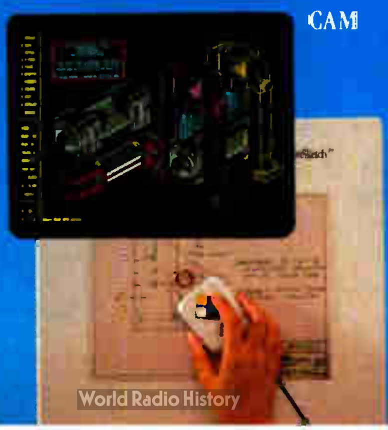

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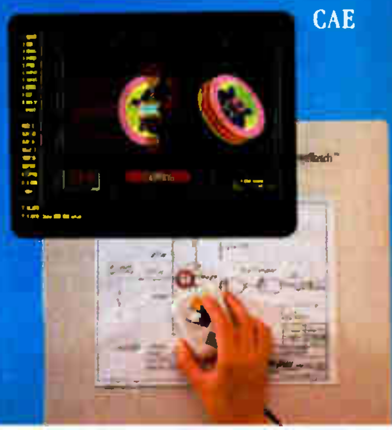

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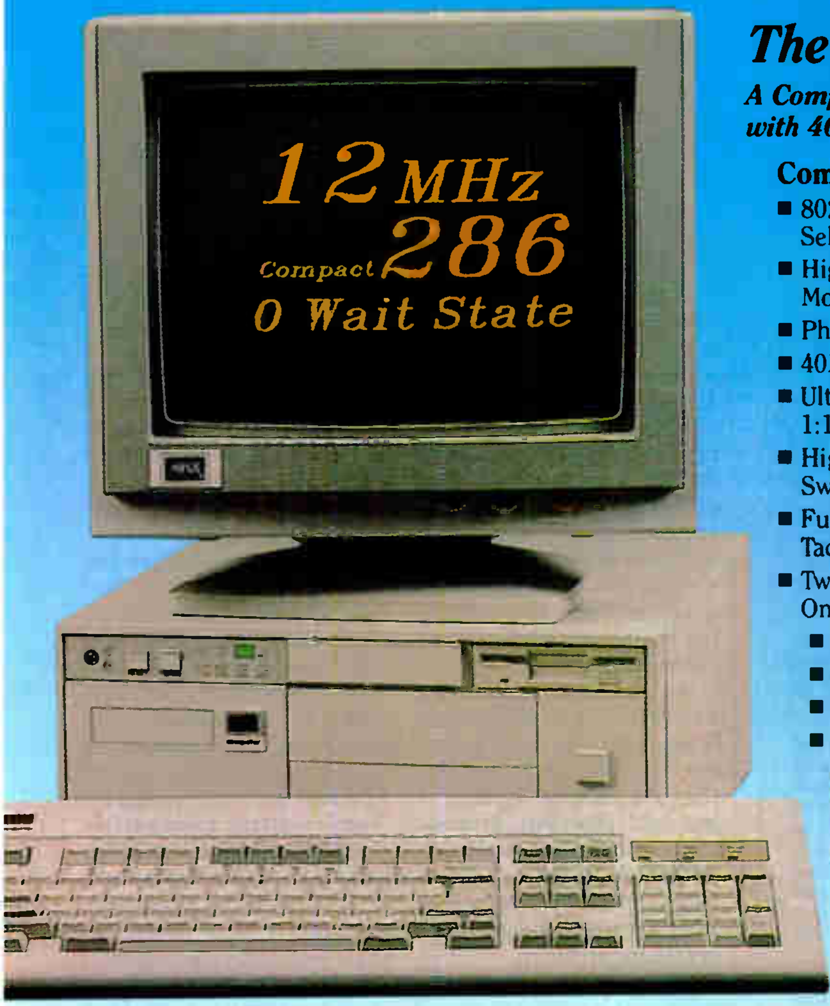

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to-understand programming example. His lucid explanations of how to perform an operation detail both C keywords and the library functions you need to accomplish a programming task.

All this explanatory material follows the conventions of the ANSI standard. New C programmers using this book to learn the language will therefore automatically use function prototypes, for example, and will understand new ANSI-standard data modifiers like `const`, `signed`, and `volatile`.

Of course, a consequence of this learned ANSI style may be confusion when a student uses a nonconforming compiler. To help in this situation, Kochan provides an appendix that describes the differences between ANSI C and "old" C. The organization of this appendix matches that of an earlier appendix that describes the ANSI version of the language. So, if you try to use the escape character \x to display a hexadecimal number and get a compiler error, you can quickly discover just what syntax is unacceptable to your current compiler.

Another useful appendix describes the standard C library. Although the functions are described only briefly, they are grouped logically—into math functions, dynamic memory allocation functions, I/O functions, and the like—to help you find the library routines you need for a given programming problem.

All in all, *Programming in ANSI C* is a solid and useful volume. —*G. Michael Vose*

Macintosh Family Hardware Reference *by Apple Computer Staff, Addison-Wesley, Reading, MA: 1988, 304 pages, $26.95 (hardcover).* The only hardware folk who will be disappointed with this book will be the ones looking for detailed schematic diagrams of Macintoshes. While block diagrams of various circuits abound, Apple has not put a wiring and parts diagram in here. Pin-outs of the external connectors are provided, though, along with explanations of what the pin-outs mean.

Each of the various Macintoshes (classic, SE, and II) is clearly explained on a subsystem basis (e.g., versatile interface adapters). The writing is crisp, and the organization of topics well thought out. The authors explain the actions and interrelations of the hardware in a no-nonsense manner that flows well from one numbered section to another. They clearly define the signals used in each subsystem and explain their expected values at relevant times.

I highly recommend this book to anyone involved with Macintosh hardware—and to the merely curious as well. It does a fine job of explaining the intricacies of the Mac in a way that does not require an advanced degree in electronics to understand.

—*Larry Loeb*

Computer Cryptology: Beyond Decoder Rings *by Karl Andreassen, Prentice Hall, Englewood Cliffs, NJ: 1988, 268 pages, $24.95.* Before the data encryption standard, public-key cryptography, and zero knowledge proofs, most of cryptography was simpler and not so mathematical. These systems from earlier days are by no means obsolete, and Karl Andreassen's book shows how to use a computer programmed in BASIC to make and break such ciphers. Not to be too presumptuous, Andreassen refers to the field as "amateur cryptography."

The book's main emphasis is on describing such well-known methods as substitution, Vignere, and transposition. BASIC programs are provided for generating each of these, followed by suggestions on ways to break them—what statistical patterns arise from each method and how studying such patterns can provide a hidden prying tool for breaking the cipher. Sev-

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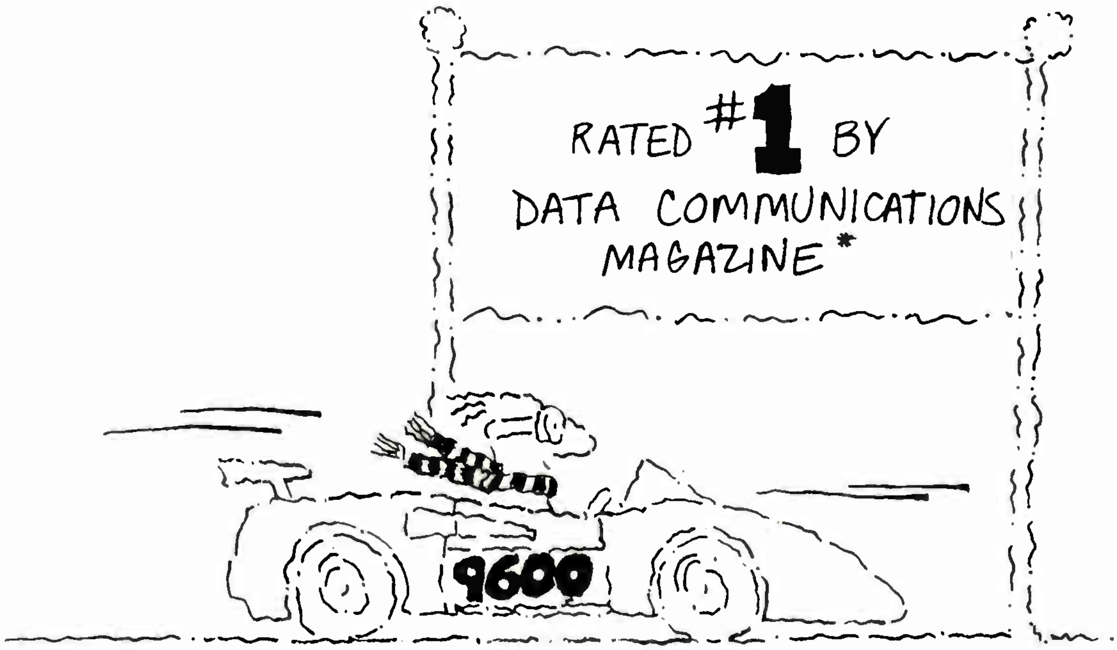

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eral programs are listed that automate the process of gathering the necessary statistical information.

Computer Cryptology: Beyond Decoder Rings makes a good introduction for people who might enjoy recreational cryptography and cryptanalysis. *—Peter Wayner*

Program Design for Knowledge-Based Systems *by Graham Winstanley, Halsted Press, New York: 1987, 226 pages, $29.95.* This concise book shows how to develop a knowledge-based system with Lisp as the implementation language. Using a mixture of formal design and rapid prototyping techniques, Graham Winstanley guides the reader from initial concepts and definitions to the development of a complete rule-based expert system. The latter chapters deal with the user interface, testing, and debugging, along with various alternative strategies, their usage, and implications. Winstanley also discusses peripheral issues of the hardware requirements.

Program Design for Knowledge-Based Systems will be useful to programmers who need to upgrade their skills from a more conventional environment. It will also be a valuable reference for system designers with some computing experience who are interested in the new field of knowledge engineering based exclusively on Lisp. In addition to providing a solid foundation in Lisp programming, the book includes details of how to design interfaces, specific examples of expert-system development, and a unique treatment of embedded expert systems. The author is a senior lecturer in electronics and computing at Brighton Polytechnic in England.

—Dong H. Kim

Expert Systems in Data Processing: A Professional's Guide *by Jerome T. Murray and Marilyn J. Murray, McGraw-Hill, New York: 1988, 237 pages, $34.95.* This is an outstanding introduction to what artificial intelligence in the form of expert systems can accomplish in various data-processing fields. The authors include many examples of how several companies, both large and small, have used the latest advances in expert systems in personnel cost reduction and risk assessment, thus gaining a competitive edge in marketing and sales. After surveying the expert systems that are in current use, they discuss the best ways to choose the profitable area of expert-system application and to avoid many possible mistakes and pitfalls. They also show how to assemble the best team for various applications.

Available programming languages, such as Lisp and Prolog, are also discussed adequately in chapter 5. The next two chapters deal with expert-system shells and how the knowledge engineer should go about choosing tools. After discussing IBM ESE (Expert System Environment) in chapter 9, the authors devote the rest of the book to the actual design and hardware requirements of an expert system.

Expert Systems in Data Processing is well organized and illustrated, and it's written in an easy-to-read, relaxed style with numerous fully coded examples of the many techniques the authors present.

—Dong H. Kim ■

CONTRIBUTORS

Mark Bridger, a professor of mathematics at Northeastern University, lives in Newton Upper Falls, Massachusetts. **G. Michael Vose** is coeditor of *OS Report: News and Views on OS/2.* He lives in Peterborough, New Hampshire. **Larry Loeb** is an engineer-turned-dental-surgeon who lives in Wallingford, Connecticut. **Peter Wayner** is a graduate student in computer science at Cornell University in Ithaca, New York. **Dong H. Kim**, a researcher and consultant, lives in Chapel Hill, North Carolina.

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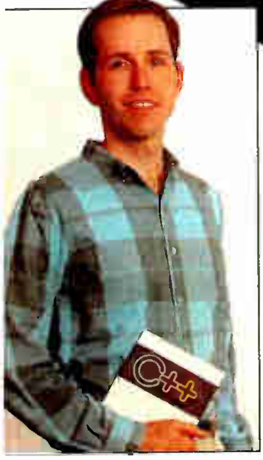

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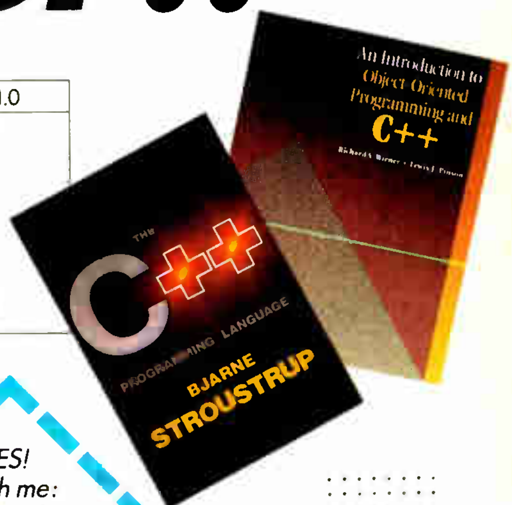
Integer	1.32	1.38	6.31	6.49
Float	0.17	0.22	52.29	51.03
*Float	32.73	37.74	52.39	51.63
Pointer	17.91	17.96	17.13	16.87
Rpointer	17.79	17.91	17.14	16.64
Loop	3.90	3.90	3.90	3.90
Optimize	0.49	0.60	8.46	8.79

Benchmarks were run on an 80286 based IBM compatible at 6Mhz with no 8087.
The float benchmark was re-run without optimization.



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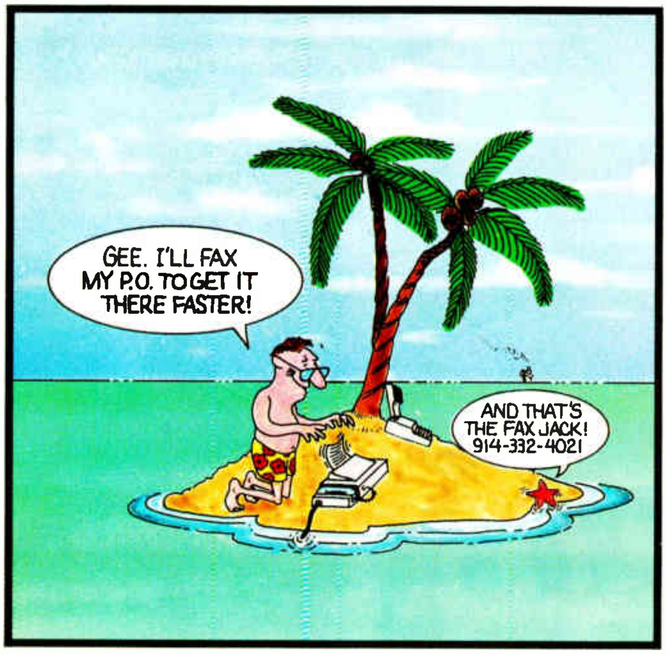

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C ASYNCH MANAGER	175	137
C TOOLS PLUS/5.0	129	99
C Utility Library	199	129
Essential Communications	185	119
Greenleaf Comm Library	229	169
Greenleaf Functions	209	157
Greenleaf SuperFunctions	265	189
Greenleaf TurboFunctions	109	79
PC-lint	139	101
TimeSlicer	295	279
w/ source	1000	899
Turbo C TOOLS	129	99

C GRAPHICS

	LIST	OURS
Essential Graphics	299	219
w/ source	595	499
GraphiC	395	322
GSS Graphic Dev. Toolkit	495	409
HALO '88	325	229
HALO '88 for MS Devel.	595	399
MetaWINDOW	195	162
MetaWINDOW/PLUS	275	232
TurboHALO	100	80

C SCREENS/WINDOWS

	LIST	OURS
C-Scape	299	282
C Windows Toolkit	100	90
Greenleaf DataWindows	295	209

	LIST	OURS
Greenleaf Makeform	125	90
HI-SCREEN XL	149	129
JAM	750	684
JYACC FORMAKER	495	453
PANEL Plus	495	395
PANEL/QC	129	99
PANEL/TC	129	99
Vitamin C	225	162
VCScreen	149	109
Windows for C	195	169
w/ Source	390	332
Windows for Data	295	259
w/ Source Code	590	479

COBOL LANGUAGE

	LIST	OURS
Micro Focus COBOL/2	900	733
Micro Focus COBOL/2 Toolset	900	733
PC-CICS	1495	CALL
Personal COBOL	149	121
Microsoft COBOL 3.0	900	599
Realia COBOL	995	799
w/ RealMENU	1145	929
RM/COBOL	950	763

COMMUNICATIONS

	LIST	OURS
Carbon Copy Plus	195	135
Close-Up (Support)	245	222
Close-Up (Customer)	195	116
Co/Session (2 user license)	249	227
Support	175	157
Application	125	116
RELAY Gold	250	229
RELAY Silver	150	139
SideTalk	120	90

dBASE LANGUAGE

	LIST	OURS
CLARION	695	599
Clipper	695	439
Clear	100	90
w/ Laser & 24 pin option	150	129
dBASE III Plus	695	399
dBASE IV	695	CALL
dBASE Graphics for C	90	69
dBASE ON LINE	69	60
dBASE Programmers Utilities	90	79
dBASE Tools for C	90	69
dBASE Tools for Pascal	90	69
dBFast	100	75
dBUG	195	179
dQUERY	150	129
FoxBASE +	395	249
Flipper	195	182
Genifer	395	259
Integrated Dev. Library	149	135
QuickSilver	599	369
R:Base for DOS	725	529
R & R	150	129
w/ Clipper/FoxBASE module	199	179
Say What!	50	45
Scrimage	CALL	CALL
SilverComm Library	150	139
The Documentor	295	229
Tom Rettig's HELP	120	CALL
Tom Rettig's Library	100	80
UI Programmer	295	229
XDB-SQL	495	419

DEBUGGERS

	LIST	OURS
386 DEBUG	195	145
Advanced Trace 86	175	121
Periscope I/512 K	795	636
Periscope II	175	141
Periscope IIx	145	106
Persciope III 10 MHz	1395	1195
Trapper	150	CALL

DESKTOP PUBLISHING

	LIST	OURS
HALO DPE	195	162
MKS SQPS	495	420
Pagemaker	695	532
Ventura Publisher	895	554

DISK/DOS UTILITIES

	LIST	OURS
Command Plus	90	70
Command Tips	90	80
Disk Optimizer	60	55
FANSI CONSOLE	75	66
FASTBACK Plus	189	142
hTest hFormat	90	80
MACE Utilities	99	90
MKS Toolkit	199	169
Norton Commander	89	56
Norton Guides	100	75
Norton Utilities	100	61
Norton Utilities, Adv. Ver.	150	101
Pathfinder	70	65
PC Tools Deluxe	80	70
Vcache	50	47
Vfeature	80	75
Vfeature Deluxe	120	111
Vopt	50	47
Xtree	70	60
Xtree Pro	129	111

EDITORS

	LIST	OURS
BRIEF	195	CALL
EDIX	195	169
EMACS	295	268
Epsilon	195	151
KEDIT	150	120
MKS VI	149	127
Multi-Edit	99	90
Norton Editor	75	70
PC/EDT +	295	269
Pi Editor	195	155
SPF/PC	245	185
VEDIT PLUS	185	115

FILE MANAGEMENT

	LIST	OURS
Btrieve	245	185
Xtrieve	245	189
Report Option	145	109
Btrieve/N	595	455
Xtrieve/N	595	459
Report Option/N	345	279
CBTREE	159	141
c-tree	395	318
d-tree	495	395
r-tree	295	241
c-tree r-tree bundle	650	523
CQL Query System	395	332
dBC III	250	CALL
dBC III PLUS	750	CALL
db—RETRIEVE	395	322
db—FILE	395	322
FABS Plus	195	172
Informix ESQL/C	595	535
Informix 4GL	995	895
Informix SQL	795	715
XQL	795	599

FORTRAN COMPILERS

	LIST	OURS
F77L	477	429
Lahey Personal FORTRAN 77	95	89
MS FORTRAN	450	299
RM/FORTRAN	595	479

FORTRAN LIB/UTILITIES

	LIST	OURS
DIAGRAM'er	129	116
DOCUMENT'ER	129	116
Grafmatic	135	119
Plotmatic	135	119
Spindrift Library	149	135
Tekmar Graphics Library	195	169

MODULA-2

	LIST	OURS
JPI Top Speed Modula-2	100	90
LOGITECH Modula-2		
Development System	249	199
Stony Brook Modula-2		
Development Package	345	309

OBJECT-ORIENTED PROGRAMMING

	LIST	OURS
ACTOR	495	423
ADVANTAGE C + +	495	479
Smalltalk/V	100	85
Communications	50	45
EGA/VGA Color Ext.	50	45
Goodies #1, #2 or #3	50	45
Smalltalk/V 286	200	169

OPERATING SYSTEMS

	LIST	OURS
Concurrent DOS 386	395	349
Microport:		
System V/AT (complete)	649	549
AT Runtime System	249	209
286 DOS Merge	249	209
SCO:		
XENIX Sys V (comp.)	1295	999
Operating System	595	479
WENDIN:		
Operating System Toolbox	99	80
PCNX	99	80
PCVMS	99	80
Wendin-DOS	139	109

OS/2 DEVELOPMENT TOOLS

	LIST	OURS
Btrieve for OS/2	595	455
Epsilon for OS/2	195	151
Greenleaf DataWindows	395	CALL
GSS Dev. Toolkit for OS/2	175	139
LOGITECH Modula-2	349	279
MS Languages	CALL	CALL
Panel Plus for OS/2	89	CALL
Rbase for OS/2	895	CALL
Vitamin C (OS/2)	345	279
Windows for C (OS/2)	295	CALL
Windows for Data (OS/2)	395	CALL

PASCAL COMPILERS

	LIST	OURS
Microsoft Pascal	300	189
Turbo Pascal	150	105
Turbo Pascal 5.0 Professional	250	175

TURBO PASCAL LIBRARIES/UTILITIES

	LIST	OURS
DATABOSS	399	359
DATABOSS TOOLS	99	89
Overlay Manager	45	39
PCX Toolkit	90	80
Pascal ASYNCH MANAGER	175	37
T-Debug Plus V. 4.0	45	40
Turbo Analyst	99	79
Turbo ASYNCH PLUS	129	99
Turbo Geometry Library	150	135
Turbo MAGIC	199	179
Turbo Plus v. 5.0	100	80
Turbo POWER SCREEN	129	99
Turbo POWER TOOLS PLUS	129	99
Turbo Professional	99	80
Turbo Professional 5.0	125	99
Universal Graphics Library	150	121

TRANSLATORS

	LIST	OURS
Bas_C (Economy)	199	179
Bas_C (Commercial)	375	323
Bas_Pas (Economy)	149	129
Bas_Pas (Commercial)	280	242
BASTOC	495	399
Brooklyn Bridge	130	CALL
dB2C	299	272
dBx TRANSLATOR	550	469

XENIX/UNIX SOFTWARE

	LIST	OURS
LANGUAGES		
ADVANTAGE C + +	695	669
APL*PLUS	995	699
C-terp	498	384
Micro Focus Toolkit	2495	1999
Micro Focus VS/COBOL	1495	1199
Microsoft Languages	CALL	CALL
RM/COBOL	1250	954
RM/COBOL-85 (286)	1500	1259
RM/COBOL (386)	1900	1589
RM/FORTRAN	750	553
ADDITIONAL XENIX/UNIX SOFTWARE		
Aspen Korn Shell	125	109
Directory Shell (286)	349	299
Directory Shell (386)	495	423

NEW RELEASES

PANEL PLUS II
The latest offering of this reliable, time-tested screen design product includes all new documentation, support for virtu screens, scrolling line wind a screen editor enhanced by greater use of pop-up dialog boxes, and many new library functions. Call for more information.
List: $495 Ours: $395

MICROSOFT QUICKBASIC 4.5
Comes with QB Advisor, an online reference system that uses hypertext technology, and the Easy Menus option that simplifies the user interface helping new programmers to more quickly become productive.
List: $99 Ours: $69

VM/386 MULIUSER
A true DOS multi-user system allowing one 386 PC to act as a host for up to eight PC-compatible terminals. A low cost alternative to networking. Lets you continue to use all the DOS software you already own.
List: $895 Ours: CALL

1,000 Brand Names 1-800-445-7899

January Specials

ESSENTIAL SOFTWARE	LIST	THIS MONTH
C Utility Library	199	129
Essential B-Tree	99	79
w/ source	198	159
Essential Communications	185	119
Essential Graphics	299	219
w/ source code	598	499
/*resident C*/	99	79
w/ source code	198	159
Screen Star	99	79
w/ source code	198	159

	LIST	OURS
Btrieve	595	455
FoxBASE+ (286)	795	599
Informix 4GL	1495	1345
Informix 4GL w/Debugger	2100	1[illegible]89
Informix SQL	1195	1[illegible]75
Informix ESQL/C	895	805
Informix 4GL (386)	2495	2245
Informix 4GL (386) w/Debug	3500	3150
Informix SQL (386)	1395	1255
Informix ESQL/C (386)	1095	985
PC/EDT +	395	352
EDIX	275	222
FORMAKER	895	813
JAM	1350	1224
PANEL Plus	795	675
Windows for C	595	479
Windows for Data	795	669
386 SOFTWARE		
386 ASM/LINK	495	389
386MAX	75	66
386MAX PROFESSIONAL	CALL	CALL
Concurrent DOS 386	395	349
DESQview	130	115
F77L-EM/32	895	805
High C 386	895	799
Microport		
System V/386 (complete)	899	799
Runtime System	299	269
MS Windows/386	195	130
NDP C 386	595	529
NDP FORTRAN-386	595	529
SCO XENIX		
Operating System	695	589
Sys. V 386 (complete)	1495	1195
VP/IX (2-USERS)	495	399
VP/IX (unlimited users)	995	799
VM/386	245	199
VM/386 Multiuser (unlim.)	895	CALL
OTHER PRODUCTS		
FLOW CHARTING II	229	207
Pfinish	395	215
Source Print	97	80
Tree Diagrammer	77	70
BORLAND		
Eureka: The Solver	167	119
Paradox 2.0	725	529
Paradox Network Pack	995	729
Paradox 386	895	625
Quattro	247	169
Reflex & Reflex Workshop	200	139
Reflex Data Base System	150	109
SideKick	85	59
SideKick Plus	200	139
Sprint	195	135
Superkey	100	69
Turbo Basic	100	69
Database Toolbox	100	69
Editor Toolbox	100	69
Turbo Assembler/Debugger	150	105
Turbo C 2.0	150	105
Turbo C 2.0 Professional	250	175
Turbo Lightning	100	69
Lightning Word Wizard	70	49
Turbo Lightning and Lightning Word Wizard	150	109
Turbo Pascal 5.0	150	105
Turbo Pascal 5.0 Professional	250	175
Database Toolbox	100	69
Editor Toolbox	100	69
Gameworks Toolbox	100	69
Graphix Toolbox	100	69
Numerical Methods Toolbox	100	69
Tutor	70	45
Turbo Prolog	150	105
Turbo Prolog Toolbox	100	69
GREENLEAF SOFTWARE INC.		
Greenleaf Functions	209	149
Greenleaf Comm Library	229	169
Greenleaf TurboFunctions	109	79
Greenleaf DataWindows, DOS	295	209
OS/2 Version	395	299
Greenleaf Bus. MathLib	325	229
Greenleaf SuperFunctions	265	189
Greenleaf MakeForm	125	99
OS/2 Version	170	135
Greenleaf DataMath Interface	75	69

	LIST	OURS
LAHEY		
F77L	477	429
F77L-EM/16	695	639
F77L-EM/32	895	805
A.I. DEVELOPER'S KIT OPERATING SYSTEM	495	459
PERSONAL FORTRAN 77	95	89
MEDIA CYBERNETICS		
Dr. HALO III	140	101
HALO DPE	195	162
HALO '88	325	229
HALO '88 for 2 compilers	475	329
HALO '88 - MS Developers	595	399
TurboHALO for C	100	80
MICROSOFT		
MS BASIC/6.0	295	199
MS BASIC Compiler (XENIX)	695	449
MS BASIC Interpreter (XENIX)	350	229
MS C	450	299
MS COBOL V. 3.0	900	599
for XENIX	995	649
MS Excel	495	329
MS FORTRAN	450	299
for XENIX	695	449
MS Learning DOS	50	40
MS Mach 20	495	329
MS Macro Assembler	150	99
MS Mouse Serial or Bus		
w/Paintbrush & Mouse Menus	150	99
w/EasyCAD	175	119
w/Paintbrush & Windows	200	139
MS OS/2 Prog. Toolkit	350	229
MS Pascal	300	199
for XENIX	695	449
MS QuickBASIC	99	69
MS QuickC	99	69
MS Sort	195	130
MS Windows/286	99	69
MS Windows/386	195	130
MS Windows Dev. Kit	500	319
MS Word	450	285
MS Works	149	99
MORTICE KERN SYSTEMS		
MKS Awk	99	85
MKS Lex:Yacc	249	212
MKS Make	149	127
MKS RCS	189	161
MKS SQPS	495	420
MKS Toolkit	199	169
MKS Trilogy	119	101
MKS Vi	149	129
PERISCOPE		
Periscope I/512K	795	636
Periscope I/OK	545	436
Periscope II	175	141
Periscope IIx	145	106
Periscope III	1395	1115
Periscope III PLUS/512K	1995	1695
Periscope III PLUS/OK	1745	1485
SOFTWARE BOTTLING		
Flash-up	79	70
Flash-up ToolBox	69	60
SoftCode	79	70
Speed Screen	49	45
WHITEWATER GROUP		
Actor	495	439
Language Extension I	99	95

PROGRAMMER'S POLICIES

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Hours 9 AM–7 PM EST. We accept MasterCard, Visa, American Express. Include $3.95 per item for shipping and handling. All shipments by UPS ground. Rush service available.

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30-day no-hassle return policy. Some manufacturer's products cannot be returned once disk seals are broken.

HALO '88

The latest version of the industry standard. Now adds to the library, subroutines and devices which facilitate the development of contemporary applications such as Desktop Publishing, Document Management, Vision, and Imaging. HALO '88's powerful functions reduce development time by offering fast, effective subroutines. And no other graphics library supports more languages, more compilers or more devices.

List: $325 Ours: $229

HALO

ACTOR version 1.2

The Whitewater Group

No Microsoft Windows developer should be without Actor, The Whitewater Group's object-oriented programming language. It will cut your design and development time in half. Use Actor to interactively prototype, test and deliver your applications in one integrated, MS-Windows based programming environment, featuring Actor's runtime debugger. In addition, you can incorporate your existing C or Assembler code into your Actor programs.

List: $495 Ours: $439

SOFTCODE...

The "Full-Feature" Program Generator

SoftCode is a new kind of program developer that gives you complete control over the type of code generated. It includes a WYSIWYG screen editor that's packed with features to give you fast results. And a fully documented Program Template Language that lets you actually create and modify your own templates. Choose from 4 Template Sets—dBASE, Pascal, BASIC or C—to instantly turn SoftCode into the generator of your choice.

THE SOFTWARE BOTTLING COMPANY

List: $79 Ours: $69

LAHEY 386 FORTRAN

Lahey Computer Systems Inc.

F77L-EM/32 is a fast and powerful 32-bit FORTRAN compiler that gives users the ability to write and port programs up to 4 GigaBytes on a 80386. All of the features that have made Lahey the choice of professional programmers have been incorporated into F77L-EM/32: Full 77 Standard, mainframe extensions, fast compilation, excellent diagnostics, and a powerful debugger. Another outstanding product from the FORTRAN experts.

List: $895 Ours: $805

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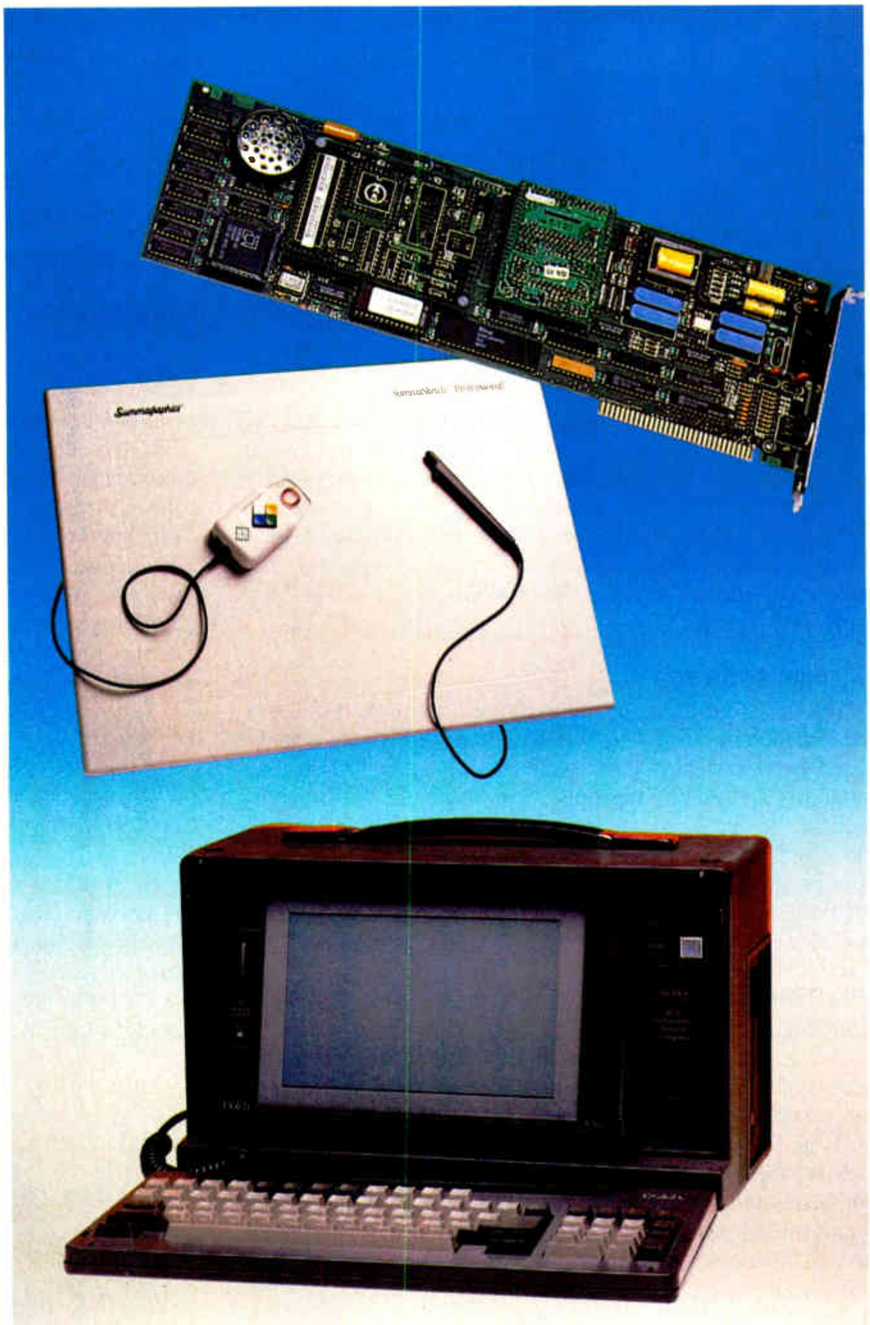
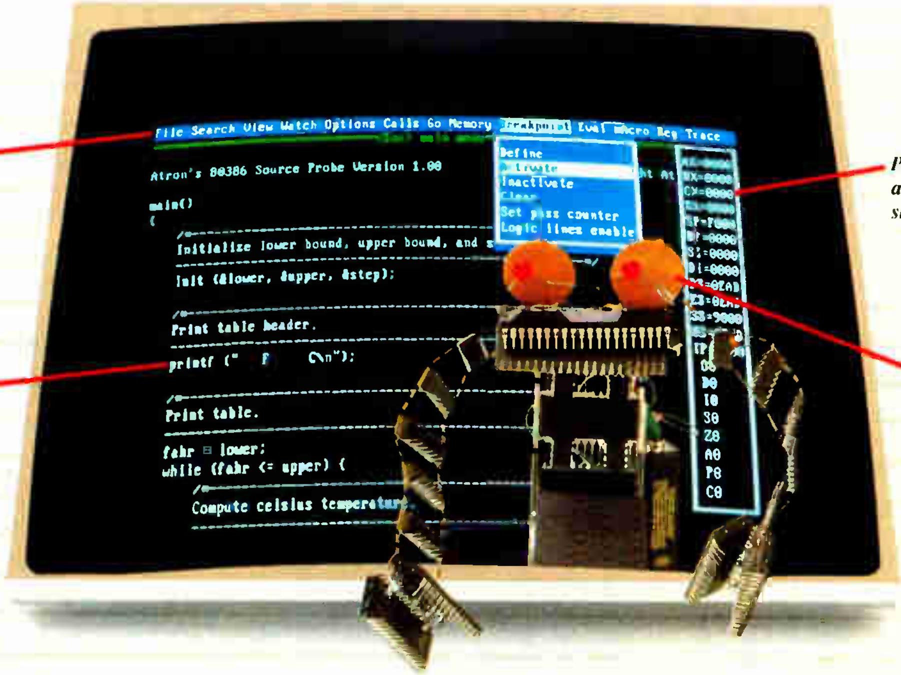
Circle 216 on Reader Service Card

Circle 29 on Reader Service Card

PRODUCTS IN PERSPECTIVE



IT'S TIME TO DO SOME SERIOUS 386 BUGBUSTING!



Welcome to your nightmare. Your company has bet the farm on your product. Your demonstration wowed the operating committee, and beta shipments were out on time. Then wham!

All your beta customers seemed to call on the same day. "Your software is doing some really bizarre things," they say. Your credibility is at stake. Your profits are at stake. Your sanity is at stake.

THIS BUG'S FOR YOU

You rack your brain, trying to figure something out. Is it a random memory overwrite? Or worse, an overwrite to a stack-based local variable? Is it sequence dependent? Or worse, randomly caused by interrupts? Overwritten code? Undocumented "features" in the software you're linking to? And to top it off, your program is too big. The software debugger, your program and it's symbol table can't fit into memory at the same time. Opening a bicycle shop suddenly isn't such a bad idea.

THIS DEBUGGER'S FOR YOU

Announcing the 386 PROBE™ Bugbuster,* from Atron. Nine of the top-ten software developers sleep better at night because of Atron hardware-assisted debuggers. Because they can set real-time breakpoints which instantly detect memory reads and writes.

Now, with the 386 PROBE, you have the capability to set a *qualified breakpoint*, so the breakpoint triggers only if the events are coming from the wrong procedures. So you don't have to be halted by breakpoints from legitimate areas. You can even detect obscure, sequence-dependent problems by stopping a breakpoint only after a specific chain of events has occurred in a specific order.

Then, so you can look at the cause of the problem, the 386 PROBE automatically stores the last 2K cycles of program execution. Although other debuggers may *try* to do the same thing, Atron is the only company in the world to dequeue the pipelined trace data so you can easily understand it.

Finally, 386 PROBE's megabyte of hidden, write-protected memory stores your symbol table and debugger. So your bug can't roach the debugger. And so you have room enough to debug a really big program.

COULD A GOOD NIGHT'S SLEEP PUT YOU IN THE TOP TEN?

Look at it this way. Nine of the top-ten software products in any given category were created by Atron customers. Maybe their *edge* is — a good night's sleep.

Call and get your free, 56-page bugbusting bible today. And if you're in the middle of a nightmare right now, give us a purchase order number. We'll FEDEX you a sweet dream.

atron

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*Versions for COMPAQ, PS/2-80s and compatibles. Copyright © 1987 by Atron. 386 PROBE is a trademark of Atron. Call 44-2-855-888 in the UK and 49-8-985-8020 in West Germany. TRBA

Circle 28 on Reader Service Card

Everex's Step 386is is built around Intel's 386SX.

The Everex for the Masses

If you want the newest model so you're assured compatibility for the future and you don't want to spend a lot of cash, you might consider the 80386SX-based machine from Everex.

The Step 386is is a small-footprint desktop model that's rated at 3.2 million instructions per second. It runs at 16, 8, or 5.3 MHz (no wait states), and you get a megabyte of memory, a 1.2-megabyte 5¼-inch floppy disk drive, and a standard 101-key Enhanced AT-style keyboard.

Especially attractive to software developers is the LED "status diagnostic display" that shows in real time which head, cylinder, and drive is being accessed. Other LEDs on the front panel indicate how fast your microprocessor is running, and a speed switch on the front panel lets you power down or up.

MS-DOS 3.3 and GW-BASIC are bundled with the system. The chassis contains two 8-bit and six 16-bit AT-type expansion slots.
Price: $3299.
Contact: Everex, Computer Systems Division, 48431 Milmont Dr., Fremont, CA 94538, (800) 356-4283.
Inquiry 861.

A Desktop in Your Laptop

The ProSpeed 286 laptop from NEC Home Electronics might make you wonder why anyone would need a desktop computer.

Here you've got a 16-MHz 80286 with a 640- by 400-pixel monochrome backlit liquid crystal display (LCD), up to 100 megabytes of hard disk storage capacity, a megabyte of system RAM (expandable to 5 megabytes), and three expansion slots.

If you want a VGA monitor, you can add one through the port on the back of your laptop.

Provided in the base package is DOS 3.3, an 82-key PS/2 keyboard, the 640- by 400-pixel monochrome screen, one 1.44-megabyte 3½-inch floppy disk drive, a standard 20-megabyte hard disk drive, a 2-to-4-hour nickel-cadmium battery, and password security software.

On the back panel are ports for a serial connection, a parallel connection, floppy disk expansion, RGB video output, an external keyboard, an RJ-11, and direct current power. The ProSpeed has an internal general-purpose laptop expansion (LTX) slot, along with two slots designed for memory and modem.
Price: $4999.
Contact: NEC Home Electronics (U.S.A.), Inc., 1255 Michael Dr., Wood Dale, IL 60191, (312) 860-9500.
Inquiry 860.

Average Users Unite!

QIC Research's latest is a 16-MHz 80286-based machine you might want for your average home.

This basic unit includes a 1.2-megabyte floppy disk drive and not much more. But it's packaged for expansion. There's a floppy/hard disk drive controller, an 80287 math coprocessor socket, two eight-bit and six 16-bit expansion slots, a serial port, a parallel port, and a game port.

Standard memory is 512K bytes of RAM on the motherboard, which is expandable to 4 megabytes.
Price: $1449.
Contact: QIC Research, Inc., 1961 Concourse Dr., Suite C, San Jose, CA 95131, (408) 432-8880.
Inquiry 863.

SEND US YOUR NEW PRODUCT RELEASE
We'd like to consider your product for publication. Send us full information, including its price, ship date, and an address and telephone number where readers can get further information. Send to New Products Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Information contained in these items is based on manufacturers' written statements and/or telephone interviews with BYTE reporters. BYTE has not formally reviewed each product mentioned. These items, along with additional new product announcements, are posted regularly on BIX in the microbytes.sw and microbytes.hw conferences.

Sharp's Hand-Held PC Connects to Desktop PCs

Sharp's 8-ounce "pocket PC" is designed as a hand-held organizer. The Wizard has been in production since 1987 but has been available only in Japan.

The Wizard will have seven basic functions, including an appointment diary, a 200-year calendar, a 600-entry phone directory, a notepad function that stores up to 16 pages of typed information, a calculator, and world and local clocks. The Wizard has alphanumeric keys and an eight-line LCD.

"Smart cards" containing time-budgeting software, a thesaurus/dictionary, and a language translator are also available.

Cabling through an RS-232C port allows you to transfer data between two Wizards, from a Wizard to a desktop, or from a Wizard to a small printer.
Price: The Wizard, $299; time expense manager, $119.99; thesaurus/dictionary, $129.99; language translator, $99.99.
Contact: Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430, (201) 529-8874.
Inquiry 862.

continued

Hard Disk Drives with Removable Storage

The Disk Pack drive is an external box with two slots for removable hard disk drives called Disk Pack modules. The SCSI port to the Disk Pack drive makes it compatible with many computers, including the Macintosh.

Mega Drive Systems is marketing the products in standard-size modules, ranging in capacity from 20 megabytes to 120 megabytes.

Access time for a single 20-megabyte drive is 65 milliseconds, but it's reduced on the 40-, 80-, and 120-megabyte modules to 19, 19, and 18 ms., respectively. Each module weighs 2½ pounds.

SCSI kits for the IBM PC XT, AT, PS/2s, and compatibles are optional.
Price: Two-slot drive, $799; 20-megabyte module, $899; 40-megabyte module, $1299; 80-megabyte module, $1699 (pricing not set on 120-megabyte version); XT/AT SCSI kit, $299; PS/2 SCSI kit, $579.
Contact: Mega Drive Systems, Inc., 1801 Avenue of the Stars, Suite 507, Los Angeles, CA 90067, (800) 322-4744; in California, (213) 556-1663.
Inquiry 866.

Mega Drive's box can hold two removable disk drives.

Mass Storage to the Max

A modular storage chassis with a single SCSI access to CD-ROM drives, hard disk drives, WORM (write-once-read-many) drives, and tape backup drives is now available from Online Computer Systems.

The Multimedia Data Storage Unit series comes in packages designed for desktop publishing, workgroup publishing, education, and resource configuration for file servers. The standard chassis contains eight slots—WORM and large hard disk drives require two slots, while smaller hard disk drives and tape cartridges need only one.

The desktop publishing package contains two Sony CD-ROM drives and a Panasonic WORM drive. Also included is a Panasonic WORM disk, a SCSI host adapter, and Microsoft extensions.

The CD-ROM drives will act as mechanisms to access "image libraries" stored on CD-ROM disks. You can sort through those images and store them on WORM drives in particular sequences for certain publishing projects.

One file server configuration includes three 676-megabyte hard disk drives, a 400-megabyte WORM drive, a Maxtor OM-800 disk, and a SCSI host adapter.
Price: $6000 to $20,000.
Contact: Online Computer Systems, Inc., 20251 Century Blvd., Germantown, MD 20874, (800) 922-9204; in Maryland, (301) 428-3700.
Inquiry 864.

Presentation Hardware for Your Macintosh

Manipulating computer graphics on-screen while you're making a presentation is the chief function of the Kodak Datashow remote for the Macintosh. It's an infrared remote-control device much like the one you use to switch channels on your television, and it works through the Apple Desktop Bus architecture incorporated on the Macintosh SE, II, and Apple IIGS. In other words, it's a slide projector remote control, except that the slide projector is the Macintosh monitor. It plugs into either the keyboard port or the mouse port.

The remote's infrared beam can send signals to a receiver up to 35 feet away. If you add a mouse extender, it will reach another 16 feet.

The remote's signals conform to keyboard equivalents used by Kodak and presentation package software manufacturers.

Standard features include forward, reverse, skipping to particular frames, reversing screen tones, inverting the image, and blanking out the image (to focus attention away from the screen).
Price: Remote, $245; mouse extender cable, $49.
Contact: Eastman Kodak Co., Motion Picture and Audio/Visual Product Division, 343 State St., Rochester, NY 14650, (800) 445-6325, ext. 883; in New York, (716) 724-3169.
Inquiry 865.

continued

Removable Cumulus Disk

The Cumulus Classic is a removable 5¼-inch half-height hard disk drive that stores 44 megabytes on a half-pound disk with an average access time of 25 milliseconds.

This SCSI-based drive comes with software drivers that provide backup features for your system's hard disk drive. Besides providing for incremental and scheduled backups, a memory-resident program allows the removable disk to "shadow" or "mirror" your system's hard disk.

In the event of a hard disk failure, the system will automatically change over to the removable media. The software has a windows-oriented interface that lets the user manipulate any combination of files in a number of ways.

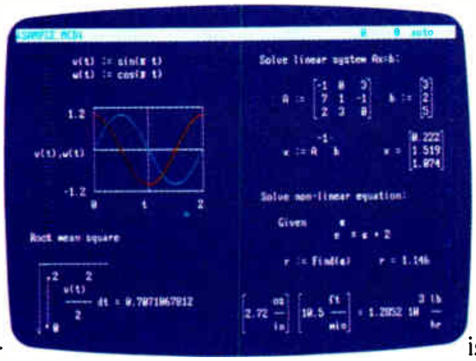
One of the long-time problems with removable storage media has been keeping the heads clean. Cumulus says it has taken care of the problem by using a fan and centrifugal force from the spinning disk.
Price: Drive and one cartridge, $1295; extra cartridges, $149.
Contact: Cumulus Corp., 23500 Mercantile Rd., Cleveland, OH 44122, (216) 464-2211.
Inquiry 867.

Your pad or ours?

If you perform calculations, the answer is obvious.

MathCAD 2.0.

It's everything you appreciate about working on a scratchpad – simple, free-form math – and more. More speed. More accuracy. More flexibility.



Just define your variables and enter your formulas anywhere on the screen. MathCAD formats your equations as they're typed. Instantly calculates the results. And displays them exactly as you're used to seeing them – in real math notation, as numbers, tables or graphs.

MathCAD is more than an equation solver. Like a scratchpad, it allows you to add text anywhere to support your work, and see and record every step. You can try an unlimited number of what-ifs. And print your entire calculation as an integrated document that anyone can understand.

Plus, MathCAD is loaded with powerful built-in features. In addition to the usual trigonometric and exponential functions, it includes built-in statistical functions, cubic splines, Fourier transforms, and more. It also handles complex numbers and unit conversions in a completely transparent way.

Yet, MathCAD is so easy to learn, you'll be using its full power an hour after you begin.

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The **Advanced Math Applications Pack** includes 16 applications like eigenvalues and eigenvectors of a symmetric matrix, solutions of differential equations, and polynomial least-squares fit.

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MathCAD lets you perform calculations in a way that's faster, more natural, and less error-prone than the way you're doing them now – whether you use a calculator, a spreadsheet, or programs you write yourself. So come on over to MathCAD and join 45,000 enthusiastic users.

For more information, contact your dealer or call **1-800-MATHCAD** (In MA: 617-577-1017).

Requires IBM PC® or compatible, 512KB RAM, graphics card.

IBM PC® International Business Machines Corporation.
MathCAD® MathSoft, Inc.

MathCAD®

MathSoft, Inc., One Kendall Sq., Cambridge, MA 02139

Circle 164 on Reader Service Card

Keep the Debugging Out of the Lower 640K

The Periscope I Revision 3 board keeps debugging out of the lower 640K bytes of DOS memory so you can develop large applications like Microsoft Windows. Its footprint in the first megabyte is only 32K bytes.

For use in the XT, AT, and compatibles, the Periscope I has a wait-state generator that controls how many wait states you insert for memory access.

It also has 512K bytes of write-protected RAM (so runaway programs won't write over it), which can store the Periscope software and all related debugging information, including symbols. You can expand the memory up to 1 megabyte by adding 256K-by 1-byte dynamic RAMs in the 16 empty sockets. The write- protected RAM is managed by a paging algorithm built into the accompanying Periscope 4.1 software.

The 32K-byte footprint is addressed in the system above the lower 640K bytes, but still within the first megabyte.

The Periscope I debugging system.

You can use it in systems with both an EGA (or VGA) card and an EMS card.
Price: $695.
Contact: The Periscope Company, Inc., 1197 Peachtree St., Plaza Level, Atlanta, GA 30361, (800) 722-7006; in Georgia, (404) 875-8080.
Inquiry 870.

Accelerate Your Mac II to 33 MHz

The DayStar Digital 33/030 Accelerator II will increase the speed of a Mac II by two to five times, the company claims. The speed increases depending on the application, with graphics applications generally not as fast as others.

The accelerator is designed around the 68030 processor running at 33.33 MHz. It more than doubles the speed of the standard 15.67-MHz Mac II and is 1.9 to 3.9 times the speed of the new Mac IIx. With the optional 33.33-MHz 68882 floating-point coprocessor, the speed of numerical calculations is increased over that of the standard 68881. But you can use the original 15.67-MHz 68881 coprocessor on the Mac II instead of the 68882.

The accelerator runs with no 68030 wait states, the company claims. This is accomplished with a high-speed memory cache, which uses 32K bytes of 25-nanosecond static RAM. Existing single in-line memory modules are not affected. The accelerator plugs directly into the original 68020 socket on the Mac II motherboard, instead of requiring a separate NuBus card. DayStar said it's compatible with all standard Mac II software and Apple's A/UX Unix operating system.
Price: $6000; 68882 coprocessor, $1000.
Contact: DayStar Digital, 5556 Atlanta Hwy., Flowery Branch, GA 30542; (404) 967-2077.
Inquiry 868.

SCSI Adapter Boots Nonbootable Peripherals

The TMC-841RL from Future Domain is a ROM-less SCSI host adapter that can address CD-ROM players, tape drives, and optical disk drives. Because there is no on-board ROM, this cuts the boot time by up to 35 seconds, the company claims.

Once loaded, the device driver that is supplied with a storage device defines the addresses for the adapter. Each adapter supports up to six disks and one tape drive. It's compatible with the IBM PC, XT, AT, and compatibles and offers an 8-megabit-per-second transfer rate. With appropriate software drivers, the TMC-841RL allows interface to DOS and Xenix operating systems, and to Novell's NetWare, the network operating system. It includes parity, arbitration, reselection, and interrupts.
Price: $90.
Contact: Future Domain Corp., 1582 Parkway Loop, Tustin, CA 92680, (714) 259-0400.
Inquiry 871.

Memory for Multiple Operating Systems

The OS/RAM4 is a 4-megabyte memory board for Micro Channel computers that automatically configures itself for DOS, OS/2, or Unix.

Software installation takes just four keystrokes. Then special software and a resident BIOS is recognized and run by the system processor *before* the operating system is loaded—much the same way the IBM BIOS is run by the system processor before the operating system is loaded.

The company claims this bypasses the catch-22 many people experience with PS/2 Models 50, 60, and 70 running OS/2: They are not shipped with the required 2 megabytes to run OS/2 and subsequently configure memory boards—and you can't configure the memory boards without first having the necessary 2 megabytes of memory.

With the OS/RAM4, a single chip serves as a complete Micro Channel interface and memory support circuit.

OS/RAM4 provides both extended and expanded memory support when running under DOS and can be partitioned in 512K-byte increments. Expanded memory is handled according to the LIM/EMS 4.0 specification, and the limit of extended memory comes from your particular computer.
Price: $395 without RAM.
Contact: Capital Equipment Corp., 99 South Bedford St., Suite 107, Burlington, MA 01803, (800) 234-4232; in Massachusetts, (617) 273-1818.
Inquiry 869.

continued

Fiber Optics Brings Bit-Mapped Graphics to Multiusers

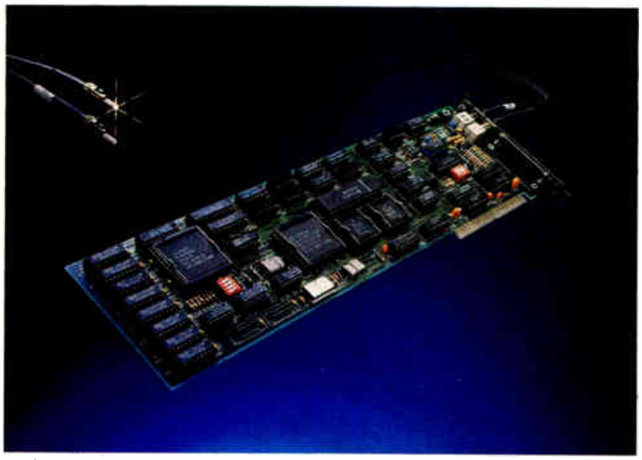
With the help of optical fiber, the PC LightCard from SunRiver Corp. brings single-user true bit-mapped graphics to multiple users. The difference is that most graphics terminals today are vector-based devices that aren't capable of writing pixel by pixel.

Multiple users means that you and as many as four colleagues with IBM PCs, XTs, ATs, and compatibles can "hot-key" from PC applications to a host 80386 machine into SunRiver's multiuser graphics environment. There you can enjoy 640- by 480-pixel, 16-color (EGA Plus) graphics.

The SunRiver system consists of multiple terminals (the original system uses dumb fiber-optic workstations) connected in star fashion to an 80386-based host PC (through a host adapter) at data rates of 32 megabits per second. The host and PC with a PC LightCard are supported on SCO Xenix System V, which runs DOS under Unix.

Two strands of multimode optical-fiber cabling are connected to each board with ST-type connectors terminating on the cards. Each card has an LED driving light at 850-nanometer wavelengths for distances of as much as 300 meters to a PIN photodiode receiver on another card. A PIN photodiode receiver catches light pulses from other cards on the network.

Features include EGA, CGA, and monochrome graphics options, multiple virtual terminals through the PC function keys, mouse connection through the on-board serial port, file transfer, and local printing of remote host applications.



SunRiver's LightCard plugs into fiber optics.

Price: $899; four-user adapter for host 80386, $799.
Contact: SunRiver Corp., 108 Business Park Dr., Jackson, MS 39213, (601) 957-0100.
Inquiry 873.

Board Supports Video/Data/Voice

With a PCAT-300 board and a videodisk player, you can store up to 150 hours of audio, up to 221 megabytes of data, up to 54,000 pictures, or any combination. Each video frame can have up to 10 seconds of audio and 4096 bytes of data.

The company claims the main reason the PCAT lets you store so much information so quickly is its use of analog technology (rather than digital). This saves time during the premastering phase because you don't need to keep stopping and starting the disk to modify input to correct for errors. As soon as the PCAT loads information onto the disk through its 500K bytes of RAM, you're ready to make copies.

The PCAT works with IBM PC AT- and PAL/NTSC-compatible video input. The dynamic range is 78 decibels, and the bandwidth is either 3.4 kHz for voice or 11 kHz for higher fidelity. Signal-to-noise ratio is 40 decibels, and the digital data is 6032 bytes per frame or 325 megabytes per disk. Data transfer is rated at 1.45 megabits per second.

With your own encoder, you prepare audio data on an audio tape with beep tones, and data is supplied on 1.2-megabyte or 360K-byte DOS-compatible disks. You can subsequently add digital data in real time from an encoded disk. You need your own videodisk player and video disks.
Price: $1984.
Contact: EECO, Inc., 1601 East Chestnut Ave., P.O. Box 659, Santa Ana, CA 92702, (714) 835-6000.
Inquiry 875.

Paradise with a VGA Plus

The VGA Plus 16 Card supports 16-bit video graphics at up to 800 by 600 pixels, and it's compatible with the IBM PC, XT, AT, PS/2 Models 25 and 30, and compatibles.

In its 640- by 400-pixel resolution mode, the Paradise VGA Plus 16 card displays 256 colors out of a palette of 262,144 colors. At 800- by 600-pixel resolution, the card displays up to 16 on-screen colors and 132 columns of text.

The card supports a 16-bit data path and Western Digital BIOS to provide high performance for AT users. It also supports all pre-EGA standards, including Hercules monochrome graphics. The company claims it is 400 percent faster than the IBM VGA card.

Also standard is Western Digital's proprietary Auto-Sense feature, which checks system bus timing and peripheral and memory configuration to make certain it's safe to run a 16-bit video BIOS in your system.
Price: $499.
Contact: Western Digital Imaging, 800 East Middlefield Rd., Mountain View, CA 94043, (415) 960-3350.
Inquiry 874.

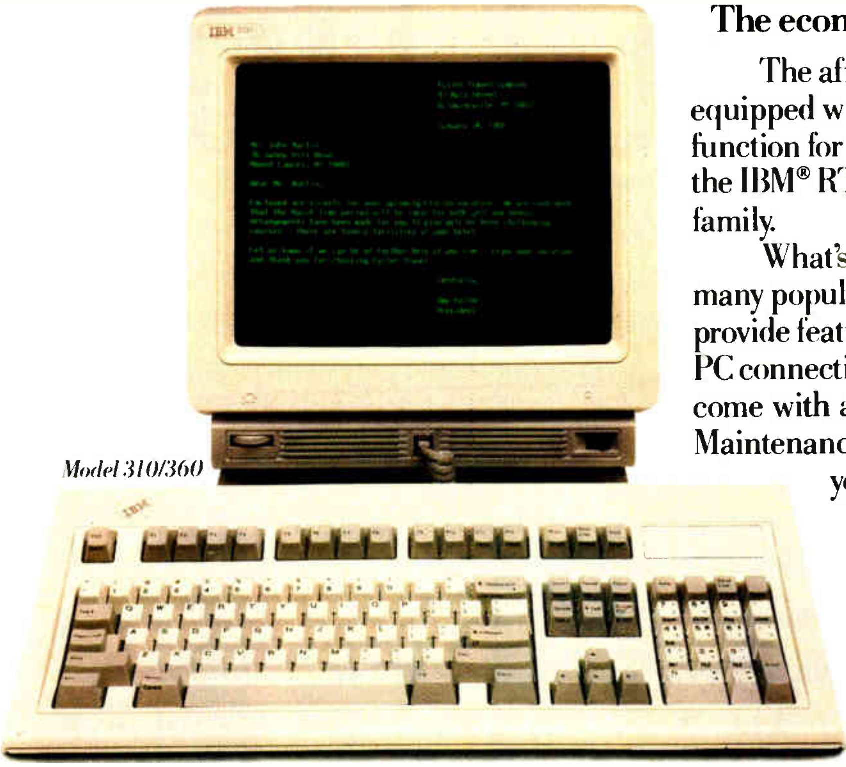
Turn Your Epson Printer into a Scanner

The SX-1000 Scanning System from Desktop Technology turns your Epson FX, MX, RX, or LQ printer into a scanning system.

Like other scanners, it allows you to digitize hard-copy drawings and photographs onto disk files that can be imported to programs such as Ventura Publisher and Aldus PageMaker. The SX-1000 works with ATs with at least 512K bytes of hard disk memory and a CGA-, EGA-, or Hercules-compatible display and mouse.
Price: $249.95.
Contact: Desktop Technology Corp., 986 Mangrove, Suite B, Sunnyvale, CA 94086, (408) 738-4001.
Inquiry 888.

continued

The best thing next to an IBM PC. Or any PC.



Model 310/360

The economics of IBM ASCII displays.

The affordable Models 310 and 410, when equipped with cartridges, offer PC terminal function for all multi-user PCs. That includes the IBM® RT-PC™ computer and the IBM PS/2™ family.

What's more, Models 310 and 410 offer many popular emulations. Optional cartridges provide features such as concurrent DEC™ and PC connectivity, and auto dial. Both models come with a 3-year warranty. Add an IBM Maintenance Agreement, and you'll get five years of IBM service for just $54.

The ergonomics of IBM ASCII displays.

They're not only economically attractive, they're easy to look at. Flat 14" screens offer non-glare viewing. Green or amber/gold short-persistence phosphors produce crisp character resolution. And each model uses the advanced 102-key IBM keyboard.

Model 410/460

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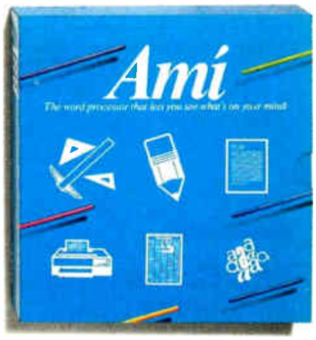


All of us want beautiful, professional-looking results from our word processing.

But who has time for the processing?

Who has time to manipulate columns and margins, align paragraphs, justify lines, tinker with leading, insert graphics and wrap text?

Let's face it. Writing is hard enough

without having to struggle with formatting when you're finished.

Well, now you don't have to.

Because now there's a word processor that lets you create your words and your page layouts *at the same time*—as one intuitive train of thought.

While making the entire process easier, friendlier and more accessible than you ever dreamed possible.

Also a whole lot faster.

In fact, Amí™ is designed to save you about three quarters of the time—and effort—you're currently spending on everything from simple letters and memos to presentations, reports and multi-column newsletters.

For people who do Windows. And people who don't.

With its WYSIWYG screen display, powerful use of frames and interactive dialog boxes, Amí looks a lot like a desktop publisher.

But it's actually a serious word processor that makes the most of the Microsoft® Windows environment.

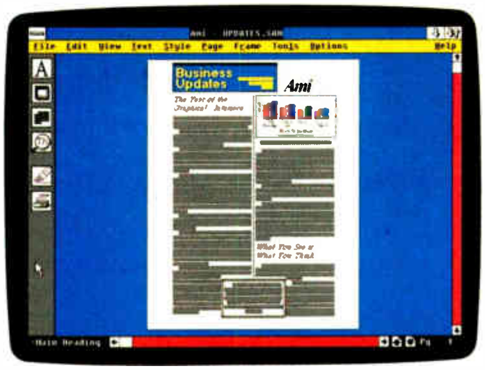
(If you don't have Windows, don't worry. A runtime version is included with Amí.)

Amí gives you everything you need to process words quickly. Like complete and efficient keyboard commands (or mouse, if you insist). A 130,000-word spelling checker. Search and replace. Cut, copy and paste. Headers and footers. Undo functions. Context sensitive help. And much more.

Amí even gives you a choice of ways to write.

In Draft Mode, you can put your head down, get your words into the computer as fast as humanly possible and worry about formatting later.

Layout Mode, on the other hand, gives you instant onscreen formatting, with automatic spacing, fonts, special effects and all the other things we mentioned at the top of this ad.



Now you can easily edit text and graphics and see the results onscreen before you print.

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You can integrate text and graphics. Import both from other programs. And admire your documents from four fully editable page views.

There's no time like the present.

Amí is the next generation in word processing. Yet it sells at a price that would make your grandparents nostalgic.

Amí comes complete with 25 pre-designed style sheets, so writing and formatting time is reduced to practically nothing.

Just $199 suggested retail.

Buy it by March 15, 1989 and you'll pay under $150. No kidding.

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All you have to do is call.

But hurry. Time's wasting.

For the dealer nearest you, call Samna at 1-800-831-9679.

Circle 238 on Reader Service Card

DEC Connectivity without the Cost

The Netmate/XLS is an 80386-based workstation specifically designed to perform your local data processing *and* to connect to networking environments like Ethernet and Digital VAX networks.

Booting up is especially easy with DataMedia's Netcard, a credit-card sized ROM card. You insert it into the Netcard slot of the machine, and it provides the boot code for Sun's NFS and for DEC's PCSA.

Once you're booted up, the Netmate/XLS will run multiple MS-DOS and VT-241 sessions in a multi-windowed Windows/386 environment with VGA and DEC VT-340 graphics support. Display resolution is 800 by 480 pixels, with 16 colors.

Performance is rated at 4.66 MIPS (millions of instructions per second), and the standard system comes with an Intel 80385 32-bit cache controller with 32K bytes of static RAM, 2 megabytes of RAM, 128K bytes of ROM, and 256K bytes of display memory.

There are three AT-style slots inside every Netmate/XLS, with a 32-bit slot for up to 6 megabytes of optional memory. Ports for RS-232C communication, your printer, and your mouse are standard—there's an option for an external SCSI port.

Also available as options are an 80387 numeric coprocessor and enhanced VGA color graphics for up to 1024-by 768-pixel resolution.

Three models are available: a diskless version, one with a 1.44 megabyte 3½-inch floppy disk drive, and one with the floppy disk drive and an 80-megabyte hard disk drive (with a 40-megabyte hard disk drive available as an upgrade option).

DataMedia's Netmate connects to Ethernet.

Price: $4895 to $6995.
Contact: Datamedia Corp., 11 Trafalgar Sq., Nashua, NH 03063, (603) 886-1570.
Inquiry 881.

10Net Communications Bridges to Token Ring

The Token Ring Bridge from 10Net Communications allows you to connect all the 10Net networks, both 10 megabit- and 1-megabit-per-second ones, to IBM-compatible token rings.

Like other hardware from 10Net, each board is equipped with software for the company's unique distributed processing environment. For token rings, 10Net offers a 10Net Plus for Token Ring software package.

The Token Ring Bridge is equipped with utilities for recording and viewing performance statistics over the network, and it requires a dedicated IBM XT, AT, or compatible. It also acts as a cluster traffic filter, eliminating cross-bridge traffic.

The next step, say company officials, is a 10Net-compatible LAN Manager network operating system, scheduled to ship this quarter.

Price: Bridge, $495; 10Net Plus software, $195.
Contact: 10Net Communications, 7016 Corporate Way, Dayton, OH 45459, (800) 358-1010; in Ohio, (800) 782-1010; in Canada, (800) 544-6105.
Inquiry 877.

FDDI Reaches the Personal Computer

Two 125-megabit-per-second local-area networks (LANs) are designed specifically for 80286- and 80386-based systems, says manufacturer Simple Net Systems.

The company claims that both the LaserLAN and the LaserLAN Plus are compatible with evolving Fiber Distributed Data Interface standards, as drafted by the ANSI X3T9.5 committee. FDDI is to data communications what Integrated Services Digital Networking is to telecommunications—the standard set of specifications for business networking in the 1990s.

Both networks are optical fiber-based systems that allow you to transmit data at more than 10 times the rate of Ethernet-based systems, one of the most popular standard PC-based LANs. This data rate feature has become important in graphics environments. Another valuable asset of optical fiber-based LANs is the fact that transmission distances can be lengthened without the need for repeaters.

LaserLAN is an LED-driven system consisting of a 16-bit full-length board with 128K bytes of RAM, Novell NetWare drivers, and a proprietary NetBIOS interface. Distances between workstations can be up to 500 meters. LEDs drive light through multimode optical fiber at 825-nanometer wavelengths.

LaserLAN Plus is a semiconductor laser-based 16-bit board with a NetWare driver and the same proprietary NetBIOS interface. Because LaserLAN Plus boards use semiconductor lasers to pulse light down single-mode optical fibers at 1300-nanometer wavelengths, distances between workstations can be as much as 1500 meters.

Both boards contain PCO transmitters and receivers and the Advanced Micro Devices chip set that's designed around the evolving FDDI. The topology of FDDI is a counter-rotating token ring. Both LaserLAN and LaserLAN Plus operate under Simple-Ware, Simple Net Systems' proprietary network operating system.

Price: LaserLAN, $4095 per node; LaserLAN Plus, $5495 per node.
Contact: Simple Net Systems, Inc., 545 West Lambert Rd., Suite A, Brea, CA 92621, (714) 529-8850.
Inquiry 878.

continued

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Luxury LanProbe LAN Analyzer

The LanProbe and accompanying software allow for network analysis of Ethernet LANs, according to manufacturer Eon Systems. It's a proprietary design; industry experts admit the nearest designed-from-scratch network management software standard is years away.

The LanProbe is designed for network planning, maintenance, and management, and it works on top of Microsoft Windows (version 2.0 or higher) on any IBM AT, PS/2, or compatible with some basic requirements.

LanProbe features a real-time map of the network, cabling diagnostics, a test library, and remote monitoring.

Specifically, functions include monitoring the cable, communications software, traffic load, equipment malfunction, and user error. It performs statistics-gathering, maintains an events log, does cabling testing, performs packet traces, and maintains several segment maps.

The hardware device attaches to the logical end of an Ethernet segment—usually thin or thick coaxial—and it monitors all the traffic. It will work with optical fiber and twisted-pair cabling with the addition of a transceiver.

Network data relating to the segment is then transferred to a workstation running the system's ProbeView software through an RS-232C port, an Ethernet adapter, or a modem connection.

The host computer must also have 450K bytes of free RAM, a floppy disk drive, 2 megabytes of free hard disk space after installing Windows, EGA or VGA graphics, and a mouse.

Price: $8000; ProbeView software, $5000.

Contact: Eon Systems, Inc., 10601 South De Anza Blvd., Suite 305, Cupertino, CA 95014, (408) 252-5440.

Inquiry 882.

Twisted-Pair Ethernet Card Supports the Micro Channel

A new Ethernet card from InterLAN is designed specifically for the IBM PS/2s and uses the same unshielded twisted-pair wiring your telephone company has been installing for years.

Extra pairs of this unshielded twisted-pair wiring are already in the walls of most buildings. Lately, any installation of telecommunications electronics like Private Branch Exchanges has involved the installation of eight pairs.

Unlike some twisted-pair Ethernet cards that need a separate transceiver, the NI9210-UTP includes the SynOptics transmitter/receiver chip that matches the SynOptics transmitter/receiver chip in SynOptics' concentrators, Models 1000, 1010, and 2500, that you put in your wiring closet. Each NI9210-UTP also includes an attachment unit interface connection if you prefer coaxial cabling.

But with twisted-pair wiring, all you do is plug a patch cable with RJ-45 connectors from the wall plug into the card in each office. Then you connect the appropriate wires from the office walls to the wires in the wiring closet.

Each board comes with extras to make installation, testing, and maintenance easier. Each card has 16 megabytes of dual-ported on-board RAM for packet buffering. On-board software helps you configure the board by taking advantage of the PS/2 Adapter Description File. Diagnostic software is also included so you can diagnose workstation configuration problems. Some cards have to be configured differently with graphics terminals, for example.

There's also support for what businesses are choosing most in network operating systems—Novell's Advanced NetWare, 3Com's 3+, Transmission Control Protocol/Internet Protocol (TCP/IP) workstations, and FTP, Inc.'s PC/TCP.

Price: $595.

Contact: InterLAN, Inc., 155 Swanson Rd., Boxborough, MA 01719, (508) 263-9929.

Inquiry 879.

All Your Files for CD-ROM

One of the problems with the more than 80 titles currently on CD-ROM is that only one person can use the massive amounts of information at a time—until now.

With CD-Net, all you need is access to a LAN, and you and nearly a dozen friends can use the same disk at the same time. You can set it up as a library of these nonproprietary files, or you can set it up to serve your business's needs with proprietary files on CD-ROM.

CD-Net is a stand-alone CD-ROM read-only network server that includes up to 11 CD-ROM players per unit. It comes standard with the CD-ROM players, a network interface card, cables and connectors, server and workstation software, and an application menu to control switching between databases.

Four standard models support 1 to 100 workstations, with Models 50 and 100 based on 80286 systems and including an expansion chassis for adding four or six CD-ROM players. The single-user Model 25 includes one to four drives, while Models 50 and 100 are available in one-, two-, or three-drive configurations. The Model 200, a tower 80386, can include from one to five drives. The expansion chassis comes in the single-user Model 10, for up to three drives; a multiuser Model 10s (designed to work with Model 50 and Model 100), which supports up to four drives; and the Model 20 expansion chassis, designed to work with the Model 200 tower to support up to six drives.

It supports simultaneous and independent access of information on the same player and multiple players for any workstation on the network. The resident memory management software recycles the data in RAM on a most-recently used basis—so frequently used information, like directory structures, usually remains in RAM.

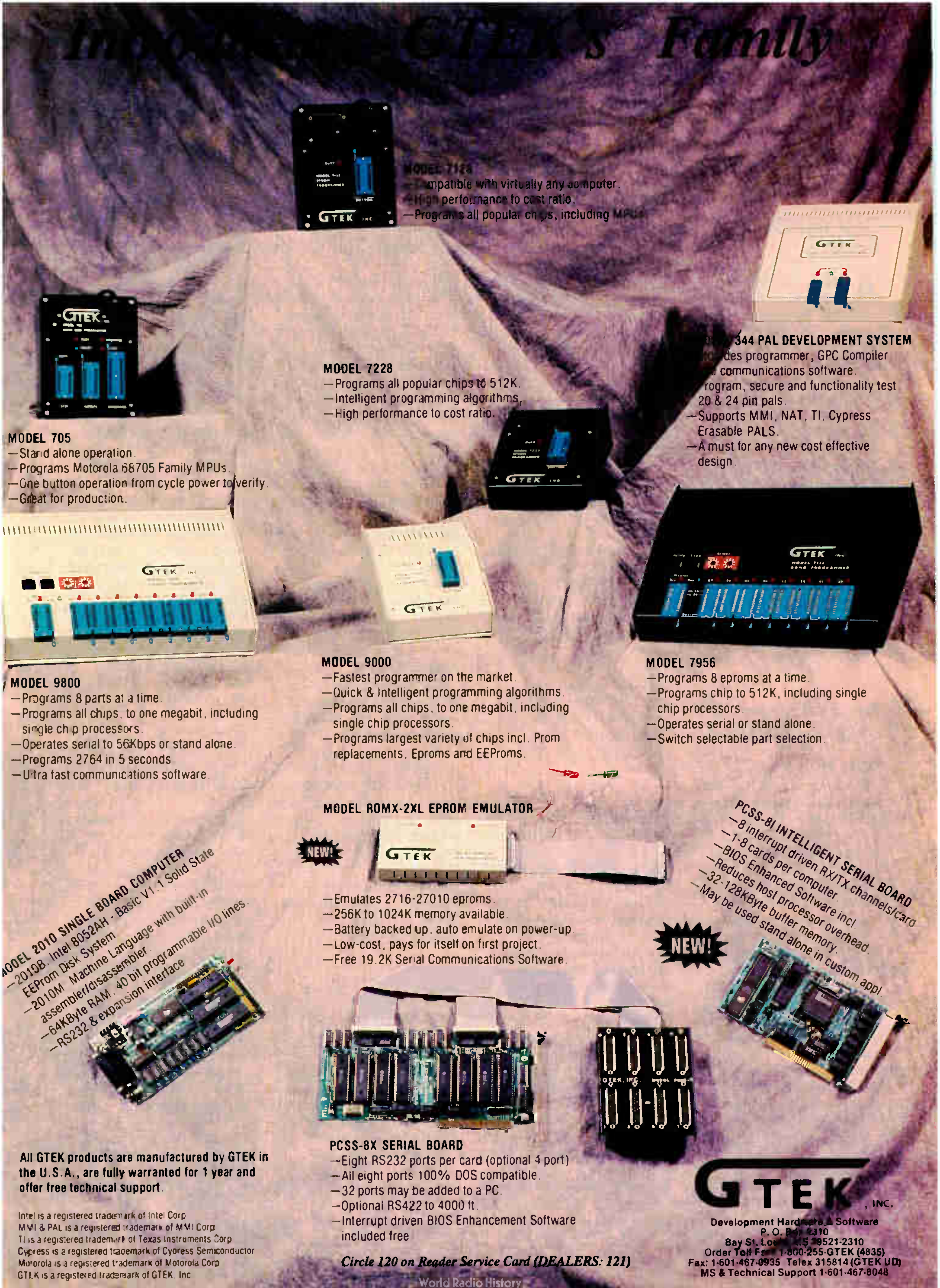
Each CD-ROM drive has between 400K bytes and 2 megabytes of memory for caching. On each drive, storage capacity is 633 megabytes, data transfer rate is 153.6 kilobits per second maximum, rotation speed is 200 to 400 rotations per minute, and average access time is 250 milliseconds, noncached. The CD-Net tower measures 8 by 25 by 16 inches and weighs 32 to 45 pounds.

Price: Model 50 with two drives, $4145; Model 200 with three drives, $9695; three-drive expansion chassis for Model 50, $3195; five-drive expansion chassis for Model 200, $6450. Add $1000 for token-ring hardware.

Contact: Meridian Data, Inc., 4450 Capitola Rd., Suite 101, Capitola, CA 95010, (408) 476-5858.

Inquiry 880.

continued



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MODEL 7128
—Compatible with virtually any computer.
—High performance to cost ratio.
—Programs all popular chips, including MPUs.
MODEL 705
—Stand alone operation.
—Programs Motorola 68705 Family MPUs.
—One button operation from cycle power to verify.
—Great for production.
MODEL 7228
—Programs all popular chips to 512K.
—Intelligent programming algorithms.
—High performance to cost ratio.
344 PAL DEVELOPMENT SYSTEM
des programmer, GPC Compiler
communications software.
rogram, secure and functionality test 20 & 24 pin pals.
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—Programs all chips, to one megabit, including single chip processors.
—Operates serial to 56Kbps or stand alone.
—Programs 2764 in 5 seconds.
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MODEL 9000
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—Quick & Intelligent programming algorithms.
—Programs all chips, to one megabit, including single chip processors.
—Programs largest variety of chips incl. Prom replacements, Eproms and EEProms.
MODEL 7956
—Programs 8 eproms at a time.
—Programs chip to 512K, including single chip processors.
—Operates serial or stand alone.
—Switch selectable part selection.
MODEL ROMX-2XL EPROM EMULATOR
NEW!
—Emulates 2716-27010 eproms.
—256K to 1024K memory available.
—Battery backed up, auto emulate on power-up.
—Low-cost, pays for itself on first project.
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MODEL 2010 SINGLE BOARD COMPUTER
—2010B, Intel 8052AH - Basic V1.1 Solid State EEProm Disk System
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—Eight RS232 ports per card (optional 4 port)
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Cool Your Chips, Buster

A heat sink kit from Scitech reduces microprocessor and coprocessor chip temperatures by as much as 30° Fahrenheit, the company claims.

Two versions are available, based on the dimensions of the chips. Model 1 works with 80286, 80386, and 80387 square chips. Model 2 works with the 80287, 8088, 8086, 8087, and V20.

You simply apply the conductive adhesive to the top of the chip and add the tiny aluminum heat-dissipation device.
Price: $10 for Model 1; $5 for Model 2.
Contact: Scitech, Inc., P.O. Box 334, Groves, TX 77619, (409) 962-3176.
Inquiry 884.

Pentax Scanner for Desktop Publishing

The SB-A4301 Image Scanner is a 16-level grayscale flatbed scanner with 300-dot-per-inch resolution.

It works with the IBM XT, AT, and compatibles with at least 640K bytes of RAM and 10 megabytes of hard disk space. The IBM interface board allows for direct memory access to speed image transfer between the scanner and the computer.

The scanner is designed to be used in a desktop publishing or optical-character-recognition (OCR) environment. Each device contains a charge-coupled device (CCD), an advanced controller chip, and a folded-path optical system.

The folded-path optical system includes the flatbed scanner concept (to make it easier to scan thick books, for example) and the specific light path from the CCD element. The illumination source is a high-luminocity fluorescent lamp.

Resolution is variable from 39 to 300 dpi in 3-dpi increments. Contrast has 10 selectable levels, and there are three settings for handling image density.

Each scanner comes bundled with three desktop publishing interfaces: GEM Desktop (an icon-based overlay for DOS); GEM Scan, for setting scan variables and editing a scanned image prior to its transfer to desktop publishing packages like Ventura Publisher and Aldus PageMaker; and an OCR package that can learn different typefaces. GEM Desktop and GEM Scan are from Digital Research, and the OCR program is from Citadel in the U.K.
Price: $2195.
Contact: Pentax Teknologies, 880 Interlocken Pkwy., Broomfield, CO 80020, (303) 460-1600.
Inquiry 887.

Joystick for Any Computer

A joystick-like cursor-positioning tool offers you an easier way to move the curser on the screen without special software.

It attaches on the outside of any keyboard that has the cursor keys in the 2, 4, 6, and 8 positions, and you move the knob like a joystick in the direction you want to move. You can also move the joystick to page up, page down, or set a macro on the 5 key and access that by pressing down on the joystick.
Price: $29.95.
Contact: Interlock, Inc., P.O. Box 2160, Castro Valley, CA 94546, (800) 541-2429; in California, (800) 643-6100.
Inquiry 886.

This Laptop's a Reader, Too

A stand-alone CD-ROM reader called DynaBook is the first CD-ROM reader that is also a personal computer. It's basically a self-contained laptop computer with a CD-ROM drive and a touchscreen, but no keyboard.

The 16-pound DynaBook has many of the standard features of an AT-compatible laptop, such as a 10-MHz 80286 processor, 640K bytes of RAM, a 3½-inch floppy disk drive, and serial and parallel ports. The system also has a paper-white LCD screen with 720- by 400-pixel resolution and a transparent touchscreen with a resolution of 25 dots per inch and 16-level pressure sensitivity. It also has a two-channel headphone connector.

Although the system does not come with a keyboard, a keyboard port is available for users who need one.

Scenario officials claim that when you add a keyboard, all standard CD-ROM applications will run as usual. A set of development tools is also available for applications developers.
Price: $4995.
Contact: Scenario, Inc., 235 Holland St., Somerville, MA 02144, (617) 625-1818.
Inquiry 883.

Enhance Your AT Keyboard with CAD Macros

The AutoKey 20/20 from Mextel is a keyboard attachment that allows you to add as many as 400 macros to many standard keyboards using about 20 macro keys.

You get access to 20 different menus, each containing 20 user-programmable function keys. You can organize menus on 20 flip-down pages that attach to the AutoKey. Each unit also contains 8K bytes of CMOS RAM to store up to 8000 keystrokes, with a 32K-byte RAM chip available as an option.

With the AutoKey, there's no software to load. You work through the keyboard cable. But keyboard cables are different. Anything IBM-compatible will probably work through the standard 5-pin DIN connectors that have the pins organized in a half-moon pattern and a notch on the bottom. Other computers have proprietary connectors.
Price: $179.
Contact: Mextel, Inc., 159 Beeline Dr., Bensenville, IL 60106, (800) 888-4146; in Illinois, (312) 595-4146.
Inquiry 889.

PC Security Brings New Meaning to Charge Cards

Harcom Security Systems is betting that the use of personal credit cards will be the PC-security access method of the future.

With the PC-Watchman, you can control both general access and access to high-security files. Each unit consists of software and a half-length card for the IBM XT, AT, and compatibles. Once installed, PC-Watchman uses a magnetic reader interface that reads your credit card and tells the system whether or not to lock out the keyboard, for example. An alarm is optional.
Price: $495.
Contact: Harcom Security Systems Corp., 130 William St., New York, NY 10038, (212) 766-1802.
Inquiry 885.

continued

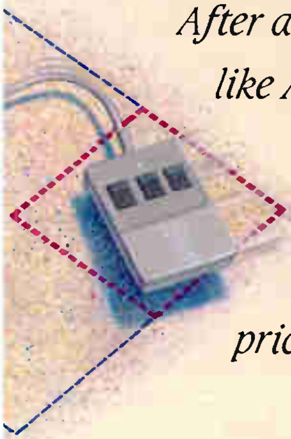
Rack and pinion for your PC.

The HiREZ™ Mouse. You can feel the difference on your first lap around the screen. The cursor responds more crisply to your control, moving 320 pixels for every inch on the desktop, versus 200 for ordinary mice. Built-in ballistic tuning and 30% less weight enable it to go the distance without dragging its tail, so you can cruise through your work in less time and deskspace.

The feeling of a sportscar instead of a station wagon.

HiREZ brings high performance to all your favorite PC software. And the Logitech name on the hood means you can count on what's inside. After all, we build mice for companies like Apple, AT&T, DEC, and H-P. All this mousepower comes with the ordinary sticker price of $149.00.

HiREZ travels less distance to complete the same task.



Because it requires less motion, HiREZ uses 62% less desk space.

For the name of your nearest dealer, call 800-231-7717. *In California:* 800-552-8885. *In Europe:* ++41-21-869-96-56.

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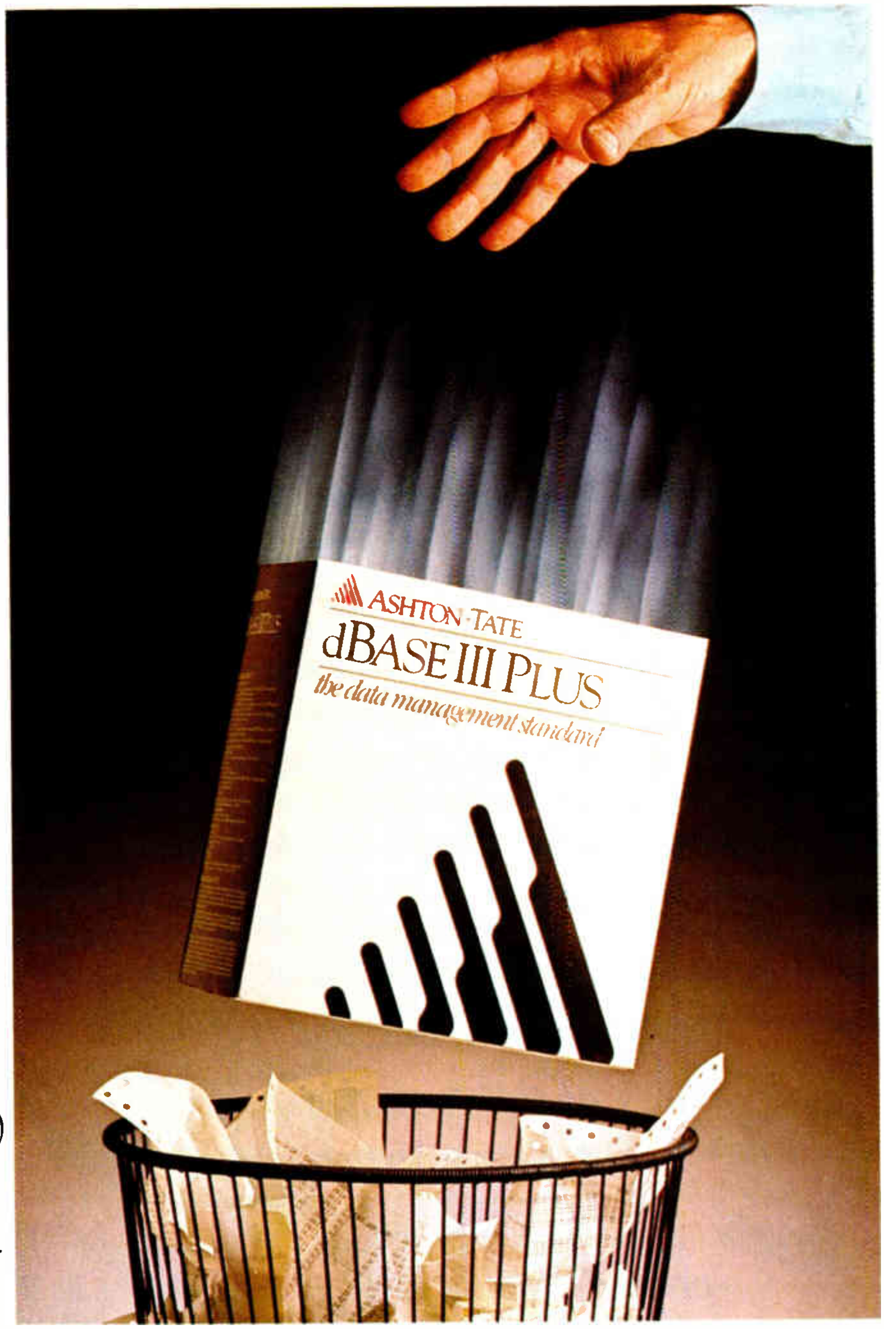
Circle 157 on Reader Service Card (DEALERS: 158)

EVERYBODY

But they're not all switching to the database management system you might expect.

In a recent industry survey,* two-thirds of the respondents who intended to buy a DBMS did not intend to buy dBASE.

And, perhaps coincidentally, two-thirds of recent R:BASE® buyers have used another DBMS before.



Why are they switching to R:BASE?

Because nobody really needs a DBMS: they only need what a DBMS can do.

And users find that the friendly facade of other software is fine for questions. But R:BASE has the right answers for their information management needs.

With R:BASE, you can handle all your data management (not just queries) without learning a single command. Our Prompt By Example (PBE) lets you point-and-pick, then R:BASE does the work.

When you find that you're repeating yourself, you automate simply by recording your actions in a macro file.

Or use our application generator to quickly create complete, correct business programs without touching a line of program code.

Data is data, but information is power.

R:BASE gives you that power.

And even impartial judges seem to agree: *PC Magazine, Software Digest, Datapro* and *InfoWorld* all just gave

IS DOING IT.

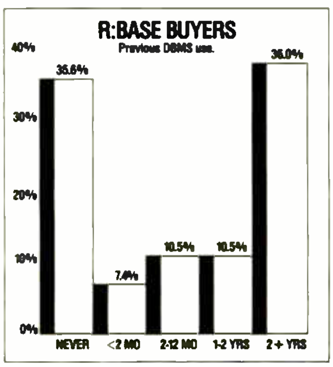
R:BASE their highest marks.

Because to its ease-of-use, R:BASE adds speed, functionality and data integrity in a combination you don't get with dBASE, Paradox, DataEase, Oracle or any of the other contenders.

R:BASE is optimized for speed, with an intermediate code compiler that makes your applications sing. And a true compiler is on its way.

You can use its English-based language in command mode, to modify programs R:BASE writes for you, or to write your own solutions from scratch.

Simple menus, prompts and our "paint-the-screen" techniques make sophisticated screens, forms and reports quick and easy to create. With R:BASE forms, you can view and update data from several tables at the same time. Create computed fields. Include scrolling regions so you can work with all the data from other tables. Add rules for data integrity.



And R:BASE is relational, so your rules stay with the tables—applications can't avoid or change them. And forms can be set up to cascade changes through related tables. So you can trust the information you get.

We also give you an SQL implementation that even novices can use to create simple yet powerful queries.

PC MAGAZINE

Software Digest

datapro

INFO WORLD

And networking is free for up to three users. It's also easy, so any single-user application can be run on a multi-user LAN with a single command. And our advanced concurrency control, unlike earlier-generation auto-refresh in other DBMSs, won't bring your network to its knees when you expand with our Six-Pack or Network Unlimited versions.

Applications that just won't quit.

R:BASE is the second-largest selling PC DBMS in the world, and it's backed by all the training, service and third-party support you'll ever need.

It's providing end-users with the information they need in large businesses and small. On stand-alone PCs and in networks sharing data with minis and mainframes. In insurance and real estate companies, factories and universities, government offices and the storefront down the street.

DO IT.

Check out what R:BASE can do for you with your local dealer, or write: Microrim, Inc., P.O. Box 97022, Redmond, WA 98073-9722.

Call 1-800-624-0810 today.

*Compute: & Software News, 9/5/88. Microrim and R:BASE are trademarks of Microrim, Inc. Other products and services mentioned are not. © Microrim, Inc. 1988.

New Actor Does Windows

Version 1.2 of The Whitewater Group's Actor takes advantage of 500K bytes of RAM under the Lotus/Intel/Microsoft Expanded Memory Specification (LIM/EMS) 4.0. It also supports Windows 286 and Windows/386 version 2.1.

Actor is an object-oriented programming language and environment that runs under Microsoft Windows. It produces stand-alone Windows applications.

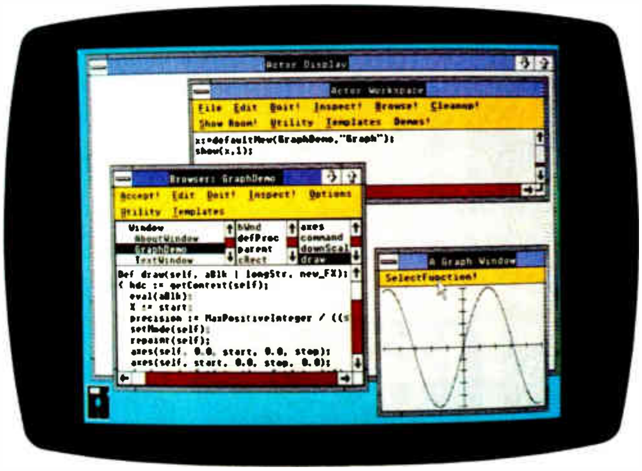
Version 1.2 offers more Windows error checking, multiple applications sessions within the limits of available memory, horizontal scrolling and support for cursor keys on edit windows, and a larger symbol table.

Actor 1.2 runs on the IBM PC, XT, AT, and PS/2s with at least 640K bytes of RAM, a mouse, and a graphics card. Actor 1.2 also requires Windows.

Price: $495.

Contact: The Whitewater Group, 906 University Place, Evanston, IL 60201, (312) 491-2370.

Inquiry 1139.



The Whitewater Group's Actor 1.2.

Link It

Pocket Soft calls .RTLink the first true dynamic linker for MS-DOS. The company reports that the linker reduces the size of MS-DOS programs on disk by as much as 92 percent.

The way the program works is by letting you eliminate code redundancies among executable files by sharing language library and user-written routines at run time. Your combined code is placed in a single run-time library with an .RTL extension.

The program works with any compiler or assembler that produces .OBJ files in Intel or Microsoft format, Pocket Soft reports. Borland's Turbo C does not work on the system.

Price: $495.

Contact: Pocket Soft, Inc., P.O. Box 821049, Houston, TX 77282, (713) 460-5600.

Inquiry 1136.

Pascal on the Mac

TML Pascal II combines TML Pascal and MPW (Macintosh Programmer's Workshop). The updated program is designed for creating MPW tools, HyperCard XCMDs and XFCNs, and other programs.

Pascal II runs under the MPW shell and supports Object Pascal, MacApp, and 68020/68881 code generation. In fact, it's the first non-Apple product that can compile MacApp code.

You can generate assembly source code and object code output, as well as integrate its code with other MPW languages, including MPW C and Assembler. Included with the program is the TML Pascal compiler, a Pascal Source formatting tool, a cross-reference tool, and example programs on disk. MPW version 2.0.2 software and documentation are also included.

The standard source code library is also upgraded, with new examples covering QuickDraw, serial drivers, HyperCard, and XCMDs.

TML Pascal II requires a Mac Plus, SE, or II with a 3½-inch floppy disk drive and a hard disk drive.

Price: $125.

Contact: TML Systems, Inc., 8837-B Goodbys Executive Dr., Jacksonville, FL 32217, (904) 636-8592.

Inquiry 1135.

MS-DOS Virtual Memory

Running on top of Phar Lap's 386|DOS-Extender, 386|VMM lets you create applications for 80386-based systems. Phar Lap reports that applications can be many megabytes, expanding beyond available RAM.

The virtual memory system uses the demand-paging hardware that's built into the 80386 central processor. The program automatically swaps code and data as needed to a standard MS-DOS file.

Phar Lap's 386|DOS-Extender is a run-time system for executing protected-mode applications on 80386 machines. If you're already running some applications under 386|DOS-Extender, you can upgrade them to use the Virtual Memory Manager with little or no source code.

Price: $295.

Contact: Phar Lap Software, Inc., 60 Aberdeen Ave., Cambridge, MA 02138, (617) 661-1510.

Inquiry 1134.

continued

A C Source Generator

Pro-C 1.2 is a C source code generator that doesn't require a run-time environment, according to Vestronix. It will generate C code for applications under MS-DOS, QNX, Xenix, and Unix.

The program is made up of menu-driven interrelated modules that support record definition; menu, screen and report generation; and update processing. The latest version of Pro-C offers control over screen layout and a post-generation procedure.

The program supports Microsoft C 5.x, Turbo C 1.x, Lattice C 3.21, and Zortech C. C-ISAM, C-Tree, and Btrieve file managers are also compatible.

Pro-C runs on the IBM PC, XT, AT, and compatibles with at least 512K bytes of RAM, DOS 2.0 or higher, and a hard disk drive.

Price: DOS version, $495; QNX version, $495 and up; Xenix and Unix versions, $995 to $1500; Pro-C Workbench source code libraries, $245.

Contact: Vestronix, Inc., Allen Square, 180 King St. S, Suite 230, Waterloo, Ontario, Canada, N2J 1P8, (519) 745-2700.

Inquiry 1137.

QNX vs. OS/2 UNIX

QNX®: Bend it, shape it, any way you want it.

ARCHITECTURE If the micro world were not so varied, QNX would not be so successful. After all, it is the operating system which enhances or limits the potential capabilities of applications. QNX owes its success (over 70,000 systems sold since 1982) to the tremendous power and flexibility provided by its modular architecture.

Based on message-passing, QNX is radically more innovative than UNIX or OS/2. Written by a small team of dedicated designers, it provides a fully integrated multi-user, multi-tasking, networked operating system in a lean 148K. By comparison, both OS/2 and UNIX, written by many hands, are huge and cumbersome. Both are examples of a monolithic operating system design fashionable over 20 years ago.

MULTI-USER OS/2 is multi-tasking but NOT multi-user. For OS/2, this inherent deficiency is a serious handicap for terminal and remote access. QNX is both multi-tasking AND multi-user, allowing up to 32 terminals and modems to connect to any computer.

INTEGRATED NETWORKING Neither UNIX nor OS/2 can provide integrated networking. With truly distributed processing and resource sharing, QNX makes all resources (processors, disks, printers and modems anywhere on the network) available to any user. Systems may be single computers, or, by simply adding micros without changes to user software, they can grow to large transparent multiprocessor environments. QNX is the mainframe you build micro by micro.

PC's, AT's and PS/2's OS/2 and UNIX severely restrict hardware that can be used: you must replace all your PC's with AT's. In contrast, QNX runs superbly on PC's and literally soars on AT's and PS/2's. You can run your unmodified QNX applications on any mix of machines, either standalone or in a QNX local area network, in real mode on PC's or in protected mode on AT's. Only QNX lets you run multi-user/multitasking with networking on all classes of machines.

REAL TIME QNX real-time performance leaves both OS/2 and UNIX wallowing at the gate. In fact, QNX is in use at thousands of real-time sites, right now.

DOS SUPPORT QNX allows you to run PC-DOS applications as single-user tasks, for both PC's and AT's in real or protected mode. With OS/2, 128K of the DOS memory is consumed to enable this facility. Within QNX protected mode, a full 640K can be used for PC-DOS.

ANY WAY YOU WANT IT QNX has the power and flexibility you need. Call for details and a demo disk.

THE ONLY MULTI-USER, MULTI-TASKING, NETWORKING, REAL-TIME OPERATING SYSTEM FOR THE IBM PC, AT, PS/2, THE HP VECTRA, AND COMPATIBLES.

Multi-User	10 (32) serial terminals per PC (AT).	**C Compiler**	Standard Kernighan and Ritchie.
Multi-Tasking	64 (150) tasks per PC (AT).	**Flexibility**	Single PC, networked PC's, single PC with terminals, networked PC's with terminals. No central servers. Full sharing of disks, devices and CPU's.
Networking	2.5 Megabit token passing. 255 PC's and/or AT's per network. 10,000 tasks per network. Thousands of users per network.		
Real Time	3,200 task switches/sec (AT).	**PC-DOS**	PC-DOS runs as a QNX task.
Message Passing	Fast intertask communication between tasks on any machine.	**Cost**	From US $450. Runtime pricing available.

QNX

For further information or a free demonstration diskette, please telephone (613) 591-0931.

Quantum Software Systems Ltd. • Kanata South Business Park • 175 Terrence Matthews Crescent • Kanata, Ontario, Canada • K2M 1W8

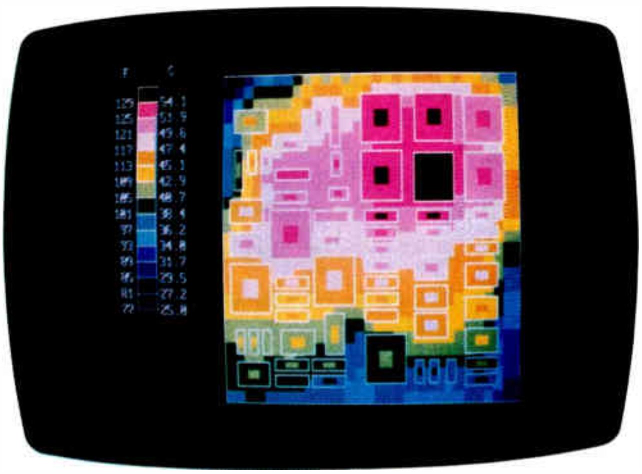
Circle 226 on Reader Service Card

Thermal Analysis

Thermal Analyzer is a three-dimensional thermal-analysis package. You can use the program to check your circuit board designs for potential thermal problems. It models component conduction, convection, and radiation characteristics, and it lets you predict thermal distributions and locate thermal problems in your designs after placing components.

By extracting information from the EE Designer III system database, Thermal Analyzer takes into consideration board size, density package type and orientation, copper density areas, and heat dissipation values. You can specify environmental parameters such as temperature and humidity, and the program uses three-dimensional modeling that simulates heat flow and thermal fields.

A component library is included, which you can add to and edit.



The 3-D Thermal Analyzer.

Thermal Analyzer runs on the IBM PC, XT, AT, PS/2s, and compatibles with at least 640K bytes of RAM, color graphics capability, a hard disk drive, and a mouse. It works with the EE Designer III electronic design system from Visionics.
Price: EE Designer III, $3995; Thermal Analyzer, $1000.
Contact: Visionics Corp., 343 Gibraltar Dr., Sunnyvale, CA 94089, (800) 553-1177; in California, (408) 745-1551.
Inquiry 1143.

Mac in the Lab

A program from GW Instruments turns a Mac II or SE into an oscilloscope, chart recorder, scrolling-strip chart recorder, or scan-line recorder.

MacInstruments turns the Mac into one of these while also offering the benefits of a computer-based system, such as mouse control, printing and storing functions, and export capabilities. You can zoom or pan through waveform data after sampling, or obtain simple statistics.

GW Instruments reports that MacInstruments samples data at high speeds because of its TurboDriver software. You can connect it with the MacAdios II data-acquisition system from GW instruments.

The TurboDriver software supports interrupt-driven background tasks, spooling to hard disk, and a variety of trigger and display options.
Price: $790.
Contact: GW Instruments, 35 Medford St., Somerville, MA 02143, (617) 625-4096.
Inquiry 1142.

Math on a Mac

Mathematical expression evaluation, plotting, and table generation is available in a $50 desk accessory for the Macintosh from Spectra Blue.

The program daMath, (pronounced "D.A. Math"), lets you evaluate mathematical expressions with up to three variables. You can make line graphs of the expressions over any range of *x* values. You can overlay multiple plots and make tables of function values that you can view and edit in a spreadsheet-like window.

Cut and paste is supported via the Clipboard, so you can use a page-layout or drawing application's graphics tools to modify daMath's graphics. You can also paste a table of data from daMath into a spreadsheet, word processor, or other application.

The program runs on the Macintosh Plus, SE, and II.
Price: $50.
Contact: Spectra Blue, Inc., 5225 East Pima, Suite 2A, Tucson, AZ 85712, (602) 327-4686.
Inquiry 1140.

National Instruments Upgrades Measure

National Instruments acquired rights to Measure from Lotus Development in April 1988 and has recently enhanced the data-acquisition and control program.

Measure consists of a set of data-acquisition drivers for Lotus 1-2-3 or Symphony for acquiring, formatting, and storing data directly into a spreadsheet. It acquires data using GPIB, RS-232C, and A/D interfaces.

Version 2.0 of Measure runs on the IBM PS/2 Models 50, 60, 70, and 80 and supports the company's new general-purpose interface bus (GPIB) boards and multifunction analog, digital, and timing I/O boards for the AT bus and PS/2 Micro Channel.

The AT-MIO-16 and the MC-MIO-16 are the new I/O boards from National Instruments. They feature programmable gain, a 12-bit A/D converter with 16 single-ended analog inputs, two 12-bit D/A converters, eight TTL-compatible digital lines, and three 16-bit counter/timer channels. The company claims that when Measure 2.0 is coupled with one of these new boards, you can acquire data 30 times faster on the AT or PS/2s.

Using Measure 2.0 with the AT- or the MC-GPIB boards, you can monitor, control, and communicate with IEEE-3488 bus-compatible engineering, scientific, or medical instruments in laboratory testing, production testing, and process monitoring and control applications.

National Instruments reports that the software user interface is unchanged in the updated version of Measure. If you've developed worksheets and macros under the original Lotus version, they will run on both the PC and PS/2s with Measure 2.0.
Price: $495.
Contact: National Instruments Corp., 12109 Technology Blvd., Austin, TX 78727, (800) 531-4742; in Texas, (800) 433-3488; in Canada, (800) 443-4484.
Inquiry 1141.

continued

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Standards are made, not born.

The leading UNIX® System on three generations of PCs, SCO™ XENIX® System V has revolutionized the way people look at both the UNIX System and PCs by revealing the amazing hidden potential of these standard hardware platforms.

In the process, SCO XENIX has become a true standard in UNIX System V software.

And like a true standard, SCO XENIX has opened up entire new markets of opportunity that have never before existed for microprocessor-based computers.

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SCO XENIX can be found running thousands of XENIX- and UNIX System-based vertical applications on powerful business systems supporting 16, 32, or even more users. And on graphics workstations running advanced engineering and scientific applications.

And, of course, on personal computers, running multiple DOS applications concurrently, or networking XENIX and DOS systems together.

Today, more and more end users are demanding the power that only UNIX System V software can bring to their standard hardware platforms.

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PC-Outline Gets a Boost

PC-Outline version 4.0 now has an 80,000-word dictionary and thesaurus from Proximity, multiuser capability, support for desktop publishing fonts, color capability, and support for a variety of printers and plotters.

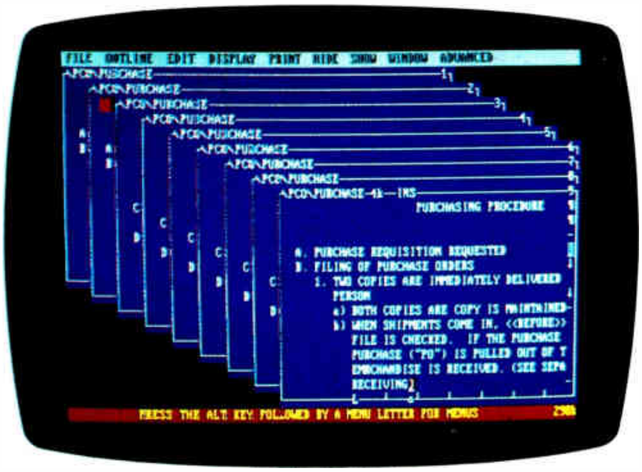
PC-Outline 4.0 runs on the IBM PC or compatibles with 256K bytes of RAM and DOS 2.0 or higher.

This version of PC-Outline is not a shareware product.

Price: $195.

Contact: Brown Bag Software, Inc., 2155 South Bascom Ave., Suite 114, Campbell, CA 95008, (800) 523-0764; in California, (800) 323-5335.

Inquiry 1148.



A sample outline from Brown Bag's PC-Outline.

What's the Big Idea?

This idea generator is designed to help you brainstorm, solve problems, and make plans using seven idea-generation techniques. The program provides links to Lotus Agenda.

The Idea Generator Plus helps you focus thoughts, stimulate ideas, and identify the best ideas and prepare them for use with Agenda, Think-Tank, or other outliners, or as DOS text files for use with a word processor.

The program encourages you to define your situation or problem, list goals, prioritize goals, and list the people involved. Then it provides seven techniques for generating ideas: focusing your goals one by one, reversing your goals, applying lessons learned from previous situations to current ones, searching for parallels between familiar activities and the situation at hand, showing other possible perspectives, focusing on the people involved, and making the most of your ideas.

You can print your idea files to your computer screen or printer, or prepare the files to link with other programs. A hot key converts idea files to Agenda's .STF file format, so you can export the files into Agenda views.

The Idea Generator Plus runs on the IBM PC and compatibles with at least 256K bytes of RAM, DOS 2.0 or higher, and two floppy disk drives or one floppy and one hard disk drive. The program is available on 5¼- or 3½-inch disks.

Price: $195.

Contact: Experience in Software, Inc., 2039 Shattuck Ave., Suite 401, Berkeley, CA 94704, (800) 678-7008; in California, (415) 644-0694.

Inquiry 1147.

Accounting Through Windows

Accounting by Design calls its first product the first accounting program that runs under the Microsoft Windows environment. Accounting by Design, which the company has dubbed "client write-up software," offers reports such as a current-period and year-to-date general ledger, and journals.

It includes a report generator that uses Windows graphics to show lines of reports on-screen. The program also has an integrity checker that lets you verify that accounts are correct and complete.

The program runs on any system that supports Microsoft Windows 286. A hard disk drive and printer are required; a mouse is recommended.

Price: $1000.

Contact: Accounting by Design, Inc., 2931 Shattuck Ave, Suite 103, Berkeley, CA 94705, (415) 845-4716.

Inquiry 1149.

continued

Check it Out

You'll never have to write another check, according to Checkfree Technologies, if you use its new check-writing program. The program removes funds from your account electronically and transfers them to institutions to which you make regular payments.

CheckFree keeps track of the account, transactions, balance, and budgets. The payments appear on your monthly bank statement, so you can verify that they are being made. The program has a check register on-screen with payments that the program has made automatically recorded and your balance adjusted for each bill paid or deposit made.

Each CheckFree customer has a personal account number for security. You enter data off-line, and transmissions to the processing center are encoded for added security. The program processes payments through the Federal Reserve bank network and never actually accesses your account, according to the company. At any time you have the ability to review, change, or cancel transactions, the company reports.

To use CheckFree, you purchase the start-up kit and fill out two registration forms. The company sends you a special account number, and you provide the company with your payment information.

CheckFree runs on the IBM PC and compatibles with 256K bytes of RAM, DOS 2.1 or higher, and a Hayes-compatible modem.

It also runs on the Mac 512K and up and the Apple II with 128K bytes of RAM; with either, you'll need the Hayes-compatible modem.

Price: Monthly service charge, $9 for about 20 transactions; start-up program, $19.50.

Contact: Checkfree Technologies, P.O. Box 897, Columbus, OH 43216, (614) 898-6000.

Inquiry 1146.

Make your point without a trace of doubt.

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If you've ever used a digitizer, you probably were surprised that it didn't do what you thought it would. You assumed that whatever you picked or moved or drew on the tablet would be accurately displayed on the screen and precisely reflected on output. In spite of its straight-forward appearance, it didn't take you long to learn that all digitizers were not created equal, or accurate, or even easy to use.

Today there's a new line of digitizers that can meet your expectations. It's the new HIPAD Plus™ series. With sizes ranging from a compact 12″×12″ to a drafting-size 44″×60,″ each model reflects HI's tradition of price/performance excellence.

Compare, for example, the sleek 9012 and 9018 models (shown below) which contain HI's exclusive tilt-correction feature. This unique feature lets you use the stylus like a pencil—no need to hold it in an awkward perpendicular position. HI's tablet captures only the points touched by the tip of the stylus, so you can make menu selections, create freehand drawings, move the screen cursor, or edit pixel-by-pixel—without a trace of doubt.

If you prefer a handheld cursor, you'll find HI's new four-button cursor has the same pin-point precision. (You'll also like the way it feels in your hand.)

The HIPAD Plus digitizers are compatible with both your CAD and graphics systems. Each model processes coordinates rapidly (up to 200 pairs per second) and has a resolution of up to 2,540 lines per inch. This all adds up to high performance and accuracy—and it means you won't be replacing your tablet to meet the high-resolution demands of the future.

And, with prices like $495* for the 12″×12″ tablet and $795* for the 12″×18″ tablet, HIPAD Plus is affordable. Make your point without a trace of doubt. For details, call 1-800-444-3425 or 512-835-0900.

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Networking XyWrite

XyWrite III Plus is a network version of the word processing program for the IBM PC and compatibles. It offers multiuser redlining that tracks editing remarks by log-in, date, and time.

The program supports DOS 3.0 file locking and access restrictions for specified network drives. It has a read-only feature that lets users review only the last stored version of any file.

System administrators can customize XyWrite with formatting standards. They can also modify files that check spelling, customize keyboards, and control fonts.

XyWrite III Plus supports network operating systems from AT&T, 3Com, Novell, IBM, and Banyan. You'll need an IBM PC or compatible with at least 384K bytes of RAM and DOS 3.0 or higher.

Price: $795 for file server; $195 per node.

Contact: XyQuest, 44 Manning Rd., Billerica, MA 01821, (508) 671-0888.

Inquiry 988.

Faxing in the Background

Macintosh users can send and receive facsimile transmissions with BackFAX while another application is running in the foreground. It runs with or without MultiFinder and requires an AppleFax modem and at least 1 megabyte of memory on any Mac.

You can keep an address book of the fax numbers that you use, along with instructions on how and when to deliver the message. The program also has a feature that keeps track of what documents you need to send and will send them at the appropriate time. It will even retry busy numbers as many times as you specify.

To use BackFAX, you choose the BackFAX icon in the Chooser desk accessory and print the document to the BackFAX outbox. Then, using the BackFAX management application, you choose the send options you want, enter the address or retreive it from the address book, and BackFAX will take it from there.

The program has some graphics capabilities that let you send your company logo on a cover page before your document. You can also incorporate complex graphics documents designed with PageMaker or MacDraw II.

Price: $245.

Contact: Solutions International, 30 Commerce St., Williston, VT 05495, (802) 658-5506.

Inquiry 986.

Cutting the Cost of File Transfer

Thompson Computing is cutting the cost of transferring files on IBM PCs and compatibles with two new file-transfer utilities. 2PC is the full-blown version that costs only $55. The program features a split-screen format to display files on both machines, and it sends files at 115,200 baud, the company reports.

Other features include pull-down menus, help screens, directory trees, chat mode, and the ability to tag files, view them, and delete them from a directory by wild cards or by selecting them individually. You can sort files by name or extension. The program also offers a print facility and lets you execute DOS commands.

2PC comes with a universal cable that connects to 9- or 25-pin serial ports.

2PCLite is a $40 version that also transfers files at 115,200 baud and offers a split screen. It uses single-keystroke commands rather than menus, and it doesn't have a chat facility.

The 2PC programs run on the IBM PC and compatibles with DOS 2.0 or higher and at least 256K bytes of RAM.

Price: 2PC, $55; 2PCLite, $40.

Contact: Thompson Computing, 587F North Ventu Park Rd., Suite 306, Newbury Park, CA 91320, (805) 498-7653.

Inquiry 987.

Managing Networks under 3+Open

On the same day that 3Com announced shipment of its 3+Open LAN Manager, the company introduced two network management products that run under 3+Open.

3+Open is an OS/2-based network operating system for computer networks that support DOS, OS/2, or Mac workstations.

3+Open LAN View and 3+Open LAN Secure enable the network administrator to control and secure resources on 3+Open networks. They take advantage of named pipes, which is an industry-standard interface for LAN communications.

The LAN View application offers you a graphical view of server statistics regarding performance, utilization, and security, in addition to network errors. You can view the statistics as they occur or from a file. The application also converts the stats into a data interchange format (DIF).

On-screen windows show an audit trail of network information, including time of errors. A click and zoom capability lets the network administrator select and expand the windows to help isolate trends and prevent network problems.

The LAN Secure application offers security through enhanced password and resource management. The network administrator can design customized password-control programs that make users change their passwords.

The security application also tracks and logs network resource access and use, so the administrator can monitor events such as invalid log-on attempts and printer use. You can also use the LAN Secure application to convert LAN Manager audit trail data into alternate formats.

To run 3+Open under DOS, you need an IBM PC, XT, AT, or PS/2 with at least 512K bytes of RAM and DOS 3.1 or higher.

Under OS/2 you need an 80286- or 80386-based IBM AT or PS/2 Model 50, 60, 70, or 80 with at least 2 megabytes of RAM and OS/2 1.0 or higher.

On Macintosh workstations you'll need 3Com 3+ for the Macintosh.

Price: LAN View, $495 per server; LAN Secure, $995 per network; LAN Manager Entry System (up to five users), $995; LAN Manager Advanced (more than five users), $2995.

Contact: 3Com Corp., 3165 Kifer Rd., Santa Clara, CA 95052, (800) 638-3266; in California, (408) 562-6400.

Inquiry 985.

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PC Tools Upgraded

PC Tools now runs on the Macintosh as well as the IBM PC. The IBM PC program has been upgraded to version 5.0 and has a new user interface with pull-down windows and support for a Microsoft Mouse. It also offers a superset of the DOS 4.0 shell, a desktop manager, a file encryption and compression program, and a backup program.

The Macintosh version offers a desk accessory, a backup utility, a file undelete feature, an unfragmenter, a recovery utility, and the ability to encrypt and compress files.
Price: $79.
Contact: Central Point Software, Inc., 15220 Northwest Greenbrier Pkwy., Suite 200, Beaverton, OR 97006, (503) 690-8090.
Inquiry 993.

PC Tools now runs on the Mac.

The DataShuttle is Launched

If your database, spreadsheet, and word processing programs are incompatible, DataShuttle can come to the rescue. It is a data retrieval and transfer program for updating databases and spreadsheets. You can convert files between most commonly used formats, such as ASCII, dBASE, SYLK, SIF, DIF, and Lotus formats.

You can select fields and rows to be processed and specify conditional transfers by comparing fields to alphanumeric values or cells.

DataShuttle runs on the IBM PC, XT, AT, PS/2s, and compatibles with DOS 2.1 or higher.
Price: $129.95.
Contact: Softway, Inc., 500 Sutter St., Suite 222, San Francisco, CA 94102, (800) 338-2852; in California, (415) 397-4666.
Inquiry 995.

DataShuttle's main menu.

Keyboard Help

Physically challenged persons who have trouble using the computer keyboard will find that the keyboard utility program Peck offers them easy access.

Peck is a RAM-resident program that lets you press keys sequentially instead of in combination. For instance, when you would need to press Control, Alt, and Delete at the same time, you can press one after another. The company reports that the program works with virtually every program written for the IBM PC family.

Peck is available alone, but it is also bundled with PRD+, a software program from Productivity Software that boosts your typing speed and increases accuracy.

Peck uses less than 1K byte of RAM and does not require PRD+. Both Peck and PRD+ require an IBM PC or compatible with DOS 2.0 or higher. PRD+ requires at least 55K bytes of RAM.
Price: Peck, $9.95; PRD+, $89.95.
Contact: Productivity Software International, Inc., 1220 Broadway, New York, NY 10001, (800) 533-7587; in New York, (212) 967-8666.
Inquiry 994.

Be Healthy and Happy

Designed for doctors, dietitians, and nutritionists, Two-Minute Nutrition Manager is a nutrition planning, tracking, and reporting program.

Registered dietitians helped design the program, which analyzes food items, recipes, meals, menus, and journals. It contains a 4500-item database and analyzes up to 73 nutrients. The program also has Food Management, Menu Planning, Preferred Meals, Food Exchanges, and Daily Journal modules. You can set up goals, and graphs will show you how close your actual food intake comes to meeting your goals. The program can even generate a shopping list of the foods it recommends.

Consumer and professional models are available. The consumer models have fewer foods and nutrients in the databases, and the professional models offer more extensive information plus the ability to personalize programs with on-line help.

The program is menu-driven and runs on the IBM PC, XT, AT, 80386-based systems, and the PS/2s with at least 2 megabytes of RAM, DOS 2.0 or higher, and a hard disk drive. There is also a version for the Macintosh II, Plus, and SE.
Price: Consumer models range from $69 to $149; professional models range from $295 to $695.
Contact: DPEX, 3333 Bowers Ave., Suite 190, Santa Clara, CA 95054, (800) 727-3438; in California, (408) 727-7121.
Inquiry 997.

Chaos in Computing

The Clearpoint Research Foundation will sponsor a symposium on chaos theory, a diverse field of study that has implications in everything from computer graphics to meteorology to studying the stock market.

Scheduled topics include the practical use of chaos in image compression, learning algorithms, and chaos in physics, computer science, and electrical engineering.

Scheduled speakers include Norman Packard, collaborator at the Center for Nonlinear Sciences; Bernardo Huberman, Research Fellow at the Xerox Palo Alto Research Center; and James Crutchfield, assistant research physicist under contract at the Office of Naval Research.

The three-day event will be held at the Top Notch Inn in Stowe, Vermont, on February 5–7.

Price: $300.

Contact: The Clearpoint Research Foundation, 99 South St., Hopkinton, MA 01748, (508) 435-2301.

Inquiry 1067.

The Mac and PC: Meeting on Common Ground

Two major users groups in one city, on opposite sides of the street: The Mac users evangelize, the IBMers sneer, and never the twain shall meet.

Until now, that is. The New York Personal Computer users group (NYPC) and the New York Macintosh User Group (NYMUG) have announced a joint special-interest group (SIG) that will explore networking, connectivity, user interfaces, file passing, systems compatibility, and other issues of working on dual platforms in the individual and corporate environments. Cynthia Harriman, who wrote *The MS-DOS Mac Connection* (Brady Books), traveled from Portsmouth, New Hampshire, on October 26, 1988, to speak at the first meeting of the SIG.

Although multisystem users groups, such as the Boston Computer Society, have held Mac/MS-DOS clinics in the past, this may be the first SIG between two single-platform users groups. The SIG has already agreed to publish a magazine in March and may sponsor a Macintosh-PC expo.

Now that Macintoshes have gained acceptance in the corporate environment, the Connectivity SIG is an idea whose time has come, according to Merv Adrian, editor of the NYPC newsletter. "It's a rather unprecedented cooperative. . .there is enough interest on both sides that everybody just felt it was a good idea to give it a crack and see what would happen," he said. "I think [the forming of dual-platform SIGs] will happen all over the place, and I think a lot of people are going to do this."

If you're interested in joining the SIG, you need to join

continued

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NYMUG or NYPC. Annual dues for NYMUG: $40; annual dues for NYPC: $25.
Contact: NYMUG, 688 Sixth Ave., New York, NY 10010, (212) 691-0496; NYPC, 40 Wall St., Suite 2124, New York, NY 10005, (212) 533-6972.
Inquiry 1064.

The Connecticut Computer Society

Not a user group per se, the Connecticut Computer Society is a nonprofit corporation that acts as a central information source for statewide computer groups, events, and activities. The group sponsors programs, seminars, and computer shows throughout the state and publishes the *CCS Computer News*, a monthly newspaper with a circulation of 12,000.

A corporate or dealer membership in CCS entitles you to a listing of your business in each edition of the newspaper for as long as the membership is current. The newspaper also covers new products, how Connecticut businesses and schools are using computers to their benefit, and consumer issues. It also publishes course, workshop, and corporate membership listings.

The Connecticut Computer Society was formed in August 1982 and currently has over 1000 paying members. Members are entitled to discounts from selected advertisers in the newspaper, discounts to CCS-sponsored events, and access to members-only opportunities.
Price: 1-year memberships: $15 for individual; $25 for family; $150 for corporate.
Contact: Karen Eisenstein, Connecticut Computer Society, P.O. Box 17-032, West Hartford, CT 06117, (203) 233-4141.
Inquiry 1066.

Getting Software Out on Time

Completing a major software project is one thing—getting it done on time is quite another. Capers Jones, founder of Software Productivity Research, is conducting a seminar for software company vice presidents, project managers, software estimating and measurement specialists, and others who manage software projects. Topics will include the metrics of project management, new methods of software measurement, and the science of software estimation.

The seminar, called Software Measurement and Estimation, will also deal with what kinds of steps corporations have gone through in establishing software measurement programs, and the danger signs that should warn you when projects have a high-risk factor.

The seminar will be held at the Hyatt Regency in Cambridge, Massachusetts, on March 28 and 29.
Price: $765.
Contact: Digital Consulting, Inc., 6 Windsor St., Andover, MA 01810, (508) 470-3880.
Inquiry 1065.

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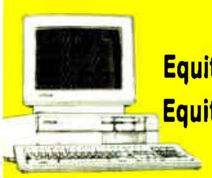

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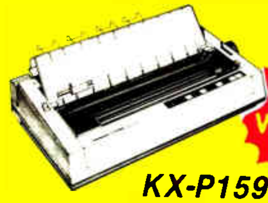

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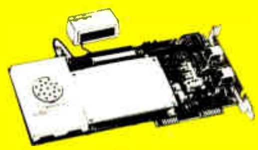

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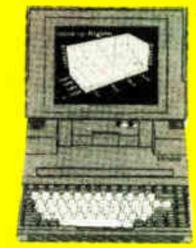

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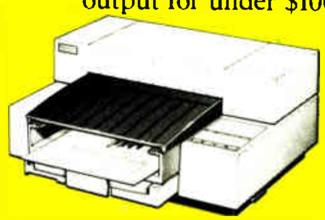

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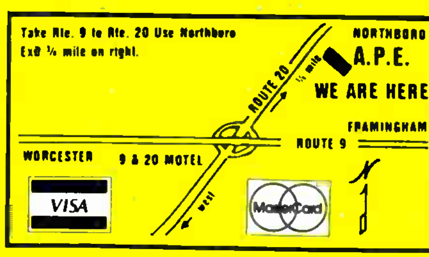

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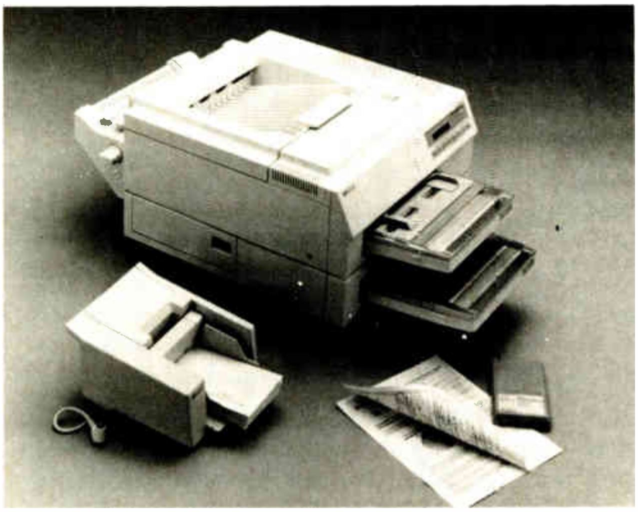

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The printer holds up to 200 sheets of paper in each of two bins, and you can print documents so that you can bind them on the left (book-style) or on the top (calendar-style). With an optional envelope feeder, the LaserJet IID can pull paper from both paper trays and the envelope feeder, resulting in presorted, ready-to-mail documents. The envelope feeder holds up to 50 envelopes.

The LaserJet IID works with the IBM PC, XT, AT, PS/2s, and compatibles.
Price: $4295; $350 for the optional envelope feeder.
Contact: Hewlett-Packard, Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.
Inquiry 1084.

Send Your Child to the Right School

The College Explorer is a program that can help you organize and rate prospective colleges and universities. You can use it to sort colleges on the basis of enrollment size, cost, acceptance rate, freshman test scores, and minimum qualifying grade on the Advanced Placement exams.

You can also tailor the program to rate college features such as majors, location, and activities by level of importance to the student before you search its file of 2800 colleges and universities. Based on your ratings, the program will provide two lists: An A list that contains those institutions that match all the desired features, and a B list that contains schools that match the necessary features.

The program's catalog of college characteristics includes financial aid and a freshman class profile, including the grade-point average, high school class rank, and admission test scores. Other categories include degree level, majors offered, location, enrollment size, housing, athletics, student activities, and religious affiliations.

Two versions are available: One works with the Apple IIc, IIe, and IIGS, and the other works with the IBM PC, XT, AT, and compatibles. The Apple IIe requires an 80-column extension card. The IBM PC requires 256K bytes of RAM and DOS 2.1 or higher.
Price: $49.95.
Contact: The College Board, 45 Columbus Ave., New York, NY, 10023, (212) 713-8000.
Inquiry 1085.

Color Video System for the Mac II

A color video system from Nutmeg Systems uses a processor-less design that lets it display color faster and with more clarity than other conventional video boards, the company reports. The Nutmeg UltraView Video System increases the data transfer rate of the Mac II to a video card by using a block transfer method between cards on the Mac's NuBus. The card can also transfer via serial method.

The key to the system is the Nutmeg 256 color video interface, a 1-, 2-, 4-, or 8-bit selectable interface card that includes an expansion slot for video memory and a second slot for video performance peripherals.

The system is bundled with a 19-inch landscape monitor from Mitsubishi Electric Corp. that offers 72-dot-per-inch resolution on a 1024- by 768-pixel display, with a 79-Hz refresh rate for a flicker-free image.
Price: $5798; $3999 for the monitor alone; $1799 for the Nutmeg 256 interface.
Contact: Nutmeg Systems, Inc., 25 South Ave., New Canaan, CT 06840, (800) 777-8439; in Connecticut, (203) 966-3226.
Inquiry 1086.

Alternative to Dedicated Serial-Data Analyzers

Serialtest is a software solution to monitoring and troubleshooting problems in serial-data communications. The program lets you use your PC-to-monitor communications between two devices or on your local-area network.

Serialtest has two modes. In monitor mode, you can eavesdrop on one or both sides of your data flow; in source mode, you can send data from one side of the communications link, sending from your keyboard, from a file, or from both simultaneously.

You can use the program to observe data and control signal changes as they occur; create and manage triggers that control the monitoring and capturing of the data; and select device titles, parity, word length, and stop bits. You can view each byte in ASCII, extended binary-coded decimal interchange code, hexadecimal, binary, octal, and decimal form. Serialtest lets you specify the size of the capture—you're limited only by the amount of the system RAM.

The program works with the IBM PC, XT, AT, and compatibles with one or two serial I/O adapters, 300K bytes of RAM, and DOS 2.0 or higher. A hard disk drive is not required.
Price: $495.
Contact: Advanced Computer Consulting, Inc., 700 Harris St., Suite 101, Charlottesville, VA, 22901, (800) 562-8378; in Virginia, (804) 977-4272.
Inquiry 1087.

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POWER:	200 watt, switching power supply with leads for 4 devices.
DISKS:	(1) 1.2 meg, half height, dual sided—quad density floppy drive. (1) 40 megabyte, half height, fixed disk drive. 40MS access time.
CABINET:	Full size AT style drawer cabinet with corporate security lock panel mounted reset switch, and status LEDs for turbo, power and fixed disk.
KEYBOARD:	Enhanced style, 101 keys with LEDs to indicate NUM locks and CAPS lock status, separate cursor pad, numeric touch pad, top mounted function keys.
DISPLAY SET:	Hi-res, text and graphics, monochrome card (Herc. compat.) hi-res, TTL amber monochrome monitor. 1 parallel port.
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SPECIFICATIONS

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POWER:	200 watt, switching power supply with leads for 4 devices.
DISKS:	(1) 1.2 meg, half height, dual sided—quad density floppy drive and 1.44 floppy. (1) 80 megabyte, full height, fixed disk drive. Seagate.
CABINET:	Full size AT style drawer cabinet with corporate security lock panel mounted reset switch, and status LEDs for turbo power and fixed disk.
KEYBOARD:	Enhanced style, 101 keys with LEDs to indicate NUM lock and CAPS lock status, separate cursor pad, numeric touch pad, top mounted function keys.
DISPLAY UNIT:	Hi-res, text and graphics, monochrome card (Herc. compat.) hi-res, TTL amber monochrome monitor, 1 parallel port.
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Host Adapter for the IBM PC AT

Future Domain Corporation's TMC-881 is a mass-storage small-computer-system-interface (SCSI) controller that supports up to six drives on the IBM PC AT or compatibles. The product includes a full-length board and software drivers for DOS, Novell, and Xenix.

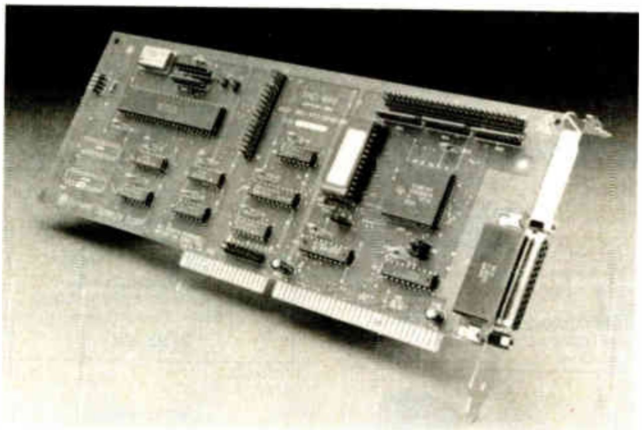
Acording to Future Domain, the board's driver for Novell Advanced NetWare 286 version 2.1 provides you with twice the throughput of conventional AT controllers and includes overlapped I/O between multiple drives.

The TMC-881 supports most SCSI-based disk drives, tape drives, optical disks, and CD-ROM players.

Price: $355.

Contact: Future Domain Corp., 1582 Parkway Loop, Tustin, CA 92680, (714) 259-0400.

Inquiry 1063.



The TMC-881 is designed for IBM PC ATs and compatibles.

Create 3-D Graphs in FoxBase Plus

Fox Software has released a graphics development software package that can create two- and three-dimensional business and scientific graphs with FoxBase data files. The program can also create what Fox calls four-dimensional graphs, a form of stacked three-dimensional graph that displays four parameters.

FoxGraph's data management system can support up to 16,000 pages, rows, and columns. You can create plots of up to 36 by 48 inches on most plotters and Presentation Technologies' Image slide maker. The program can also create IMG (image) files for Ventura Publisher and Tag Image File Format files. The program works with a host of laser printers and supports PostScript output devices.

FoxGraph works with FoxBase Plus 2.10, FoxBase Plus/386, and FoxBase Plus/LAN. FoxBase Plus 2.10 works on the IBM PC, XT, AT, PS/2s, and compatibles and requires DOS 2.0 or higher with FoxBase Plus 2.10, and DOS 3.1 or higher in the 80386 and LAN versions. FoxBase Plus/386 requires 2 megabytes of extended memory and a math coprocessor. FoxGraph supports CGA, EGA, VGA, and Hercules monochrome boards and requires 640K bytes of RAM. A hard disk drive is required.

Price: $295.

Contact: Fox Software, Inc., 118 West South Boundary, Perrysburg, OH 43551, (419) 874-0162.

Inquiry 1062.

Routines for QuickBASIC Programmers

To help prevent QuickBASIC programmers from reinventing the wheel, Project X Software Development has released more than 350 routines and several add-on programs, including an object screen generator, a library manager, and a source code formatter.

The Object Screen Generator lets you create any free-form screen, generate code for the screen, and modify it at a later date, the company reports. You can use the Library Manager with QBTools, QuickBASIC 4.0, and Bascom 6.0. The manager is designed to manage object files as they are switched in and out of libraries. When it creates a LIB file, the manager automatically resolves all external calls for you. An Include manager can build files that include only the routines that are specific to a program.

Routines in the program include B-tree indexing, spooler control, screen and window management, input routines, pull-down menus, dialog boxes, scroll and list boxes, mouse control, low-level file access, sorting, searching, keyboard status, bit manipulation, and more.

The program works on the IBM PC, XT, AT, PS/2s, and compatibles with DOS 3.0 or higher and 512K bytes of RAM.

Price: $89.95.

Contact: Project X Software Development, Inc., 1257 Marlyn Rd., Philadelphia, PA 19151, (800) 678-2112; in Pennsylvania, (215) 922-2557.

Inquiry 1059.

Running MS-DOS on Your Macintosh

PerfecTEK's MS-DOS coprocessor board for the Macintosh II lets you run MS-DOS software on your Macintosh and attach peripherals for both operating systems on one machine, the company reports.

Based on the Intel 80286 processor and running at 10 MHz, the Mac/DOS II board provides IBM-compatible parallel and serial ports; Macintosh font, style, and size selection in DOS applications; and WYSIWYG printing from DOS applications on the Imagewriter and LaserWriter series of printers. The board can also provide 1 megabyte of expansion memory when you're not using it to run MS-DOS applications.

The Mac/DOS II hardware consists of a 32-bit board that fits into a single Macintosh II slot. It has a socket for an optional 80287 math coprocessor. Included with the package are file transfer utilities and a cable that you can use to directly transfer files from the PC to the Mac without buying an external 5¼-inch floppy disk drive for the Macintosh II. An MS-DOS hard disk drive can be emulated on any Macintosh-compatible hard disk drive. You can select the size of the virtual disk drive from 1 megabyte to 32 megabytes.

The board and software require a Macintosh II running System 4.0 and Finder 5.4 with 1 megabyte of memory. To run MultiFinder 1.0 effectively, 2 megabytes are required, the company reports. The package supports MS-DOS 3.2 or higher.

Price: $1495.

Contact: PerfecTEK Corp., 1455 McCarthy Blvd., Milpitas, CA 95035, (408) 263-7757.

Inquiry 1061.

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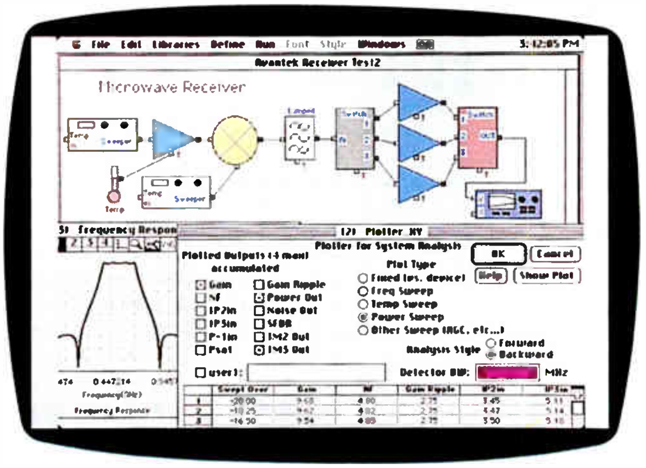


Modeling the Physical World with Blocks

One of the most powerful capabilities of the computer is simulating physical processes and conditions. By simulating a process or design on a computer, designers and engineers can save the time and expense of building and testing physical prototypes. Business and financial analysts can also use simulation programs to model problems.

Extend, from a company called Imagine That!, is a powerful simulation program for the Macintosh that uses block diagrams to model physical systems. Each block in the simulation represents part of the physical process, and each is connected to other blocks with inputs and outputs that represent the physical conditions of the system.

To simulate a home-heating system, for example, you would have blocks representing the furnace, the walls, the roof, the thermostat, and inside and outside temperatures. Variables might include the thickness of the roof or wall insulation and the heat output of the furnace. By varying such system parameters, you can run a variety of "heating tests" to see how much time and energy are required to heat the house under various environmental conditions. The independent variables (like temperature and energy) tested in the simulation are plotted as a function of time.

Extend is a complete system for developing simulation block diagrams. You start with a blank worksheet and build blocks and connections using the design tools. You can set up dialog boxes and help files for blocks that require user input for modifying the parameters of the simulation. The blocks ultimately connect to a plotter block, which can have up to four inputs. When you run the simulation, the inputs are plotted on the screen. A table at the bottom of the plot lets you read the plot values at any time simply by moving a vertical pointer to the appropriate time on the plot.

The heart of the system is its ModL "simulation scripting language" for writing scripts that define the function of each block. ModL is a C-like language that includes a large library of mathematical functions and operators for defining block equations and plotter functions. The language has queuing and delay line functions, fast Fourier transforms, integration, random-number generation, financial and statistical functions, and a set of power and trigonometric functions. ModL supports real, integer, and string data types, as well as fixed and dynamic arrays of up to five dimensions.

ModL includes system messages that are sent to blocks during the simulation. For example, a system message might be "ON CHECKDATA," which tells the block to validate its data. Extend also has a set of system variables, like "DeltaTime," so that the block equations can dynamically change their values over time.

You can save blocks in libraries for using repeatedly in other simulations. Extend comes with a collection of blocks for electronics and digital simulation. Some of these provided blocks have several hundred lines of code. The company is also working on libraries for other disciplines, like mechanical engineering.

Creating working simulations of real physical processes is not a trivial exercise, and it requires knowledge of the physical process you're simulating. If it's an electrical circuit, for example, you have to know the equations that represent the behavior of the circuit.

Extend is a powerful system, and it is not easy to learn. The tutorial is brief and provides little guidance in writing block scripts. The 216-page user's manual is comprehensive. You can study the example simulations to see how the system works.

One comparable IBM PC program, Tutsim, uses block diagrams. However, rather than providing a complete programming language like Extend's ModL, Tutsim provides a large library of programmable blocks. Other than plotting, Tutsim does not have the graphics capabilities inherent in a Macintosh package. With Extend, you can not only plot the simulation, you can also build the model visually with the block design tools.

At the time of this writing, Imagine That! said it would soon release version 1.1 of the software. The new version will allow file and serial port I/O, so that you can hook up Extend to laboratory equipment or use external data files.

—Nick Baran

THE FACTS

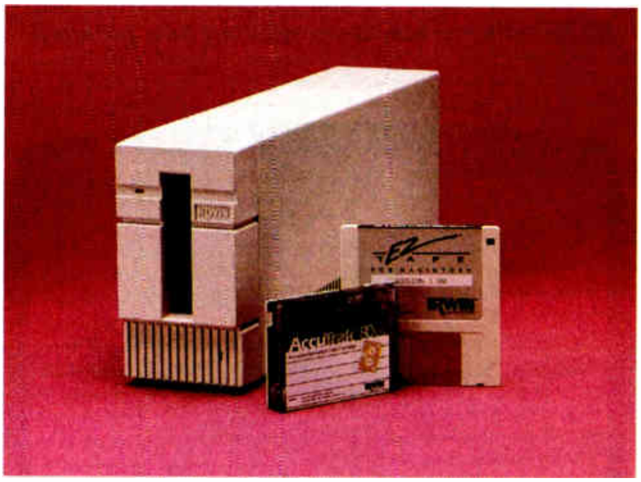
Extend 1.05
$495

Imagine That!
7109 Via Carmela
San Jose, CA 95139
(408) 365-0305
Inquiry 1015.

Requirements:
Mac Plus, SE, or II with a hard disk drive or two floppy disk drives; System 4.2 and Finder 6.0 or higher.

continued

With Tape, Backing Up's Not Hard to Do



THE FACTS

Irwin Model 5080
$1695

Requirements:
Mac with at least 1 megabyte of RAM, at least 128K bytes of ROM, a SCSI port, and a 25-pin/50-pin SCSI cable (50-pin/50-pin cable for daisy chaining with other peripherals).

Irwin Magnetic Systems, Inc.
2101 Commonwealth Blvd.
Ann Arbor, MI 48105
(313) 996-3300
Inquiry 1016.

Cher's Law of Exercise can be adapted to backing up hard disks. If we don't back up our hard disks at least once a week, we feel the way Cher does if she doesn't exercise every day: guilty. We know the crash is coming, and we know we have to prepare by storing copies of all those files in a safe place. Still, doing backups is like doing push-ups: drudgery.

The **Irwin Model 5080** tape system for the Macintosh not only makes backups painless, but it puts 80 megabytes of data into a ¼-inch DC-2000–style tape cartridge. Irwin's AccuTrack minicartridges (they look like squat audiocassettes) come preformatted, so you can pop them right in and write away, which in itself is good reason to use these tapes.

Although the Model 5080 employs a proprietary recording format, that might be a fair price to pay for the single user, considering that formatting a cartridge can take as long as half an hour with some systems. Irwin claims its tapes are highly reliable because of servo signals embedded along each tape track; these signals keep the read/write head accurately centered over the track it's looking at.

Hooking the subsystem to the Mac is simple, as long as you have the right cable. The tape box plugs into the Mac's small-computer-system-interface (SCSI) port or into another peripheral, like an external hard disk drive. If you want to hook it up directly to the Mac, you need a cable with a 25-pin connector on one end and a 50-pin connector on the other end. Before you even unpack the Model 5080, go buy one of these MCAB25 cables, because Irwin doesn't provide one.

But, oddly enough, the company does provide a cable with a 50-pin connector on each end. This cable is fine for stringing the tape system to another SCSI peripheral, but I'd bet most users will want to hook it directly to the Mac. Besides making the connection, the only other thing you have to do is set the address selection, done by turning a little dial.

Making a backup is about as easy as it can be. Irwin's EzTape Iconographic program, which runs under Finder and MultiFinder, is refreshingly stripped down and straightforward. It makes for a stymie-free trip through the backup process. Our unit came without a manual, but that turned out to be no problem because the software is so clear. You just click on a few menu choices to specify what kind of backup you want to do (or mark the files you want to back up) and get the process going. Irwin has an update to EzTape Iconographic that lets you set up automated backups, but we couldn't get that update in time for this report.

I timed some random backups and found that the Model 5080 is acceptably quick, especially compared to some other tape drives. It took a fast 5 minutes to copy and verify 10 megabytes from a Mac II 40-megabyte hard disk.

Wanting to see the drive handle individual files, I had it back up some PageMaker documents. It took about 2½ minutes to copy a 264K-byte file to tape, update the tape directory, update the tape header, and verify the data. Restoring such a file to the hard disk took about 45 seconds. Most users in the real world will be doing global backups about once a week, so that's the speed that's most important, and on that count, the Model 5080 will be acceptable to all but speed freaks.

If you're looking for a secondary storage device that makes backups painless, the creatively named Irwin Model 5080 tape system is a definite must to check out. And there's something nice about being able to pack 80 megabytes of data on a tiny tape (that costs about $30). My only beef is with the folks at Irwin who decided not to throw the appropriate SCSI cable into the box. They format the tapes, and they make the software easy to use; but they also make their customers go out and buy a cable before they can find out just how nice the tape drive is.

—D. Barker

Jumbo Works for Peanuts

Be honest now. When's the last time you backed up the data on your hard disk? If you're like over 90 percent of microcomputer users, you seldom (if ever) do. And it will take a catastrophic disk crash to shame you into it.

No matter how easy today's backup programs are to use, it's still a royal pain to sit there and swap floppy disks, especially with large-capacity hard disk drives. Tape backup units, which pack 40 or more megabytes onto a single cartridge, are far and away the easiest way to back up data. But they've been expensive, averaging in the $600 to $700 range in the IBM PC–compatible world.

Colorado Memory Systems has decided to do something about that expense with a tape backup unit it has aptly named **Jumbo**. When compared with its competitors, Jumbo's $399 list price is peanuts. Colorado Memory Systems developed the QIC-60 tape drive, which became an industry standard when Tecmar licensed it and

continued

THE FACTS

Jumbo
$399

Requirements:
IBM PC, XT, AT, PS/2, or compatible with 384K bytes of RAM and MS-DOS 2.0 or higher.

Colorado Memory Systems, Inc.
800 South Taft Ave.
Loveland, CO 80537
(303) 669-8000
Inquiry 1017.

IBM sold the drive as an option for PCs.

Jumbo uses the QIC-40 standard, which puts up to 40 megabytes on a small DC-2000 tape cartridge. I've reviewed other tape backup units, and many of them are a pain to install and set up. There are different models for different computer systems, not to mention DIP switches and jumpers to puzzle over.

But Jumbo is a refreshing exception. After removing the cover of my AT, all I had to do was slide the tape unit into the empty space under my 1.2-megabyte floppy disk drive, hook up power and the extra floppy disk ribbon connector, and put the cover back on. Then I copied the supplied software to my hard disk, started it up, and it worked. (For those of you with non-standard disk setups, there is a disk-select jumper.)

This drive is a good example of what's happening in the world of hardware, where lower prices don't necessarily mean shoddy merchandise. Application-specific integrated circuits and surface-mount construction have resulted in low part counts. Jumbo has only four ICs and no adjustments for the electronics. It's simple and rugged, and it should last a long time.

There's an optional mounting kit available for the IBM PS/2 line. There's even an external cabinet if you've run out of room in your system case. Jumbo's circuitry automatically senses whether it's hooked up to an XT or an AT, and it sets its data transfer speed accordingly: 250K bytes per second for regular PCs and 500K bytes per second for ATs.

The backup software that comes with Jumbo is sophisticated and easy to use. In truth, I never opened the software manual because using the backup system is a simple matter of reading the screen. Like any good backup software should, it gives you the option of doing the backup immediately or automatically at a predetermined time—like in the

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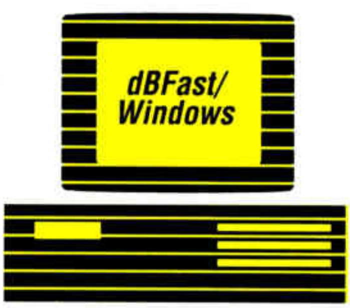

middle of the night. And it will also back up all files on Novell and 3Com networks.

Makers of tape backup units are fond of backup benchmarks. But think about it: A few seconds plus or minus don't mean much if your system is doing the backup when you're not around. However, if you must talk numbers, Jumbo is no slouch. It took 12:57 to back up 1296 files on my hard disk, a total of over 28 megabytes of data.

Jumbo is inexpensive, easy to install and use, and well built. It brings secure data backup within the reach of nearly all PC users. Now, what's your excuse?

—Stan Miastkowski

dBASE IV: Setting the New Standard?

After many months of speculation both about the product and when it would finally arrive, **dBASE IV version 1.0** is here. It represents a quantum leap over dBASE III Plus in functionality, power, and ease of use.

The first difference that you notice between the two is size. While dBASE III Plus would run in 256K bytes with two floppy disk drives, dBASE IV needs 640K bytes (or more) and a hard disk drive.

The number of fields per record has been increased from 128 to 255. The maximum number of keys (indexes) per table has been raised from 7 to 47. Using DOS 3.1 or higher, dBASE IV will support up to 99 open files at any one time (but still only 10 data tables). Field length and the maximum size of the command line have both been raised from 254 to 1024 characters. The maximum number of memory variables has been raised from 256 to 15,000, freeing developers from one of the most irksome constraints of dBASE III Plus.

Indexing is a major improvement in dBASE IV. With dBASE III Plus, you could have up to seven indexes (each costing a file handle) open for a single data table. With dBASE IV, you can have up to 47 index files open inside a Master Index File (.MDX) that takes up only a single file handle.

While dBASE III Plus allowed for a single parent-child relationship to be active, dBASE IV allows multiple children related by different keys to a single parent. In many instances, this allows for a substantial reduction in code size and complexity.

Finally, dBASE IV has a significantly higher execution speed than dBASE III Plus. This increase in speed comes because dBASE IV preparses code to save execution time. It compiles dBASE programs into intermediate code, checking for syntax errors while assembling code tokens for execution. The resulting code requires dBASE IV or dBASE Run Time to execute.

You might find that your dBASE III Plus code generates compiler errors when first run under dBASE IV. As an interpreter, dBASE III Plus simply executes the first line of code that meets the specified condition of an `IF/ELSE/ENDIF` or a `DO CASE` structure. If there's no `ENDIF` or `ENDCASE` statement, it doesn't matter because the interpreter never reaches that line. This makes a difference with dBASE IV, however, so you'll be finding out all about your bad coding practices.

Some commands in the new program are different from those used in competing products, such as FoxBASE and Clipper. The menu commands are a good example. But the changes have improved the dBASE language.

This new version of dBASE adds many enhancements and new features to the language while retaining compatibility with dBASE III Plus. Detail-

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ing the differences and additions to the commands and functions available (a total of 310) is the subject of a good-size book. Many have been improved, and new ones will keep even expert developers busy for quite a while. Some of the more interesting command sets include commands for creating Lotus 1-2-3-like menus, a real BROWSE command, windowing, and two-dimensional arrays.

What is truly extraordinary about dBASE IV is that much of its power is also available to the nonprogrammer through the task-oriented nonprocedural Control Center. The Control Center is to dBASE IV what the ASSIST mode is to dBASE III Plus. All similarity ends there. The Control Center is a powerful shell that lets you develop real customized applications without having to write a line of code.

The Control Center is a collection of well-thought-out work surfaces that let the nonprogrammer (and the programmer) define data tables, screens, reports, and labels, and finally tie them together through the application generator. The work surfaces are intuitive in nature, and, with only a little experience, a *confident* beginner will be able to design functional programs.

As for this year's hot database topic, dBASE IV sort of does SQL. Well, actually, dBASE IV emulates SQL using dBASE data tables. It lets you use a set of SQL commands inside dBASE when you SET SQL ON. When you do this, you deactivate dBASE IV commands that are in conflict with SQL.

This is an overwhelming product. A new era has finally dawned for the dBASE language. Thanks, Ashton-Tate.

—Anne Fischer Lent and Malcolm Rubel

THE FACTS

dBASE IV version 1.0
Standard Edition, $795;
Developer's Edition, $1295

Requirements:
IBM PC or compatible with 640K bytes of RAM, a hard disk drive, and DOS 2.0 or higher (DOS 3.1 or higher for extended file support).

Ashton-Tate, Inc.
20101 Hamilton Ave.
Torrance, CA 90502
(213) 329-8000
Inquiry 1018.

Database of the Dead

Getting organized for dying isn't exactly a happy subject, but unless you've got plans for fooling the Grim Reaper, it's something you have to think about. **For the Record** is a Macintosh program that helps you organize your important personal information and store it electronically in one place. Of course, you don't need a computer program to do this; a ledger or notebook could serve the same basic purpose. But this program does more than just serve as a computerized cigar box.

What For the Record does is guide you through the process of setting down all the bits of personal, financial, and legal information your family or friends will need to take care of your posthumous affairs. It's basically a database program, where you record your significant details by filling out forms. Rather than having a big stack of forms to sort through, the program fetches the appropriate paper when you select the category of information you want to record.

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the Objects of Value category from one side of the screen, you get on the other side a window of subcategories, like precious metals, art, stamps, and computers. Selecting the subcategory takes you to the related screen form, where you type in the name of the object, a description, what it's worth, when and where you got it, its serial number, and whereabouts of ownership papers.

A category called Emergency Information is where you record vital data like how to reach your children's appointed guardian, who to notify of your death, who has power of attorney, and other items that your survivors will need after you've become a decedent. Likewise, there are categories covering sources of income, sources of debt, securities, vehicles, insurance policies, business interests, tax records, medical information, personal documents, memorabilia, what you want done with your body after you no longer need it, biographical notes, and hiding places (where you divulge the location of treasure maps or proof that Elvis is alive or whatever it is you've been hiding from your loved ones).

If you wanted to get all this business in order, you could probably do so in a day using For the Record, assuming you had all the information accessible. The program is set up nicely; you can start with the first category and work your way through the entire database, filling out the forms related to each subject.

The Nolo Press folks, who brought us WillWriter, have thought of pretty much everything. Thus, by the time you've used the program, you have a thorough record of all your personal information. This package can save you lots of time and even some lawyer's fees. The disk holding your records isn't a legal substitute for the records, but it sure will help your survivors find what they need to find when the time comes.

The program has some nice touches that facilitate filling out the forms, including an icon that sends you into a clean entry sheet or the next screen. And if a particular form doesn't allow space for all the things you want to record, you can use the program's notes feature, which lets you attach a page of notes to any record (when I was using the program, I came across a notes page that apparently a Nolo programmer had left there, containing the lyrics to "Mary Had a Little Lamb").

For the security-minded, there's a way to lock any or all categories; this uses a simple password scheme that, as Nolo admits, a competent hacker could figure out, but it will thwart the casual snoop from getting to your information.

This is a dandy little package for collecting all your records and data—and even bits of autobiography—in one place. Just be sure your executor knows how to boot up a Mac; he or she will probably not have much trouble working through the program to retrieve the information, but the executor has to know how to get in there to start. The inch-thick manual that comes with the program is only part manual; it's mostly a helpful adviser on getting your affairs in order. As the folks at Nolo Press say, you can't take it with you, but you can at least let someone know where you left it.

—*D. Barker* ■

THE FACTS

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TO THE STARS

Jerry ponders on portables and, laid low by the flu, examines game designs

Last week I went to Washington, DC, to participate in NASA's posthumous presentation of the Distinguished Public Service Medal (NASA's highest award) to my friend and mentor Robert A. Heinlein. Appropriately, the ceremony was held in the Air and Space Museum of the Smithsonian Institution, and it was nicely done. The medal was appropriate, too; Robert Heinlein's stories of what we can do if only we have the nerve have had a profound and beneficial effect. I only wish they'd got around to giving it to him in his lifetime.

I also talked to some people about the space program and what they want me to do. Depending on the outcome of next month's election, which you'll know by the time you read this, I may be a bit more involved than I am now.

On that score: the Lunar Society, an outfit mad enough to think we might be able to put a colony on the moon well before the end of this century, needs a science education coordinator. Dozens of low-cost experiments, ranging from computer simulations to simple chemical analyses, will have to be done. Most are within the capability of a good high school science laboratory, and many would make excellent Science Talent Search (STS) projects. As an example: we don't really need to spend millions of dollars developing "space-rated" items. Many everyday objects will work fine. Unfortunately, some won't: ordinary felt-tip pens, for example, give off some pretty noxious fumes when exposed to vacuum or low pressure (and worse when burned).

One good STS project would be to take items like standard electric power outlets, put them in a vacuum for a few weeks, and analyze the resulting gases. Another experiment would be to take what's outgassed from such items and pump the gas in a closed cycle through a water bath, extremes of cold and heat, and into a tub full of algae. A high school lab isn't likely to have a gas chromatograph to analyze the results (although some do), but nearly any university should be willing to cooperate. There are literally dozens of potential projects like that; the problem is coordinating the work. Any volunteers?

The Portable Wars

I do more traveling than I like—for all the mess, Chaos Manor is a pretty comfortable place—but there is one advantage. No one has yet found a way to telephone me on a train or in flight. Alas, I suppose it's just a question of time: Mr. Heinlein's *Between Planets* has teenagers carrying personal telephones on backpacking expeditions, and Geoff Goodfellow has been carrying a personal telephone to the Hackers' Conference deep in the Peninsula Hills for several years; someday, I just know I'll get saddled with one. For the moment, though, long flights are a good time to get some work done, provided you have the proper tools.

The question is, what are the proper tools?

What I've been carrying lately is the Zenith SupersPort 286. This is a machine that grew out of the Zenith Z-18x series of portables, and it is a full 80286 machine complete with a 20-megabyte hard disk drive. The Zenith backlit screens are wonderful: you can read them in just about any light conditions. If the room light is bright enough, you can dim or even turn off the backlighting to save battery power.

Unlike the earlier Z-18x series, the SupersPort's screen will tilt to any angle, including flat horizontal, which makes it much easier to set up an optimum combination of tilt, brightness, and contrast. About the only time I've ever had trouble with the SupersPort has been when I was inside in dim light with bright windows all around me. That happened once on a train in the Arizona desert, and once on the porch of a Zurich restaurant facing the lake. Even then, I could read the screen; it just wasn't comfortable—but no other portable would have been better under those conditions, and many of them would have been plain impossible.

Like its Z-18x predecessors, this would really be good enough to be your only machine, depending, of course, on just what you do with computers. The SupersPort doesn't have color, but it is Hercules-compatible, and for that matter, unlike some of the Z-18xs, the SupersPort's EGA video output jack really works. There aren't any slots, but you can install an internal modem.

There's provision for additional memory and a math chip. (If you do any calculations at all and you don't have a genuine Intel math chip for your computer, go get one. They're simple to install and the most cost-effective speedup device I know of.) The keyboard is a bit small, but it doesn't take long to get used to it. I'm told there is (but don't yet have) a tiny memory-resident program to swap the Caps Lock and Control keys to make typing easier. In other words, the SupersPort really is a full IBM PC AT-type computer.

It's also heavy.

I like to avoid checked luggage whenever possible. This means I get on an airplane carrying a briefcase, a garment bag, and a computer. Sometimes, after COMDEX for instance, I also have several canvas book bags of stuff I collected at the show. (Some airlines have begun to get sticky about the "two carry-on items" rule; when they do, I tell them my briefcase is my purse and point to all the

continued

women with purses in addition to two items. So far, no one has bothered me on flights out from COMDEX.) Anyway, I generally have plenty to carry; and when you change planes, your flight will inevitably come in at gate 3 to connect with one at gate 37 leaving in 10 minutes. I think they run a linear programming model on a Cray to achieve that.

The result is that every trip I feel the weight of the SupersPort's shoulder strap. "Never again," I mutter as I scurry down the corridors of the Dallas airport. "Next time I swear I'm taking a lighter machine."

The problem is, which one?

The lightest of all are the TRS-100 and NEC PC-8201 laptops. These are pretty good little computers. There's no backlighting, but they're surprisingly readable, even in fairly dim light. I've been able to work with the PC-8201 in the darkened cabin of an overnight flight to Europe. These two machines have BASIC and quite a good text editor in ROM; longtime readers will recall I used the PC-8201 to write this column while I was in Liechtenstein.

The "normal" screen of 8 lines of 40 characters is impossible, but Traveling Software's Ultimate ROM II (isn't being twice ultimate a bit like being "very unique"?) lets you have 8 lines of 60 characters, which isn't enough, but it's better than working with a typewriter. If all you're doing is making notes and writing short articles, these machines are pretty good.

There are some problems. On my last trip, I took copies of *Strategy of Technology*, *Prince of Mercenaries*, and a new book Larry Niven and I are working on called *A Labor of Moles*. I had them all on the SupersPort's hard disk, and I managed to get some work done on each of them. I couldn't have done that with the PC-8201. While Traveling Software's LapDOS will let you couple a battery-powered 3½-inch floppy disk drive to a PC-8201 or TRS-100, it's quite slow; changing from book to book would not have been so easy.

On the other hand, it would have been possible. There are still situations where the TRS-100 and the PC-8201 make a lot of sense, especially if they're jazzed up with some items from Traveling Software's catalog: a spelling checker in ROM, a way to add a megabyte of memory to the TRS-100, and programs to squirt text from the laptop to a DOS machine. Given the light weight and low price, the older laptops aren't dead yet.

The next step up is the Toshiba T1000. This little gem has DOS in ROM (alas, version 2.2, but you can boot it with 3.x if you need DOS 3 features). There's one floppy disk drive, and it has no backlighting. Unlike the TRS-100 and PC-8201 laptops, the memory is volatile. In a word, it's your basic unadorned PCompatible laptop. It also weighs about 5 pounds, compared to my SupersPort's 15+ pounds. (Part of the SupersPort's weight is the bag, a large power converter, and other auxiliary stuff that could go in checked luggage but never does.) Many writers swear by the T1000. David Drake loves his; he often works outside in his backyard and considers the T1000 ideal for that.

The T1000 is a "full PC," meaning you can run your favorite word processor and other DOS software; one friend with back problems has hers set to play mahjongg while she lies flat. It also has a full screen. It doesn't weigh much more than the PC-8201 and the TRS-100. It costs more, but on balance you get quite a lot for the added weight and price.

If you want to spend more money, you can add a 768K-byte nonvolatile RAM disk. This should be really handy, since it speeds up disk operations, and being nonvolatile, it is safer than a hard disk.

For communications, get a WorldPort 300-/1200-bit-per-second modem; it's about the size and weight of a pack of cigarettes and works very well. I'm told you can also buy a gadget that backlights the T1000's screen.

All told, the T1000 is extremely tempting and definitely preferable to the smaller laptops. In my judgment, the real battle of the laptops is between the T1000 and the SupersPort. (A number of other laptops have hard disk drives, but the SupersPort's batteries—provided you deep-discharge them at regular intervals—last over 3 hours, which is a good bit longer than any other machine I've tested or even heard of.)

I haven't really made up my mind on which to take on trips. When I'm humping baggage through airports, I swear I'll never carry the SupersPort again; but when I actually sit down on the plane or in my hotel room, I'm mighty glad I have the full machine.

Usually what happens is that the night before a trip I dither, and finally decide to carry the SupersPort. Then I mutter curses at it in airports.

There are several reasons for that choice. First, I sometimes do programming on trips; and since I can't carry the reference documents, it's important to have all the help files instantly available on the SupersPort's hard disk. I have to

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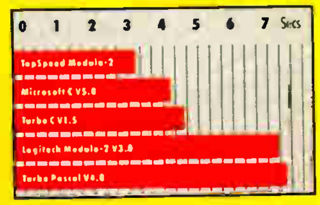

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confess, though, I do less and less programming all the time.

Second, it's very nice to have several books all instantly available. The SupersPort does really rapid disk accesses, making it simple to switch from one chapter to another, or even from one book to another. Whether that's sufficiently convenient to warrant making me a beast of burden is another matter.

The latest reason I put up with the SupersPort's weight is Symantec's GrandView. This program is so neat I can't see how I ever lived without it. It's actually worth humping baggage to have it.

GrandView is the logical successor to ThinkTank: an outline processor with a good text editor. The editor is really good enough to write columns with—I know at least one columnist who uses nothing else—and since GrandView has the capability for multiple windows, I can do about half my trip work without ever leaving it. GrandView, alas, really needs a hard disk.

There's one more possibility I haven't tried: the T1000 with the additional 768K-byte RAM disk. I'm told that GrandView operates very well with a RAM disk. That could make the T1000 a really powerful contender, and it would be a great deal lighter than the SupersPort. We'll see. I suspect, though, that when all the tests are over, I'll still be lugging the SupersPort and muttering curses.

Game Designs

I came back from Washington, DC, with a sore throat that soon developed into a cold and went from there to a full case of the flu. I'm basically pretty healthy—megavitamins seem to help keep my immune system in good shape—but even so, I was sick enough that I didn't much feel like working. The upshot was that I spent a few days mucking about with new computer games.

They're getting pretty good. Some, like Wall Street Raider, are educational to boot: Raider is a detailed simulation of corporate finance. Playing one against the computer isn't a lot of fun—the computer isn't too sophisticated—but if you get three other people, you can really learn something about stocks, mergers, takeovers, and the general world of finance, and have a whacking good time in the bargain.

However, it's no game to play when you're nursing a cold. I've found by and large that when the flu gets you, the best thing to do (other than go to bed, which is boring) is to go conquer something.

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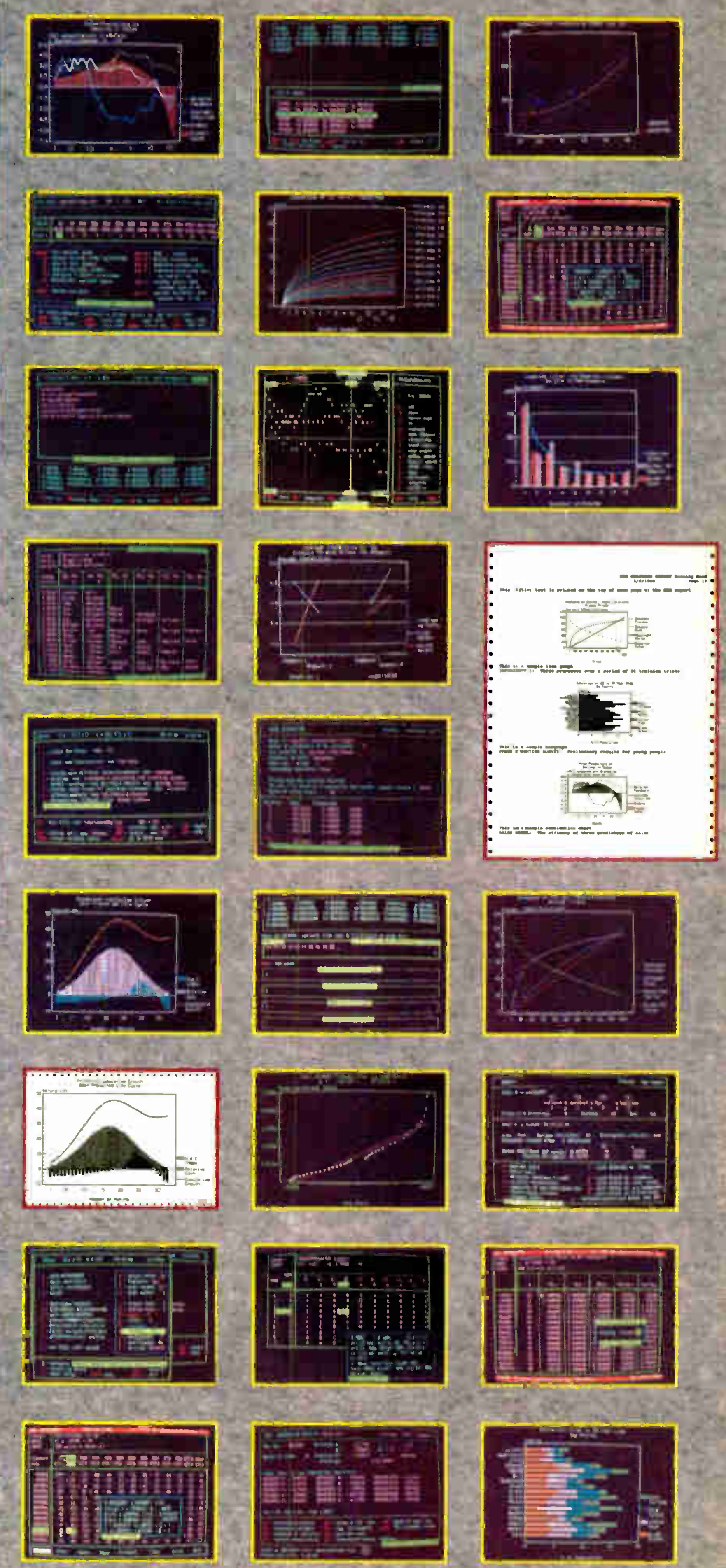

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One of the more fascinating war games is Empire. This is a PC (IBM, Atari, and Amiga) version of the game that Walter Bright wrote for big minicomputers. It was ported over by Mark Baldwin. Strategic Conquest (Macintosh only; a Mac II version has been announced, but I've never seen it) is pretty directly based on the old Empire, and it was published before Baldwin got Empire converted to PCs.

Empire is published by Interstel. They also do Star Fleet One and have announced but never shipped Star Fleet Two. Presumably because they began as a space-war-oriented company, they've surrounded Empire with a fairly silly scenario shell, something about being dropped onto a planet with a single army and the mission of conquering the whole place. All of that is about as silly as the game's box cover: a drawing of an overdressed chap who looks to be under 20 and has enough gold braid and medals to make any generalissimo proud. More to the point is the warning printed in the manual: "Empire has been known to be addictive. Typical battles can take several hours to resolve. Interstel assumes no responsibility for lost productivity on the part of the players."

The odd part is that they're right. Empire is an addictive game, and I've been wondering why.

First, the game is easy to play. Just take the mouse and use it to indicate where your troops should go. If you want to start a battle, try to move where an enemy force is.

Second, it goes in tiny increments. It's easy to make just one more move; and although there are a lot of units, you can give them general orders—such as go this way until you find something, or sit here and wait for something to happen—so you don't have to fool with each unit in each turn.

Third, the conflicts are resolved instantly: you attack, and you find out what happens. Then you move another unit. As with point two, this leaves no clear stopping point. It's always tempting to make just one more move and see what that does.

Fourth, the user interface is intuitive. It's not as good as I'd like. The mouse response can sometimes be annoying. I've sent Baldwin suggestions for new ways to display needed information. Still it's more than adequate for the job.

Fifth, the game isn't easy to win, but you probably will. The enemy isn't entirely predictable. He can surprise you, and of course you never know what the world map looks like until you've conquered, or at least explored, the territory.

Summing it all up, Empire tempts you to play just a little longer and find out what's going to happen next.

Another series of computer war games is based on the old board game Stellar Conquest. Reach for the Stars, which has been the game of the month here a couple of times, is certainly the best implemented of these; alas, it's available only for the Mac, which is probably not a coincidence since it's the Mac interface that makes it so easy to play. Stellar Crusade is another; this one is available for the Atari ST and the IBM PC (and probably some other machines). The user interface isn't anywhere near as nice as that of Reach for the Stars, but Stellar Crusade does try some innovations.

The one I've spent the last 2 days mucking about with is Anacreon, which is published by an outfit called TMA

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Mitsubishi Model	Screen Size (inches)	Horizontal Scan Frequency (kHz)	Mask Pitch (mm)	Compatibility/Resolution							
				NTSC	CGA	EGA	VGA Std.	VGA Ext.	Apple Mac II	1024 x 768 (48 kHz)	1280 x 1024 (64 kHz)
Diamond Scan 14 (AUM1381A)	14/13V	15.7 ~ 36 auto-tracking	0.31	•	•	•	•	•	•		
Diamond Scan 16L* (HL6605TK)	16/15V	30 ~ 64 auto-tracking	0.31				•	•	•	•	•
Diamond Scan 20A (HA3905ADK)	20/19V	15.7 ~ 36 auto-tracking	0.31		•	•	•	•	•		
Diamond Scan 20L* (HL6905TK)	20/19V	30 ~ 64 auto-tracking	0.31				•	•	•	•	•
XC1429C	14/13V	31.5	0.28				•				
XC1410C	14/13V	22 or 15.75	0.40		•	•					
XC1430C	14/13V	22 or 15.75	0.31		•	•					

*Microprocessor-enhanced programmable display settings

(undoubtedly the author, George Moromisato, in another guise). The manual is thick and informative and full of good ideas, but, alas, doesn't give the address of the company! That's actually not surprising: the whole game is filled with excellent ideas, mostly well implemented, and then spoiled by inattention to some vital detail.

I am about to be more critical of Anacreon than the game deserves; most of its sins are committed by one or another start-up software publisher, and indeed, it's their very generality that tempts me to discuss them. Then, too, I've just spent the last 2 days (and nights) playing this thing, so I've given it a lot of thought. Incidentally, you should note that I *have* been playing the game. True, it was mostly a way to be distracted from my flu, but I've got plenty of other games here, or for that matter there are a lot of new science fiction novels I haven't read. It says a lot for Anacreon that although it was pretty frustrating at the beginning, I did keep at it.

Anacreon (the name is based on one of the barbarian kingdoms in Isaac Asimov's *Foundation* series), like all the Stellar Conquest derivatives, is a kind of super Hammurabi, with provision for rather simple combat thrown in. Hammurabi, for those who came late into the computer revolution, is one of those early BASIC games that appeared early on, just after the MITS Altair computer came on the market.

Half the people I know wrote a Hammurabi program back in the 1970s; for many, it was the first program they'd ever written in their lives. It was a game of allocation of resources. How much wheat do you feed the peasants as opposed to how much to save as seed corn? Do you borrow money from Gonzor the Toothless (who wants exorbitant interest) or neglect to buy a new grindstone? And so forth. The Stellar Conquest derivatives are much more sophisticated now, but they still require you to make economic decisions.

This is all right when you're working with half a dozen planets, but after the game gets going and you have 40 or so places to worry about, it becomes tedious in the extreme. Anacreon tries to handle this in a fairly novel way: you don't issue detailed orders to your planets, you designate what that planet will concentrate on making. After that, it will take care of itself, notifying you if it's out of some raw material it needs.

So far, so good; but once again, after 30 or 40 turns, you are bogged down in details. Stellar Conquest games all have the feature that the only way to win is to build enormous fleets; but since your empire is scattered all to heck and gone, you get tiny forces on each planet. Then comes the task of concentrating those—and very few of the silly games have any automatic provision for doing it!

Empire solves much the same problem by letting you set flight paths: aircraft produced by rear-area cities can be automatically sent to some convenient forward area without your having to notice them. Stellar Conquest games desperately need that kind of feature: a way to order a planet to send each type of force it produces to some designated place or places (there are several kinds of warships, and you generally don't want to mix them in one fleet), and keep doing that until further notice.

Now since the need for this feature is

continued

so obvious, and so few games of this kind have it, one wonders why this happens; and I suspect it's because the game designer has long since stopped playing the game to its conclusion—and may well be sick of it. In any event, the designer is "testing" it rather than playing it. This probably happens to designers of other types of software as well: it's "tested" but not *used*, so that each individual feature works fairly well, but crying needs that don't arise until things get complicated just aren't seen.

Anacreon's next problem is in the user interface. While portions of this are quite good, some are just annoyingly buggy, and much of it is incomplete. Bugs include one routine in which the system will accept a character input; but if you insert a number, it gives an error message and makes you start over (after which it accepts the number it previously rejected). You can designate planets either by their names or their numerical coordinates. The routine in question allows, among other things, the naming of the planets—which must be identified by their numerical coordinates before you can name them. Since I can't recall all those numbers, I have to look at the screen map to see what the coordinates are—and doing that triggers the bug. This is a trivial bug, but it's annoying, and I do wonder why it wasn't fixed.

However, fixing that bug isn't what's really needed. What Anacreon really needs is a way to let you point and shoot: use either the mouse or the cursor keys to designate which of the doggone planets you're trying to name, or go to, or attack. Anacreon was written in Turbo Pascal 4.0, and about half the game inputs *can* be done with menu bars and the cursor keys; the other (and most often used) inputs have to be laboriously typed in, even though right there on your screen is a list of the items you have to type in. It's clear that Anacreon, again like a lot of self-published software, was rushed into production before it was really finished.

One wonders why this should be so. Start-up companies are at a horrible disadvantage. They have no advertising budgets, no mailing lists, no word-of-mouth reputation. They're a bit like beginning actors.

Charlton Heston once told me that getting ahead in acting was more a matter of luck than talent and skill; but then he hastily amended that. "What I meant," he said, "was that there are a lot of skillful and talented people out there, far more than the industry can absorb, so that it takes luck, at least one good break, to rise above the crowd. However, if you haven't done your homework and developed your skills, one good break won't do you any good because you won't be able to exploit it."

It seems to me that software start-ups are in the same position. There are a lot of good programmers out there. A lot of them have good ideas. Many of them go on to develop their ideas, and a surprisingly large number then try to publish their stuff. I must get 100 such attempts each month, and I probably don't get them all. I look at perhaps 10 of those, and I'll be the first to admit that luck has a lot to do with it. A good cover letter explaining just why this is different from all the "yet anothers" helps a lot, but in the last analysis, I look at stuff by whim.

Since there is so much unexamined software lying around Chaos Manor, I'm not going to spend a lot of time with anything that's confusing, or contains annoying bugs disguised as features. I've

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said all this before; and since being considered for review in a BYTE column is the equivalent of the actor's one lucky break, you'd think a software author would take a lot of care to see that the product is as solid as possible.

Alas, most of it is likely to be like Anacreon: pretty good if you're willing to spend time mastering it, but hard to get into if you're not an enthusiast.

More examples. Item: The game's Options menu lets you enable or disable the Pause feature. This is important, because the game has a time clock running, and since each move can take half an hour or so, and few of us are immune to dinner announcements, telephone calls, and other distractions, you really *must* be able to halt that clock while doing something else. Alas, it is nowhere explained how to do that. The thick manual has an index, but no entry for Pause.

Item: you can save the game only after you have completed a move. Moves take a long time, especially when you're first learning the game, and particularly during some of the economic phases when you have to collect fleets and send them after raw materials to be delivered to factory worlds (once again, there is no "automatically trade these materials between these planets" command).

Here you've invested 15 minutes of time making moves and getting everything set, you need to look something up in the manual, and the phone rings. The game clock ticks on inexorably (it updates itself from the system clock, so that even if you use DESQview and stop the thing from running in the background, you can't stop that damned clock). You can't save, you can't pause, and if you move hastily, you'll probably blow the game. What do you do? Even if you know the secret to Pause, you're still in trouble.

Start-ups aren't the only ones who can manage to do things goofy.

If you're the game developer or one of his close friends, you don't have that problem; you know what you're doing. Besides, you're probably no longer playing the game, you're just "testing" it.

I could go on, but surely the point is made? I get a lot of software like that, and not just games. Anacreon got several lucky breaks. If it hadn't been for the flu, and my particular interest in stellar empires in general and Isaac Asimov's *Foundation* in particular, I'd never have got past its bugs; Anacreon would have ended up with its disks scrubbed and the manual in the Notre Dame paper drive, which would be too bad, because it's really a darned good implementation of the Stellar Conquest idea.

Incidentally, start-ups aren't the only ones who can manage to do things goofy. Interstel, publisher of two of my favorite games, has put out a thing called First Expedition, which manages faithfully to simulate all the long boring aspects of sailing: they make you sit there and steer

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for long minutes in real time while absolutely nothing happens on-screen. I can't imagine that anyone at the company ever *played* this turkey.

The moral of this is left as an exercise to the reader, particularly those of you who want to publish your own software.

Note on Turbo Pascal

Anacreon was written in Turbo Pascal 4.0. It's a good example of just how complex a program you can write in Pascal. It also stretches the limits of a 512K-byte machine. The author has recently updated to Turbo Pascal 5.0 and reports that although it's not a real problem, he is having some difficulty getting his big program and the debugger going at the same time; its pure size limits are the root of the problem.

Fortunately, Borland's new Turbo Debugger can be run on an external machine, meaning that you can have the debugger in one PCompatible (it can even be an old PClone) connected to your AT with a serial cable, and run your program on the large machine. This not only saves memory, but often you can find out a lot from crashes, since you haven't crashed the machine doing the debugging.

Turbo Pascal 5.0 also allows overlays in expanded memory, which is another neat solution to the memory limits of most machines.

It has a great tutorial, and there are scads of Turbo Pascal toolkits, not only Borland's but many developed by third parties. I am more and more becoming convinced that Turbo Pascal is the programming language of choice for people who are more interested in *what* they want the machine to do than in how to make that happen. Turbo Pascal may be neither as elegant nor as portable as C, but it's sure less obscure. I think it may well be the language for the rest of us.

Power Point

The Mac II isn't indispensable, but it's getting close. I still don't use it to write books or to do taxes, or indeed any of the day-to-day stuff, but I could. While I was in Washington, I went to Tom Clancy's house for lunch, and there sat his little Mac Plus, which is still the only computer he has for both writing and database organization. I couldn't write books on the small Mac because I can't see that small screen well enough, but I can see the Mac II just fine—and clearly if Tom Clancy can turn out his blockbusters on a Mac Plus, I ought to be able to do it with a II, especially since I have a Plus networked into the system as well.

It's partly out of habit that I don't concentrate on the Mac II and say to heck with everything else. There's also software familiarity: I've got used to PCompatibles, and there really is a lot more interesting software for PCs than for the Mac. Finally, while MultiFinder doesn't work very well yet, DESQview on a big 80386 machine certainly does, and I've got very used to being able to pop from my word processor to my database, then over to the modem, then into GrandView for notes. . . .

On the other hand, even though I don't use it every day, I'd really *hate* to give up the Mac II. When we do use it, nothing else will do the job half so well.

Even though I don't use it every day, I'd really hate to give up the Macintosh II.

Microsoft's Power Point is a good example of that. This is a program that lets you organize presentation materials. You can make briefing charts, organization charts, color pictures and maps, and just whole bunches of other stuff, in black and white or in color. To get color pictures from the Mac II's screen onto a projector, you can either get an electronic slide maker or do what we do and shoot the picture with Datacam and use photographic methods. Black and white prints out nicely on the LaserWriter IINTX, of course: if you want ViewGraphs, you print on acetate.

I've only got started with Power Point. As with most modern Macintosh programs, it's easier to *use* than to talk about it; you just sort of noodle around doing what seems obvious, and after a while it clicks.

Of course, you can also read the manual. Power Point's manual is extraordinarily complete, with lots of color illustrations. Much of it consists of descriptions of what the program can do; these are followed by copious examples, in clear and precise language. This is getting close to the model of what a good manual should be. It's also supplemented by pamphlet-format quick reference and template guides. It's this kind of quality that makes it difficult for small outfits to compete with the Redmond giant.

I could run on at length about Power Point, but I won't; I'll just say that if you're in the business of putting on briefings and otherwise making presentations, you might want to seriously contemplate getting a Mac II just so you can use this program; it's that good. Highly recommended.

MacSpin

People generally aren't interested in statistics. I suppose I am more than most because back when I was in graduate school in psychology, Dr. Aaron Paul Horst insisted that his students go over to the math department and really learn the calculus of probabilities rather than faking it by taking "Statistics for Social Scientists." I can't say I had fun doing that, but the course was worth the effort.

That was just before John Tukey and his students effectively revolutionized the field of statistics. Tukey insisted that you needed more than mathematical models to understand data; that you ought to play about with it, manipulate it, examine it in different ways, rather than mechanically crank out an analysis of variance that would produce a table of "significant" differences without giving much hint of what that meant.

Tukey and others seized upon early developments in computer graphics to make their case and developed novel ways to look at clouds of data points. The programs ran on a computer system that cost the equivalent of a half million 1988 dollars.

MacSpin was written by several of Tukey's graduate students, and it does on a Macintosh what his original programs did on Stanford's large and expensive system back in the 1970s. I was much impressed with version 1 of this program when it came out several years ago; I'm even more impressed with version 2.

Who needs MacSpin? Actually, almost anyone with a Mac will find it interesting. The program comes with a bunch of data sets, all of them rather fascinating. One is a plot of the known galaxies. When you first put it up on the screen it makes little sense, but then as you rotate the image, you see big holes and gaps. Why should that be? Then you see the pattern and realize that it's the Milky Way.

Other canned data sets include hospitals and livability of cities. Use these to get a feel for what the program can do; by then, you may have thought of other things to examine. I'm about to put in the

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data on my books: sales, year published, number of pages, cover price, with or without coauthors, and everything else I can think of, then see if anything interesting pops out. I've also got a couple of other projects in mind.

The MacSpin documents indicate that the program is copy-protected. Weary of that, I used Copy II Mac to put it on my hard disk and get it over with. I have since discovered an undocumented feature: although the documents don't say so, its manufacturer, D[2] Software, removed the copy protection from MacSpin some time ago.

MacSpin is an excellent program, particularly if you're one of those unfortunate people who hate statistics but are always having them thrown at you. A few hours of hacking about with MacSpin will teach you more about correlations than you ever learned in "Educational Statistics." Recommended.

Northgate Keyboards

Did you like the feel of the old IBM PC keyboard? The one that went "klik-klak!" (Sorry: we just went to opening night of *The Tales of Hoffmann*. Placido Domingo was superb as usual. A new Hoffmann libretto and arrangement based on recently discovered Offenbach notes, but that's another story.) Anyway, if you liked that keyboard, you may be interested in the Northgate OmniKey 102. It has that feel, without the disastrous key layout of the old IBM.

Indeed, the OmniKey 102 has about as good a key layout as any I know, and the feel is quite good. It has the function keys in a group on the left (XT style), rather than across the top. The Escape key is where it belongs, the Backspace and Return keys are oversize, and there are a number of other interesting layout features.

I like this keyboard; whether I like it more than my DataDesk keyboards is debatable, but I sure do like the feel of the OmniKey 102.

There's one real problem. Northgate sent me four of those keyboards. Three of them have the annoying habit of repeating a letter sometimes (keyboard bounce); one has a sticky 2 key that I can't fix with silicon lubricant. I'm sure these keyboards were just off the assembly line, and it may be they were part of a bad batch; but sending me three mildly defective keyboards out of four doesn't argue well for their quality control. Worse, people for whom I have a great deal of respect tell me that trying to get Northgate to honor a warranty is a very difficult and time-consuming business; they do it, but apparently their system is swamped.

I have discovered that the keyboard bounce happens only when the keyboard

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is used with a very fast 80386 machine; with normal AT and XT machines, you will never see it.

For all that, I do like the darned keyboard, and I have been oddly reluctant to change it, even if every now and then I have to correct "annnd" or "kkeeeeep." The bounce doesn't happen very often, the spelling checker generally finds all those cases anyway, and—and besides, I guess I really do like to hear the keys go klik-klak!

Winding Down

I'm out of space, and as usual there's an enormous pile of good stuff in the ready line. Broderbund has a new Macintosh HyperCard program called DTP Advisor; it's a tutorial and management system for people interested in desktop publishing, and you really can learn a lot by using it. There's askSam. I am getting seriously annoyed at companies that use odd orthography for product names, and I often swear I will never review another, but in fact this is a darned good free-form database program, easy to learn and easy to use, just the sort of thing the casual user needs; it hasn't yet got a permanent DESQview window on my system, but by next month it may.

There's Stephen Manes's *Complete MCI Mail Handbook* (Bantam, 1988). I find MCI Mail indispensable, but their user manuals suck green turtles; Bantam's new book is both an introduction and a reference, and it's excellently done. There's also Que's new *HyperCard Quickstart*, an excellent tutorial to getting started with Macintosh HyperCard: how to use it, and also how to author your own card stacks. If you've been curious about what HyperCard is all about, this is the book to get.

We've also got Gofer for the Mac. Gofer, for those few who don't know, is a program that searches all over your hard disk to find files containing the stuff you've asked it to look for. It works intuitively, it's very fast, and if you've got stuff scattered all over the place the way I do, you really have to have this program for the PC. I haven't done much with the Mac version, but given my 330-megabyte Priam MacDisk, I expect to use it a lot.

The book of the month is Michael Wood's *In Search of the Dark Ages* (Facts on File, 1987); it will tell you more about Alfred the Great and Athelstan than you thought you wanted to know. Wood shares that with Tom Clancy's *The Cardinal of the Kremlin* (he told me he wouldn't give me the antidote to what he put in the lunch if I didn't say that).

The game of the month is clearly Anacreon; despite its problems, it's playable and the flavor is good, much like Beam Piper's old Space Viking series. Also, the author is busily fixing bugs even as I write this. (I called him a few minutes ago and read him what I've said.)

I've just read this over, and it's interesting that I find myself thinking up excuses for not using the Mac II more. You can make whatever you want to of that. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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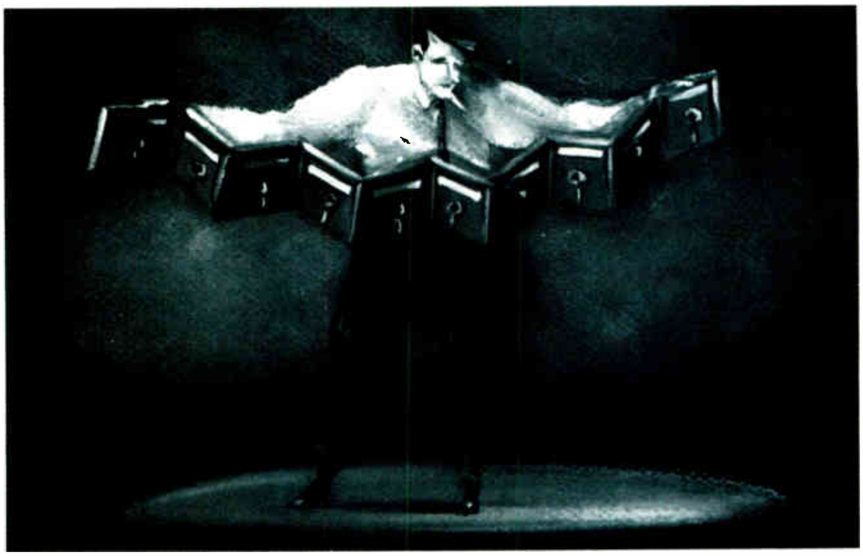
THE BLIGHT OF BLOATED SOFTWARE

WordStar 5.0 is a fine new version of a classic, but it's no longer lean and mean; are word processors getting too big?



Lately, I've been doing some hard thinking about the nature of word processors and word processing in today's computing environment. We've reached a technological bottleneck of sorts, and I'm not sure I like what's happening as a result. The problem lies in the rapid proliferation of laser printers and their effects on the design of software interfaces.

A few years ago, before laser printers had gained widespread acceptance, there was a direct correspondence between screen displays and output devices. Computer monitors and printers (dot-matrix and daisy-wheel) were standardized on 80-character monospaced lines. What you saw on the screen was what you got on the printer; true WYSIWYG was the order of the day.

Laser printers with scalable typefaces are now destroying the standard of 80 characters per line and 66 lines to a page. Software developers are faced with the necessity of tracking font usage and devising methods for depicting that information on the screen. In the MS-DOS world, largely bound to 80-character display devices, WYSIWYG has become an impossibility. We've been left with cumbersome word processors that embed complex font commands in text and interfaces that are relatively hostile to the user, if only due to the requirements of formatting.

Over on the Macintosh side, with bit-mapped displays and an operating system designed to manipulate fonts, there has been little hassle. But MS-DOS users will need to switch to Windows, the OS/2 Presentation Manager, or one of the Unix windowing shells before they can play with fonts without having to master arcane and mystifying command systems. Most of today's state-of-the-art word processors are transitional programs, trying desperately to bridge the gap between 80-character screens and proportional-spacing laser printers.

I don't know if everyone needs the program overhead this causes. Business letters, report drafts, and college papers don't require the quality of laser-printer output, and expensive laser printers are beyond the reach of many single users and small businesses. Why clutter up disks with fat programs and umpteen support files? Why slow down performance with features that may not be used?

I'd like to suggest to the manufacturers of word processing packages that they consider releasing "junior" versions of their programs, stripped of the laser-printer stuff but retaining all the other power features of their top-of-the-line software. Let's retrieve a little of yesterday's compactness and ease of use in today's products.

WordStar Gets Bigger

What brought all this nattering about WYSIWYG to mind was a month with WordStar Professional 5.0 (MicroPro, $495). The program is certainly ready at last to take its place among the leading word processors of the day; WordStar users no longer need to make embarrassed noises when they mention the product. But WordStar now suffers from some of the bloat associated with supporting the newer output devices, so it's no longer lean and mean, and not all the new features are as smooth as they should be. MicroPro has made literally hundreds of changes to the program; I'll sketch the most significant ones.

To begin with, WordStar can now reformat paragraphs automatically. This is considered to be a minimum requirement for a modern word processor, and its absence relegated earlier versions to in-

continued

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famy. I found the program as shipped just a hair too slow for my taste, especially compared to speed demons like XyWrite. However, it turns out that you can set the speed to your taste using WordStar's modification utility. After a bit of tinkering, I got it nicely tuned to my preference.

Next, WordStar's Control-key menus are no longer the only interface available. If you like, you can opt for pull-down menus that conform to IBM's Systems Application Architecture guidelines. For old WordStar hands, the new menus are disconcerting—it's particularly odd to select a menu item and watch the program insert an old-style dot command into text—but they do provide a simpler form of access for novices struggling to master the program. If you're already trained in WordStar, you can turn off all the menus and rely instead on your memory of the keystroke sequences.

Windowing has been added, but of a limited sort; you can open only two views. MicroPro claims that its research indicated that this is what the majority of users wanted, but I wonder if it's enough. I'd be happier with three views and could see use for more.

There's an undo command, macros, support for laser printers (including PostScript devices), direct import of dBASE and Lotus 1-2-3 files, a text-search utility that lets you locate files by words or phrases in them rather than having to find them by filename, and a thesaurus that actually provides short definitions of words. The spelling checker is one of the best I've ever used.

By far the most impressive new feature, though, is a page-preview mode that lets you see documents as they will appear when printed. It's unquestionably the most elegant preview on MS-DOS machines, and it's good enough to rival most Macintosh word processors. On an EGA monitor, you can display a full page at a time, zoom down to tighter magnification of smaller regions, or zoom back out to a thumbnail view showing up to 32 pages at a time. All this is done in actual fonts, and graphics—even color graphics—appear in position in any view.

The documentation is up to MicroPro's usual high standards, and it's arguably the best in the product category. The automatic installation procedure, however, is an abomination. . . because there is none. When a program comes on 12 disks, it's unconscionable not to give users at least a batch file to help them get the program loaded and configured.

On the whole, though, I was pleased with the changes to WordStar, rough edges and all. If you're looking for a new word processor, add WordStar Professional 5.0 to your comparison shopping list. And if you currently use WordStar, an upgrade is in order.

Off to Buy a Cat

Though a leopard can't change its spots, a Cat can lower its price. The Canon Cat, a writing machine that is based on technology developed by Jef Raskin at Information Appliance, has been reduced from the $1495 at which it was introduced last year to a mere $995. This buys you both the Cat itself and the Canon 180, an 18-character-per-second daisywheel printer. That's finally a reasonable price. I've been lusting after this baby ever since Jef showed me a prototype of the Information Appliance software about 4½ years ago, and tomorrow I'm going to rush out and purchase one. I'm as excited as I was the day before I bought my first Macintosh.

I've always been intrigued by this machine's minimalist approach to computing. It strikes me as a closer equivalent to a notebook than anything else anyone's got, with enough software smarts to make sense out of randomly entered pieces of text. The Cat is an unusual computer, unlike any other machine on the market, conceptually positioned someplace between a full-blown computer system and a pocket calculator.

The Cat is a small unit with a 9-inch black-on-white monitor, a single 3½-inch floppy disk drive, and an attached Selectric-style keyboard. The footprint is roughly 13 by 18 inches. For those of you who remember the dark ages, the Cat

continued

looks like a scaled-down, redesigned version of the old Intertec SuperBrain, though the Cat's muted gray/beige color is far more at home in today's office environment than the garish red, white, and dark gray of the SuperBrain.

Its unique software is what makes the Cat special. It's a full word processing and data management system in ROM that lets you create a huge scroll of text that can be broken into pages for output; there are no files per se. You find your way through this collection of information by using two keys at the top of the keyboard to initiate forward and backward searches. When you keep pressing one of these keys, each letter you type becomes part of the search string. As the Cat moves its cursor after each keystroke, rather than at the end of your entry, you rarely have to type an entire word to reach its next occurrence.

Highlighted blocks can be copied, moved, deleted, or sent to the printer. If the block is made up of numbers or a mathematical formula, the Cat will calculate the result. You can also enter programs in either Forth or 68000 assembly language, and the Cat will execute them.

There are other goodies, too: a simplified system for disk operations, an internal 300-/1200-bit-per-second modem, and a 90,000-word spelling checker.

You haven't heard much about the Cat because Canon doesn't seem to want to let you know that it's a computer. Canon has been marketing the product as a competitor to memory typewriters and dedicated machines like the Magnavox VideoWriter. So you can't find the Cat in computer stores; you can get one only through office equipment dealers.

I suppose that if you see the Cat as a piece of office equipment, the bundling of a daisy-wheel printer is a logical idea. I, however, have no desire to acquire a device that sounds like a pneumatic drill. And the Cat has built-in drivers for Epson/IBM printers, the Canon Laser Beam Printer, the Bubble-Jet, and other Canon printers, so the daisy-wheel printer is not an essential item. When I called Canon to ask if it was possible to buy the Cat minus printer, I was told that any decision to break up the bundle was "up to the dealer" and that there is no official Canon price for a solo Cat.

Canon's California office gave me the names of two stores in my area, and I called both to see what they would do for me. The first refused to split up the bundle and tried to convince me that the daisy-wheel printer was a marvelous bargain. I didn't dispute that, but I still didn't want one. The second outfit was quite amenable to selling a printerless Cat, and it quoted me a list price of $799. I don't know if the same 50 percent success rate would apply nationwide, but I'm fairly confident that you can find a Cat by itself if you want one.

It could be that the Cat is the perfect writer's tool. I don't know if my initial admiration will hold up after extended use. I'll report next month on my reaction to running the Cat for day-to-day tasks. ■

Ezra Shapiro is a consulting editor for BYTE. You can contact him on BIX as "ezra." Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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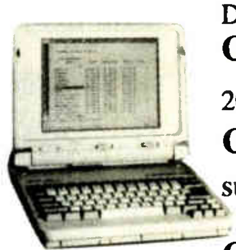

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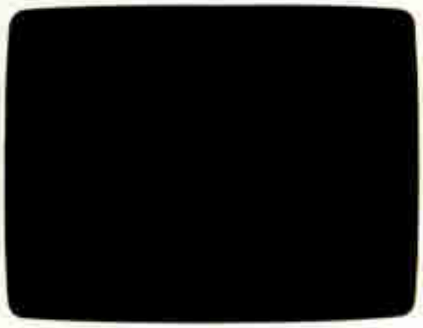

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So, Maybe You Do Need a LAN

If you have to do more than share a laser printer, a LAN may be just what you need

Last month, I wrote about Bill Miller, an Oklahoma patent attorney who needed to share a laser printer. It looked then like he probably didn't need a LAN. Why? Because the only thing he really needed to share was the printer, and there were easier and less expensive ways to do that. There is, however, more to life than laser printers.

For example, there's the case of the contract office in a small government agency in Washington. I'm not allowed to say which agency, but it has a problem that's not unlike those in private industry. Documents are generated by members of the 10-person staff, and they have to be approved by more senior members. When the approval is finished, the document has to be printed on a laser printer and stored somewhere safe.

This office generates modestly sized documents, often less than 20 pages and always less than 100 pages. In addition, members of the staff need to have access to common spreadsheets and to be able to print them. The staff currently has no need to use any outside services.

Unlike the legal office in last month's example, the people in this government contract office are not saddled with old, unsupported computers. Instead, they have a group of Zenith Z-248 computers purchased under the military's arrangement with Zenith Data Systems. These are AT-compatible computers that will work with readily available network hardware.

Let's take a look at whether or not this office needs a LAN.

Sharing Information

What this office needs is to share information. While most users think of local-area networks in terms of sharing scarce peripherals such as laser printers, you should realize that sharing information is at least as important. The key to the value of your network is sharing.

The kind of network you need, and the capacity of your network, depend on exactly what you need to share and how much there is of it. In the case of the government office in this example, there are a number of documents that vary in size from about 20K bytes to about 200K bytes. In most cases, the sharing doesn't take place until one user is finished with the file and notifies the next one that he or she can have it. At that point, the next user can move the file to his or her machine and continue work.

As you can see from the example so far, this is an office where the files are fairly small, as is the volume of transfers. The users need some way to send notes to each other, and they do need the ability to share the laser printer when the time comes to print out a draft or a final copy of the documents.

Which One to Use?

Here is one of those examples that have many possible solutions. The office could go with a LAN that has a dedicated file server. That would give the staff access to common files on the server, as well as other network services such as electronic mail. Another option, and the one they chose, is to go with a peer-to-peer network, in this case DCA's 10Net.

The decision makers chose 10Net partially because of its relatively low cost per workstation and partially because it is relatively easy to install and maintain. It doesn't have the speed and capacity of a huge file server, but it doesn't have the cost associated with one, either. Instead, each workstation can share a portion of its hard disk with the others. Each can

continued

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Zenith Z-248........$2999 to $6799
Zenith Data Systems
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Glenview, IL 60025
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Inquiry 951.

also make peripherals available for sharing with other network users, so the workstation with the laser printer can act as a print server for the entire network.

A Look at 10Net

Digital Communication Associates' 10Net has been quietly growing in acceptance. Its stronghold was once in Europe, but the company has shown significant growth in the United States and Asia. One of the major reasons for this growth is that 10Net is relatively inexpensive to install and use. Another is that 10Net is available in a fiber-optic version that has become quite popular with U.S. and Soviet intelligence and diplomatic communities—a fact that demonstrates it can work in a secure environment.

In its most basic form, 10Net is a twisted-pair network that transmits information at 1 megabit per second. This means that it uses cable very similar to telephone wire and will transmit a typical document file in a second or two. The network is cheap to install, and it's fast enough for most uses.

Its easy installation is one of 10Net's major points. All that is required is to connect the twisted-pair cable to a pair of screw terminals. You run the cable from one workstation to the next, and when you have connected all the workstations, your network is complete. Installing the network interface card is also easy; you just insert it into an expansion slot inside your computer.

Relatively little maintenance is required with this type of network. Because each user controls the hard disk drive on his or her individual computer, and because there is no file server, a network administrator has little to do. The greatest problem with this sort of network is that you can only access files on other users' hard disk drives if they have their computers turned on. This can be a problem if there is likely to be much need to use the network at odd hours when the other computers will be turned off.

Real Life Use

In actual use, users share portions of each other's disk drives and share designated peripherals. Which ones they have access to depends on parameters that can be controlled by the person using the

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workstation. This means that people on the network can't read what's on your computer unless you want them to.

To the users, the disk drives on the network look like disk drives on their own computers. Likewise, the network printer seems to be just like a printer connected to their own computers. You control this setup through a series of commands normally loaded with a batch file.

In the office in this example, when the initial draft of the document is ready for the next person, it would simply be copied to his or her computer. This could be done by either person involved, with an E-mail note telling the other that it has happened. Once the next person is finished, the document is moved along to its subsequent location. At any point in this chain, it can be sent to the laser printer.

Other Choices

There are, of course, other choices in low-cost, peer-to-peer networks. TOPS is also a twisted-pair network that will let you work with Macintosh computers as well as IBM PC compatibles. Another choice is LANtastic, which Jerry Pournelle tells me is nothing short of wonderful. I understand that he even managed to network his Amiga with this product.

How Do You Decide?

Last month you saw that some small offices may have a few of the needs normally associated with a LAN but really don't need one. A printer server was all they needed. This time, we see that there are low-cost, easy-to-implement solutions to true local-area networking. There is, of course, a wide variety of server-based LANs. How do you decide which one is right for your business?

The key to deciding is to determine what your needs actually are, as well as to make a realistic appraisal of your needs for the next few years. To do this, consider these points:

- What do you actually need to share? Is it a single peripheral, such as a laser printer? Is it information? Is it many peripherals?
- What is the nature of the information you need to share? Is this a system that is primarily handling E-mail? Will you transfer documents? Will you need to move extremely large files (e.g., CAD files)?
- How big will the network be? How many people will use it? How much distance must be covered?
- Do you need a central storage area for files? Do you need some other sort of centralized service (e.g., a wide-area network gateway)?

Answers to these questions will give you a more thorough knowledge of your networking needs. While there are no magic numbers that automatically indicate one network over another, the answers will give you the information you require to begin specifying your network. You can find the right network by realistically looking at your needs and applying those needs to the solution. ■

Wayne Rash Jr. is a consulting editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can reach him on BIX as "waynerash."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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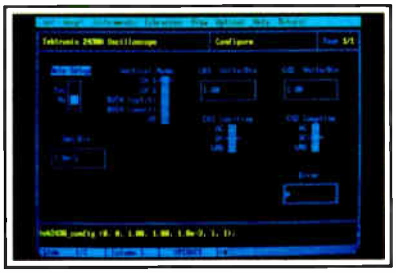

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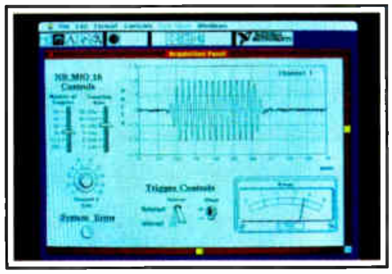

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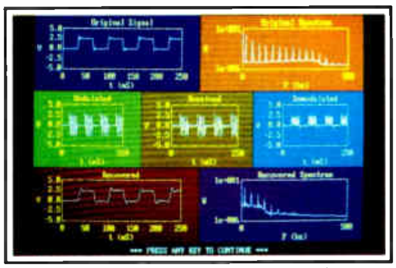

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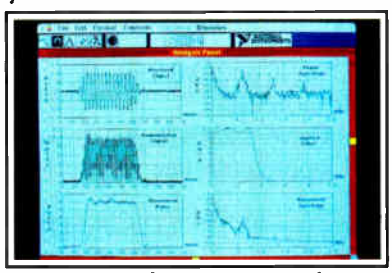

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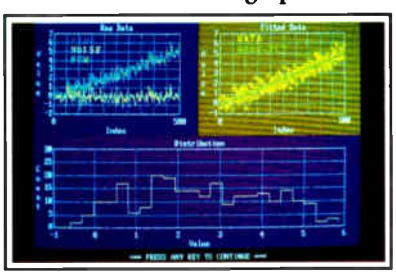

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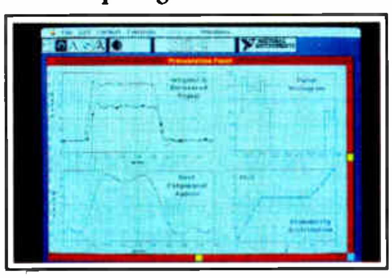

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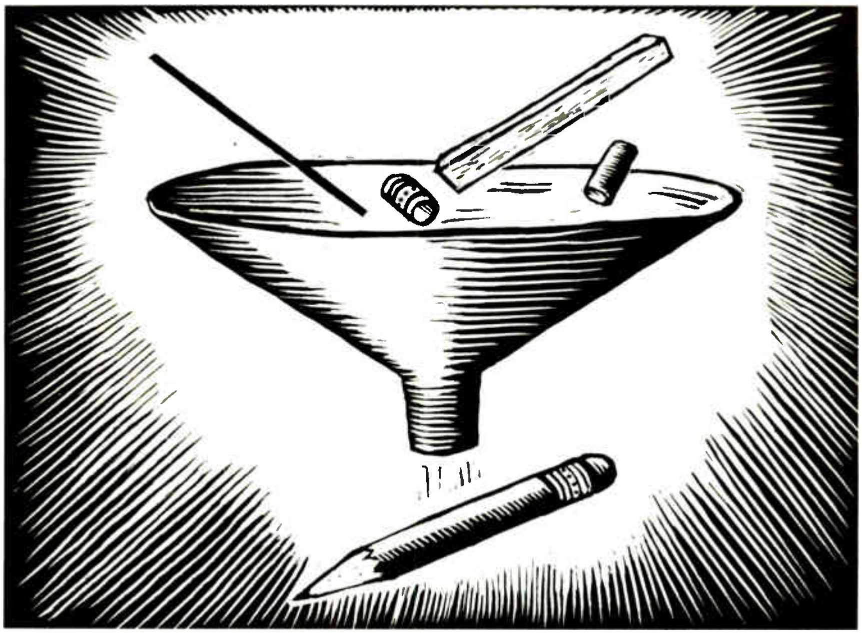
HOOKED ON SMALLTALK-80 FOR THE MAC

A new implementation of this language makes it a winner



In the past few months I've been sold on the virtues of object-oriented programming. I've toyed with the AT&T's C++ preprocessor on Unix, the object extensions to MacForth on a Mac II, the MacApp program shell that runs under MPW (Macintosh Programmer's Workshop), and the Extend simulation system from Imagine That!, a simulation-design system that adopts certain object-oriented programming concepts.

But the system that's really brought the practical power of object-oriented programming home to me is Smalltalk-80. In fact, I think I've become a Smalltalk-80 addict—so much so that I'm working on a new short course for next year that focuses on Smalltalk-80 and object-oriented programming.

It didn't used to be that way. I've toyed with Smalltalk-80 before, using the early beta 0.4 release available from the Apple Programmers and Developers Association (APDA) for $75. This release was incomplete, it was a little flaky, it provided only a byte-code interpreter, and it was poorly documented. With these shortcomings, I gave up using the language on a Mac until I found out about the full release from ParcPlace Systems.

Its Smalltalk-80 system is not limited to the Mac; in fact, there are versions that run on Sun 2, 3, and 4 workstations, Hewlett-Packard 9000s, and Apollo 3000 and 4000 workstations running some flavor of Unix. A DOS-based version for 80386 machines is also due out soon. It would be hard to imagine, however, that these Smalltalk-80 implementations could work any more smoothly than the one I've been using on a Mac II. Still, the system operates nearly identically across processors, which gives it a big advantage in terms of program development and transportable code.

The reason for this coherent implementation across processors and operating systems is the system's structure. Smalltalk-80 consists of two functional parts: a virtual image and a virtual machine. The virtual image contains the Smalltalk-80 language and compiler, the run-time system, graphical system libraries, and a whole slew of program-development tools. The virtual machine links the operating system and hardware of a particular computer to the virtual image.

Smalltalk-80 is a pure object-oriented system. Unlike more traditional procedural languages and systems that approach data and algorithms separately, Smalltalk-80 considers them together, as objects. Where procedural languages like C derive their power mostly from algorithm composition and data typing, pure object-oriented languages (like Smalltalk) dispense with this data/algorithm dichotomy.

Everything in Smalltalk-80 is an object. Once you understand how an object is created, you've grasped the essentials. The agents that act upon those objects are called *methods* (corresponding to a function or procedure in a procedural language), while a message is the way in which one object communicates with another (akin to a function or procedure call). Indeed, all the actions that take place in Smalltalk-80 are the result of objects messaging other objects.

Object-oriented programming systems also support sophisticated object-ordering methods, called object *classes*, so that you can assign similar properties (behaviors) to a group of objects (individual objects in a class are called *instances*) and work with them as a class.

As a full object-oriented system, Smalltalk-80 also supports object *inheri-*

continued

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comes from this modeless environment and visual interface. You're never "in" the editor or "in" the compiler, per se. Everything's available to you all the time. The interface is the one developed at Xerox Palo Alto Research Center (PARC, from whence comes the name for ParcPlace, a Xerox spinoff company), which spawned the Xerox Star and later the Apple Lisa and Mac. This means windows galore, a mouse, pull-down and pop-up menus, and the rest. Each of the development facilities can be used anyplace in the system, including text editing, debugging, performance monitoring, version management, system updating, and a bunch more.

Other development tools include inspectors, an impressive set of context-sensitive browsers, and some special cross-referencing tools that can access all system code and any reusable code module. You can also define primitives easily and use them to call and link external routines written in other languages, like C (the system is MPW C compatible), so you need not toss out any of your current favorite routine libraries when you migrate to Smalltalk-80.

The system also supports all the Mac-specific functions you need for program development. You can access the Mac's serial ports and use color directly. Smalltalk-80 permits Clipboard and Desk Accessory access. It is compatible with the MultiFinder (including background processing), supports TOPS and AppleShare, provides PostScript printing using the Print Manager, and gives you access to the Mac Toolbox through user-defined primitives. If you run version 2.3 on a Mac II, you'll also get support for the 68020 instruction set and the 68881 math coprocessor.

It is fairly easy to get started learning the system, since it includes some built-in applications that you can browse through, plus good documentation and on-line help. Of course, the best help comes from the user interface itself. Smalltalk-80 constantly gives you visual feedback for every action you take. All the object definitions that make the Smalltalk-80 environment so rich for development can also be included in the applications you're building. You can incorporate these library objects directly into your code or refine them as needed, making for a rapid development process.

Development is also enhanced by the quick access to system-level functions that's provided. The pop-up System Menu is just an option key or mouse click away regardless of what you're doing when you need it. From this menu you can create a new System Browser that presents information (displayed hierarchically) about the Smalltalk-80 system itself. Garbage collection, which the system does automatically (as it does reference-counting and memory compaction), can also be invoked manually from the System Menu. This mark-and-sweep collection routine cleans things up nicely when you've been coding for a while, especially if you've created some circular structures.

The System Menu also controls workspace creation (for editing code), file listings, specific project views, a running system console window (called the system transcript), and a command to suspend the system and return to the Finder, leaving Smalltalk-80 in the background under MultiFinder. These views and commands just scratch the surface of this complete programming environment.

I've been so taken with ParcPlace's Smalltalk-80 system that I'm spending time developing personal applications that I wouldn't have bothered with before, when I was using Lightspeed Pascal (my usual development environment), because the effort needed just wasn't rewarded by the results.

Smalltalk-80 encourages you to pull together quickie applications because it's so easy to grab and modify the basic objects they require. And if you're not quite satisfied with the results, no problem: You can dip into the library of objects for another stab at it. This system is the first programming environment I've used on the Mac that actually made me *want* to develop software.

If you, too, want to get started with Smalltalk-80 on the Mac but need some background information about object-oriented systems, you should dig out your August 1981 and August 1986 issues of BYTE. These two issues covered, respectively, the Smalltalk-80 system and object-oriented programming.

Adele Goldberg's Smalltalk-80 book is also a good place to get started (*Smalltalk-80: The Language and Its Implementations*, Reading, MA: Addison-Wesley, 1983; written with David Robson). Have fun with Smalltalk-80 on the Mac. I sure do. ■

Don Crabb is the director of laboratories and a senior lecturer for the University of Chicago. He is also a consulting editor for BYTE. He can be reached on BIX as "decrabb."

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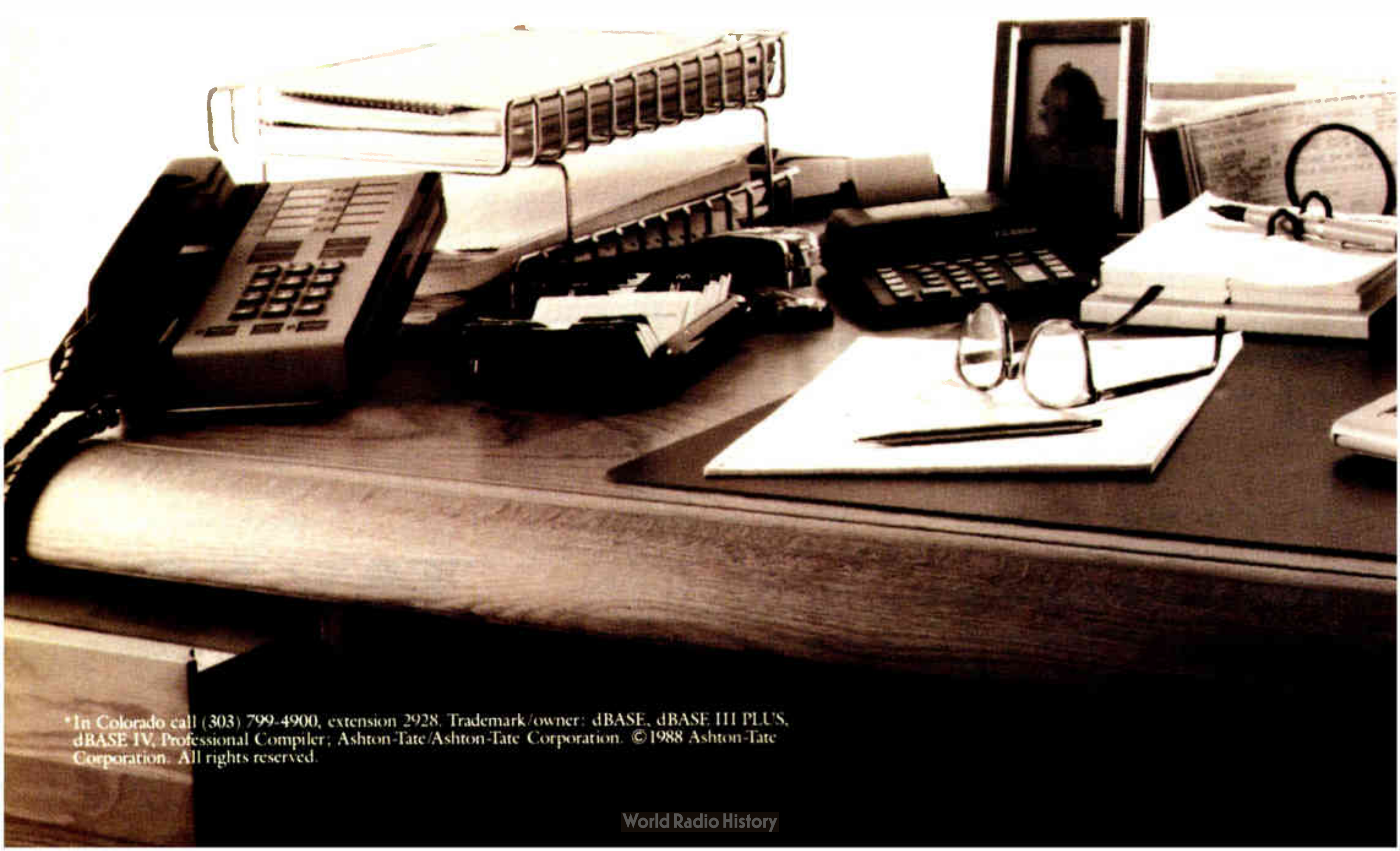

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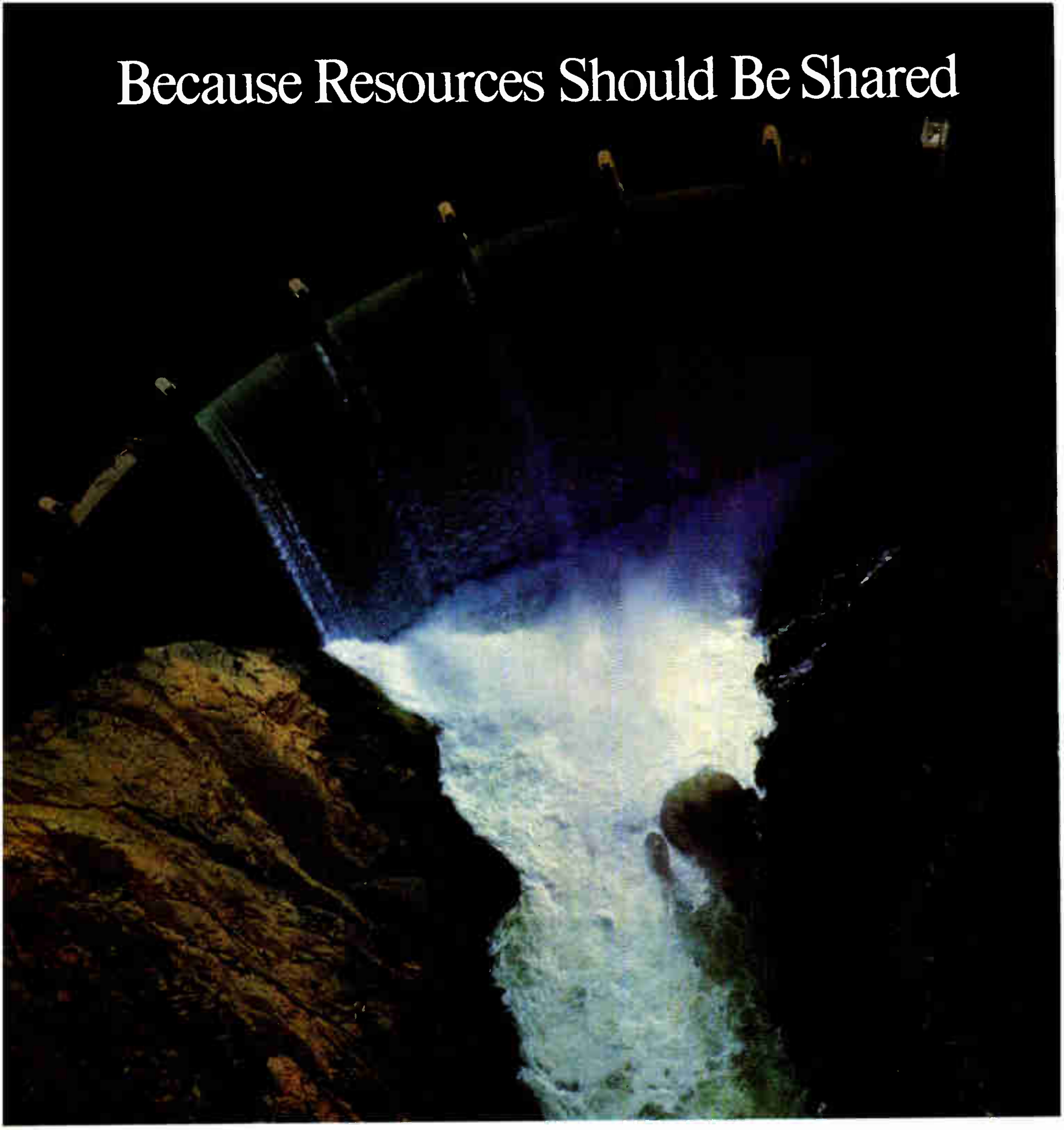

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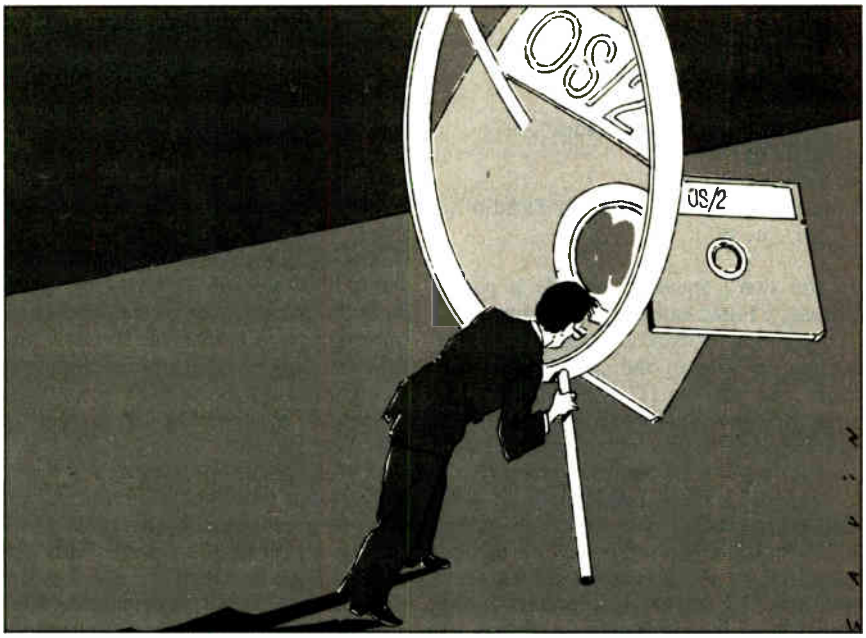
1988 IN REVIEW: OS/2'S FIRST YEAR

For an operating system less than a year old, OS/2 is doing well



It will be late December by the time you read this, so Merry Christmas to all. For IBM PC programmers, Christmas came early this year. OS/2 is chock full of nifty toys—things like dynlink libraries, threaded multitasking, virtual memory, and, yes, even the flawed first cut at the Presentation Manager. It all adds up to a much more ambitious operating system than we expected DOS 5.0 to be.

For PC users, though, OS/2's arrival sometimes seems more like Halloween: Version 1.0 is big, scary, and crawling with bugs. But rest assured that programmers are busily unpacking their new toys and learning how to use them.

For an application platform in its first year, OS/2 is doing very well. Virtually all major PC software vendors have released (or, more likely, have pledged to release soon) OS/2 versions of their current DOS programs. Given the marketing power behind OS/2—IBM—it will almost certainly be *a* major operating system, and more likely *the* operating system of choice on PC compatibles of the mid to late 1990s.

However, OS/2 will also succeed on its technical merits. It does what an operating system must do: manage raw machine resources in a secure and fundamentally consistent manner. Application programmers who have until now struggled to overcome the limitations of DOS can get out of the operating-system business and concentrate on the business of writing applications.

Background Telecommunications

We don't have to wait for everything. An asynchronous communications program is one of the mainstays of every PC user's arsenal, and two Canadian programmers—T. Blahovici and E. Zuck—are first out of the gate with one that runs under OS/2. It's a shareware program called Logicomm, and it closely resembles the popular DOS shareware program Procomm. There's one crucial difference: Logicomm, being an OS/2 program, can run in the background.

I can start a BIX session, use Logicomm to initiate a lengthy download, then just flip it into the background and continue working on some other task in the foreground—like writing this column. Logicomm works well. It doesn't drop so much as a bit while in the background, even when set to regular priority. (There are regular and high priorities; when you turn high priority on, Logicomm gets more cycles when it runs as a background task.)

Its major downside is that there is, currently, no scripting feature. You can get Logicomm from Logistique LMM (1550 Barre St., Montreal, Quebec, Canada H4L 4M6, (514) 748-9192). The authors ask $30 for it.

Software Development, OS/2 Style

People often ask me what they'll need to start doing development in OS/2. I tell them to learn C, if they haven't already done so. Whether you love it or hate it, C is to OS/2 what it is to Unix—the language the system was written in, and therefore the one for which tools exist.

Microsoft's C Compiler is an industry standard: It's fast enough, it's comprehensive, and it generates excellent code. A companion debugger, CodeView, represents another industry standard. It supports source code-level debugging, interactive evaluation of C (or FORTRAN or BASIC) expressions, and watchpoints that let you view the contents of changing variables.

OK, so you've got the dynamic duo, Microsoft C and CodeView. How do you

continued

ILLUSTRATION: KERRY GAVIN © 1989

go about writing an OS/2 application? Applications use the services that OS/2 provides by calling points of entry called APIs: Application Program Interfaces. There are hundreds of APIs, organized into groups according to the kind of machine resource they control: processes, memory, disk files, the mouse, or the screen.

Using an API is just like calling a function; you write its name and follow that with a list of arguments. For instance, to find out what my program's process ID is, I would use the API called DosGetPid. The following fragment shows how:

```
ret_code = DosGetPid(&MyPID);
if ret_code
  printf("Process ID=%d\n",
   MyPID);
else
  printf("DosGetPid failed: %d\n",
   ret_code);
```

If you don't speak C, here's a paraphrase: "First, call the get-the-process-ID API. Check its return code. If the return code is zero, the call worked out fine. The process ID is in MyPID, so print it. If the return code is *not* zero, the call failed; print the return code so I can look it up and see what went wrong."

How did I know that there's an API called DosGetPid? I looked it up in the OS/2 *Programmer's Reference*. It names each API function, details the number and types of arguments required, and says something about when and how to deploy each function. You'd be completely lost without that kind of information. The only fly in the ointment is that you can't buy just the *Reference*. Until recently, it came only with the $3000 Software Development Kit (SDK). But the situtation is improving.

Microsoft now offers a Programmer's Toolkit that is available for about $350. For a while, the Toolkit even came with Norton Computing's *On-Line OS/2 API Guide*. Norton offers guides for a number of languages, and the *OS/2 API Guide* is priced at $150 separately. (Those of us who shelled out $3000 for the SDK don't get the Norton guides.) And several substitutes for the OS/2 *Programmer's Reference* are also available, notably Ed Iacobucci's *OS/2 Programmer's Guide*.

So to start out in OS/2 programming today, you'll need to spend the better part of a thousand bucks for OS/2 itself, the necessary tools, and the necessary documentation. Will it get cheaper? Certainly, in time. When an inexpensive language product such as Microsoft's QuickC or Borland's Turbo C becomes available for OS/2, protected-mode programs will litter the landscape.

While You Wait

Until OS/2 applications do start to litter the landscape, we've got lots of things that run best under DOS. Unfortunately, DOS is a single-user, single-tasking system. The 80386 chip can do better than that with its built-in virtual 8086 (V86) capability, which permits multiple DOS programs to run concurrently on an 80386 machine.

There are several V86 manipulators, and I'll discuss them in a future column. But I find myself using IGC's VM/386 more than the others (believe me, I've got them all) for several reasons: It's bulletproof, it's flexible, and the technical support is top-notch.

VM/386 actually *boots* separate sessions. It creates separate virtual machines, each with its own CONFIG.SYS and AUTOEXEC.BAT. As the burden of the multitasking rests on the V86 hardware support, VM/386 can be fairly bulletproof. One (unfair) test of multitaskers is a game from Electronic Arts called Skyfox II, a game like the circa-1978 Atari Star Raiders.

Skyfox II is unfair because it's one of those games that bypasses DOS and the BIOS for *everything*. It kills most multitaskers, makes OS/2's compatibility box die, and gives DESQview fits. But VM/386 just takes it in stride. Just don't forget to leave the game in pause mode while it's in the background, or the Xenos will merrily destroy all your starbases while you Excel in the foreground. And when you are completely stuck (with VM/386, not Skyfox II), IGC employs friendly, helpful support people.

No, it's not OS/2, but it will do, at least until *OS/2* is OS/2.

OS/2 Tip of the Month: Neat Features and Subtle Changes

It's nice that OS/2 does have commands like the familiar DOS commands COPY, DIR, and DISKCOPY—the vast majority of OS/2 commands act just like their DOS counterparts. Thus, I tend to avoid the manual and use them just as I did under DOS.

Big mistake, for some commands. For example, if you're using MODE to control your screen, MODE BW80, MODE MONO, and MODE CO80 behave as before, but they also can optionally be invoked with a second parameter, the number of lines on the screen. You can tell your EGA monitor to show 43 lines with MODE CO80,43 or tell your VGA monitor to show 50 lines (in glorious Squint-O-Vision, as my father—who is a recent convert to PCs—would say) with MODE CO80,50.

MODE also now enables an option to verify any writes to a floppy disk. The command is MODE DSKT VER=ON, and it's more powerful than the VERIFY ON command. It actually reads back data written to a floppy disk and compares it to what it is supposed to be. Very thorough, but obviously slower: A series of floppy disk writes that normally took 24 seconds went to 37 seconds when MODE DSKT VER=ON was invoked.

You may be accustomed to using the DOS 3.3 APPEND command. More likely, you're not—it's an obscure way to create a search path for data files. And that's just as well, because it's available under OS/2 only in the compatibility box, and—as of version 1.0 of OS/2—it doesn't even work there.

Happily, OS/2 provides a superior alternative, a near-identical command for use in protected mode called DPATH. Put simply, DPATH tells D system where to find D data. If an application can't find a requested file in the current subdirectory, it looks in other subdirectories named in the DPATH command. Why the new name? DPATH is a different approach. It is, for one thing, an internal command, unlike APPEND, which is external. And unlike APPEND, DPATH records the data path in an environment string. You can see environment strings under DOS or OS/2 by typing the command SET. You'll see a result like

```
COMSPEC=C:\COMMAND.COM
PATH=D:\DOS;D:\XDOS;D:\WP
DPATH=D:\WP\MEMOS
```

In this example, the environment string COMSPEC contains the value C:\COMMAND.COM. As you would imagine, COMSPEC tells the system where to find COMMAND.COM. The PATH string is connected to the PATH command, and likewise for the DPATH command. Environment strings are a sane way to simplify the task of modifying system parameters on the fly. ■

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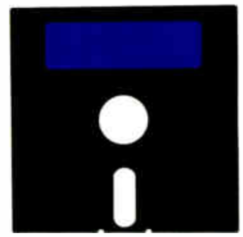

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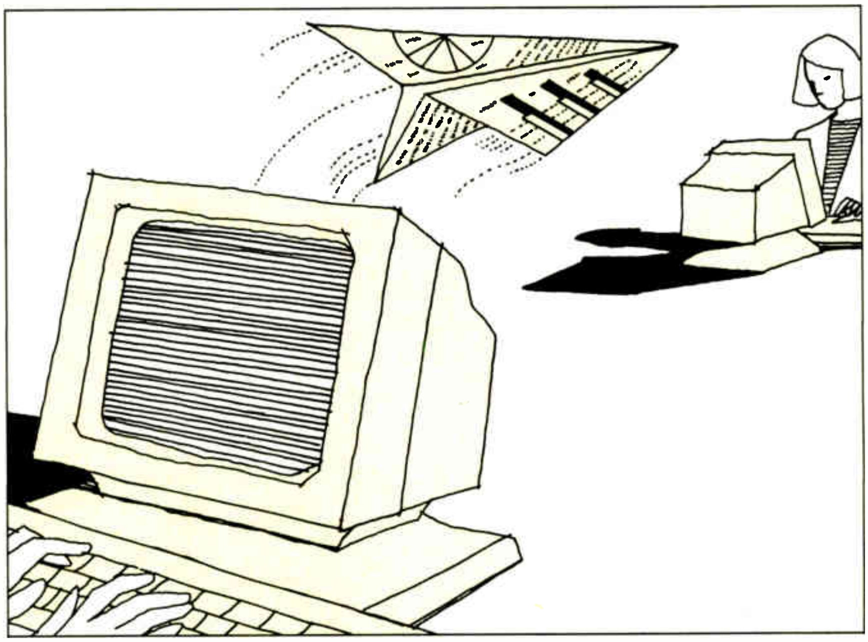
MAKING APPLICATIONS TALK



With a few enhancements, the Communicating Applications Specification could take the pain out of file transfers

If you've ever exchanged computer files by modem with a friend or coworker, you know firsthand what a trying and time-consuming process it can be. In most cases, you both stop what you're doing at the moment, run modem programs, configure your systems, make a connection, and manually start a file transfer between the two machines. Alternatively, you can use a bulletin board or electronic-mail service as an intermediary, incurring both costs and delays.

Last September, Intel and Digital Communications Associates, Inc. (DCA), jointly announced a potential solution to this problem: the Communicating Applications Specification (CAS). The goal of CAS, according to the specification, is to "allow software developers to easily integrate communications into their applications."

In theory, CAS will let you send or receive information from *within* an application just as if you were accessing, say, a printer—and it can deliver the data either in ASCII form or as a facsimile that any CCITT Group III fax machine can receive.

Intel and DCA are promoting CAS as a universal standard, although it is currently implemented only for Intel's Connection CoProcessor board (an intelligent fax modem card). Let's take a look at CAS version 1.00A, both as an interface to this specific board and as a standard for microcomputer communications in general.

What Is CAS?

CAS is an application program interface (API) that lets a program send and receive files without "knowing" the characteristics of the underlying hardware. Using CAS function calls, a program can start a file transfer (or schedule it to occur later) by issuing a single command. The transfer takes place in the background while other work continues.

Using CAS, an application could let you send documents as ASCII text files (using a special transfer protocol designed by Intel for fax modems) or as faxes with 80 by 66 or 132 by 88 characters per page. You could also send and receive files in the PCX or DCX graphics format (generated by programs such as Z-Soft's PC Paintbrush) or exchange those files with fax machines.

It's important to understand at the outset that CAS is not designed to handle every computer communications need. It's not suitable, for instance, for use as part of a "live" terminal emulation program, so it does not address the longstanding problem of having to access the hardware directly to do interactive serial communications on IBM PC-compatible computers. Instead, it focuses on doing one thing well: providing hassle-free background file and image transfers.

Inside CAS

The basic architecture of CAS is shown in figure 1. One or more applications make requests of a terminate-and-stay-resident (TSR) program called the Resident Manager, which in turn uses a Transfer Agent to send or receive the file. Each type of communication hardware (e.g., fax and mainframe link) has its own hardware-dependent Transfer Agent to deal with transmission of data over the associated medium.

For example, the Intel board comes

continued

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with a Connection CoProcessor Application Manager (CCAM) that contains both the Resident Manager and the Transfer Agent. Processing is distributed between the host CPU and a dedicated 80186 CPU on the board. In theory, you don't *have* to have an intelligent peripheral board to run CAS. The coprocessor on the Intel board helps with high-speed fax operations, but other kinds of transfers (e.g., exchanging files via conventional modems) might be handled entirely as "background" tasks on the host CPU.

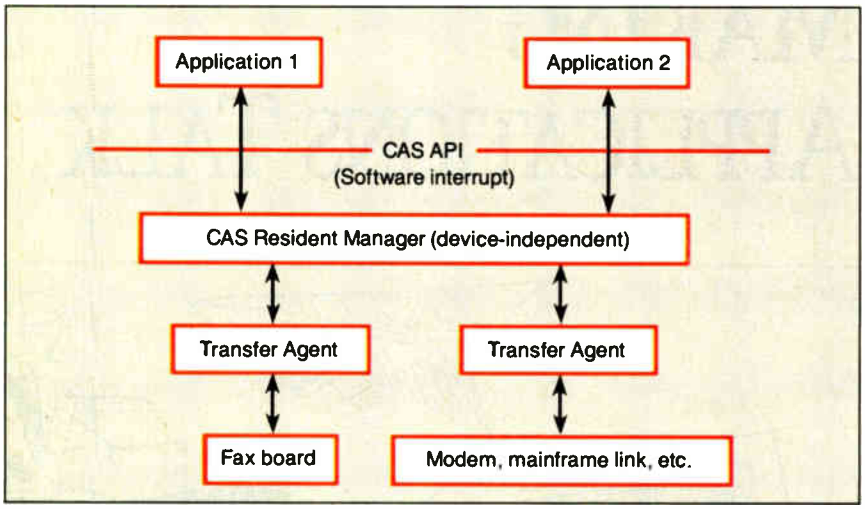

Figure 1: *One or more applications make requests of the Resident Manager, which in turn uses a Transfer Agent to send or receive the file. Each type of communication hardware (e.g., fax board or mainframe link) has its own hardware-dependent Transfer Agent to deal with transmission of data over the associated medium.*

The Resident Manager handles five categories of CAS *events*:

- *Send*: The local computer sends data to a remote machine (e.g., a computer or fax machine).
- *Receive:* The local computer receives data from a remote machine (transfer initiated by the remote agent).
- *Polled send:* The local computer prepares for a remote machine to call and sends data when the call comes in.
- *Polled receive:* The local computer calls a remote machine and retrieves data from it.
- *Log:* The local computer makes a record of a communication attempt.

An application program can initiate three of these events: a polled send, a polled receive, or a send. These events are called *tasks*, and you can schedule them to happen at a future date or time (so that, for example, file transfers can occur in the middle of the night, when rates are low). The other kinds of events happen as a result of the activities of the Resident Manager and/or remote machines calling in.

The Resident Manager keeps information about events in *queues*, which consist of groups of DOS files on the local disk.

Using CAS from Within an Application

An application interacts with CAS in the same way that it interacts with MS-DOS: through a software interrupt called the ***multiplex interrupt***. The application invokes CAS functions by placing values in specific CPU registers and invoking interrupt 2F hexadecimal; the results are returned either in registers or through memory. A complete description of each function is beyond the scope of this article, but table 1 gives you a general idea of the facilities available to an application in the initial version (1.00A) of CAS.

Because all CAS functions are available through the set of function calls listed in table 1, any application can provide a "front end" for CAS. Presumably, an application will let you earmark data for transmission, pull up a phone book, select a person or persons to receive the data, and start the transfer process. This same "front end" should also be able to let you examine information that has come in from other machines and bring it into the application.

Limitations of CAS 1.00A

The current implementation of CAS appears to work well for its original application: sending and receiving faxes and files using Intel's Connection CoProcessor software and other applications designed to work with that specific board. However, the initial version of CAS has limitations of which users (and software developers) should be aware.

First, CAS offers few provisions for security. If your CAS board is configured to answer the phone, there's no way to prevent fax "junk mail" from quickly filling up your hard disk. By the same token, if your system is waiting for another system to call for a file, there's no way to make sure that only the intended recipient (rather than some other caller)

continued

Table 1: *Functions available to applications in the initial version (1.00A) of the Communicating Applications Specification.*

- Abort the Current Event
- Delete a File
- Delete All (Queue) Files
- Find First Entry in Queue
- Find Next Entry in Queue
- Get Event Data
- Get Event Status
- Get Event Time
- Get External Data Block
- Get Hardware Status
- Get Queue Status
- Get/Set Autoreceive State
- Move Received File
- Open a File
- Run Diagnostics
- Set Task Date
- Set Task Time
- Submit a Single File to Send
- Submit a Task

gets the file. Furthermore, if you want two different callers to call in for files, there's no way to earmark files for the correct caller.

Second, CAS does not let you call an unattended system and request an arbitrary file. You can only retrieve a file that has been "sent" to you.

Finally, the CAS specification does not provide for expansion in a few key areas. There is no way, for instance, for an application to ask CAS, "What kinds of communications hardware are available on this machine, and in what formats can they exchange data?" There is also no documented way to attach additional Transfer Agents to the Resident Manager software provided with the original Intel board. This means that—at least for the moment—only the Intel Communications CoProcessor can be used with Intel's software. If a vendor other than Intel wants to produce a CAS-compatible board, it must write its own implementation of CAS from the ground up—and it's not clear that CAS software from different vendors will be able to coexist peacably on the same machine.

A Few Suggestions

Intel and DCA can address the problems and limitations of CAS in several ways. First, it should be possible to require callers to identify themselves before a transfer begins—and to make sure that only the right caller gets the chance to receive or transmit a particular piece of data. This solves the problems of junk mail and unauthorized access.

Second, the Resident Manager should be expanded to provide transfers of arbitrary files to authorized callers. A good model of this sort of facility is UUCP, the Unix-to-Unix Copy Program found on virtually any Unix machine.

Finally, the Resident Manager should be made separate from the Transfer Agents, and a well-documented interface between the two should be created. Facilities should be provided for Transfer Agents (implemented as TSR programs) to "register" with the Resident Manager, providing the names of the hardware devices they control and the file formats they accept. To avoid potential incompatibilities due to multiple implementations of the resident manager, Intel should license its resident manager at a nominal cost to vendors who provide their own Transfer Agents.

A Good Start

Should you invest in hardware that uses CAS? The answer depends on your needs and the future direction of the CAS specification. Until a large number of vendors adopt CAS, there may no great advantage to buying a CAS-compatible product rather than a dedicated fax board. However, Intel has indicated a willingness to share its file transfer protocols and other aspects of its CAS implementation—and to evolve the specification to accommodate future needs. If this happens, CAS may turn out to be a boon to those of us who want to get information from one place to another without worrying about data-transfer rates, parity, modem speeds, or the other arcane mysteries of computer communications. ■

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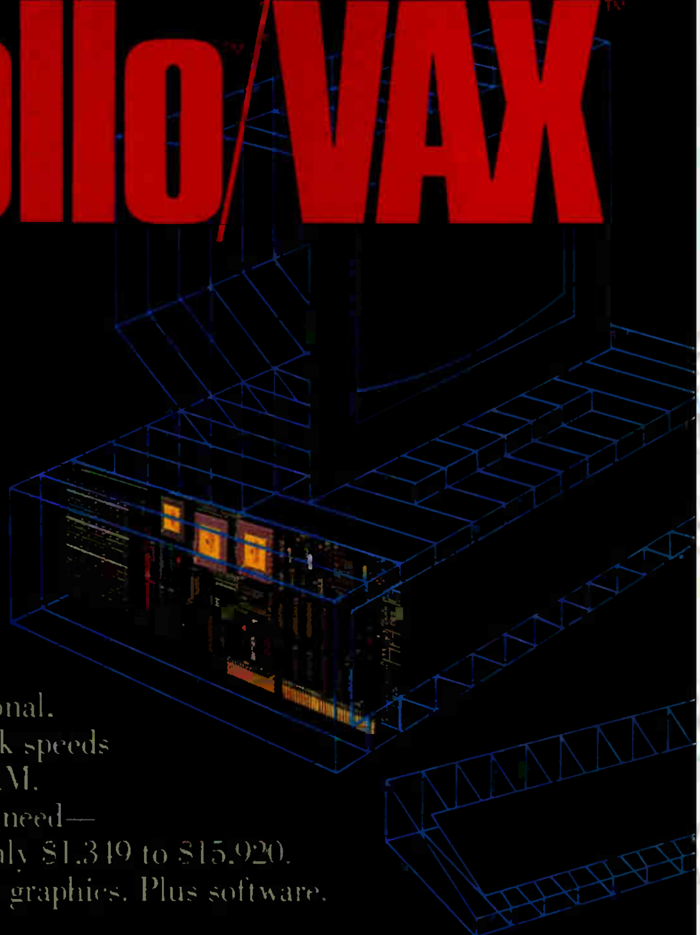

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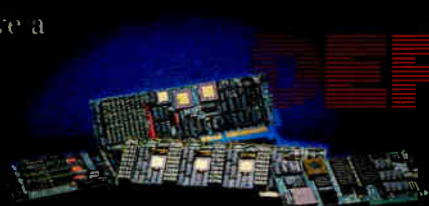

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Graphic Details

BYTE's testing editors compare 21 high-end, IBM PC–compatible digitizing tablets

Stanford Diehl
and Steve Apiki

For obtaining accurate graphics input, the digitizing tablet is more powerful than the mouse. Digitizing tablets are more precise and sample faster. Also, the stylus and fixed surface provide for a more natural drawing motion.

You pay a price for increased performance: The average cost of a digitizing tablet is about $800, versus only $150 for a mouse. But with system performance spiraling upward—and CAD, desktop publishing, and graphic design now everyday applications in the DOS world—more users are finding these devices a worthwhile investment.

Digitizing tablets provide a range of features that make them attractive to artists and designers. Most tablets offer a choice of pointing devices. These include a pen or stylus, which are both easy to handle, and a cursor (also called a puck), which provides pinpoint accuracy. The tablet's fixed drawing reference makes it possible to digitize older, paper-based designs and bring them up to date. Many manufacturers have added versatility with multibutton cursors and menu templates that offer realistic alternatives to keyboard command entry.

Making a Point

Like a mouse, a digitizing tablet acts as an input device for your microcomputer. It usually includes a tablet and some type of pointing device, called a transducer. The tablet has a flat surface with a defined space, or active drawing area, where you can place a map, a drawing, or a menu overlay. You then point to areas within the work space, and the tablet sends coordinate data to the application you're running (like AutoCAD) that corresponds to the location of the transducer. While a mouse reports a relative position based on the last known position of the mouse, a digitizer returns an absolute location regardless of the last known position of the transducer.

The cursor is a flat rectangular device with a cross-hair sight for pinpointing a location. Most cursors have four buttons. Though the cursor is a more accurate pointing device, the pen or stylus lets you input data more naturally. The only difference between the pen and stylus is that the former contains an ink cartridge, while the latter does not.

To activate the pen or stylus, you press down on the tip. The tip button on the stylus and the puck's pick button act much like the left button on a mouse. For instance, in AutoCAD's sketch mode, you press the stylus's tip button to begin drawing. The AutoCAD screen then displays a line as you trace it across the pad. Pressing the tip button again deactivates the transducer. For additional functionality, some styli and pens include a button on top of the barrel.

Many applications, especially CAD and drawing software, include driver software for a variety of digitizing tablets. Vendors provide additional compatibility by emulating other popular tablets, like the Summagraphics Bit Pad and MM Digitizer Series, which has become the industry standard.

Tablet Technologies

Digitizers employ a variety of technologies. Most common is the antenna-transmitter technique, in which evenly spaced horizontal and vertical wires within the tablet represent an *x,y* coordinate grid. The internal wires sense the magnetic (or electric) field emitted by the transducer. The horizontal wire closest to the transducer coil, registering the strongest signal, reports the *x*-axis data, while the closest vertical wire returns the *y*-axis data. Together, they represent the coordinate location of the cursor or stylus coil. The more closely spaced the wires, the higher the resolution.

Some systems energize the grid instead of the cursor or the stylus. Each internal wire holds a known signal. The pointing device picks up the signal of the closest horizontal and vertical wire, returning the resultant coordinate pair.

All the digitizers we tested used one of these techniques. However, some nonstandard technologies also digitize and input information (see the text box "Digitizers with a Twist" on page 169).

Performing Arts

The specifications commonly used to define a digitizing tablet's precision are found in table 1. Resolution tells you how many distinct points a digitizer can distinguish within the drawing area. If the vendor claims resolution of 200 lines per inch (lpi), a tablet with a 12-inch by 12-inch work space will recognize ordinate points from 0 to 2400 along both axes. The cursor must then move at least 1/200 inch before it can report a new position.

Accuracy measurements tell you how closely the digitizing tablet can approximate a known standard. Theoretically, a digitized line will deviate from its actual length by only as much as the accuracy figure. Accuracy measurements provided by the vendors range from 0.001 to 0.035 inch, with 0.01 being the norm.

Stylus proximity defines how far the transducer can move from the tablet before it stops transferring coordinate data. Some tablets require the cursor to contact the pad, while others continue to report cursor position even with the transducer an inch or more away from the drawing surface. The larger the distance between cursor and pad, however, the more accuracy suffers.

Accuracy figures usually refer to operation with a cursor. A stylus can't maintain the same level of precision because the cursor provides a more stable pointer at a uniform height above the pad. Furthermore, the stylus coil, housed in the body of the device, may not report the true position of the tip. This is because orienting the pen at a comfortable angle for drawing introduces a tilt error. We tested for both stylus proximity and stylus error as part of our benchmark tests (see the text box "Digitizing by Numbers" on page 170).

The 21 digitizing tablets selected for this Product Focus represent a variety of devices available for the IBM PC and compatibles. All tablets have either a 12-inch by 12-inch or a 12-inch by 18-inch active drawing area, and they use standard antenna-transmitter or energized-grid technology. Individual descriptions

continued

Table 1: *Features and testing information for the 21 digitizing tablets reviewed.*

Digitizing tablet	Price[1]	Active area (inches)	Resolution (lpi)	Accuracy (inches)	Max. output rate (points/second)	Emulations	Pointing devices available
CalComp 23120 (Drawing Board)	$625[2]	12 x 12	1016	0.025	144	CalComp 2000, HI[3], Hitachi[3], GTCO[3], Summagraphics, Mouse Systems Mouse	Stylus, 4-button and 16-button cursors
CalComp 23180 (Drawing Board)	$1125[2]	12 x 18	1016	0.025	144	Same as 23120	Same as 23120
CalComp 25120	$915[4]	12 x 12	1280	0.025	125	CalComp 2000, 2200[3], 3000[3], and 9100; GTCO[3], Hitachi[3], HI[3], Kurta[3], Numonics[3], Summagraphics[3]	Stylus, pen, 4-button cursor
GTCO Digi-Pad PC 1111A	$599	11 x 11	1000	0.010	100	None	3-key stylus; pressure-sensitive stylus; 1,4,5 and 16-button cursors
GTCO Digi-Pad PC 1117	$839	11 x 17	1000	0.010	100	None	Same as 1111A
GTCO Micro Digi-Pad 1212	$540	12 x 12	200	0.025	61	Summagraphics	Stylus, 4-button cursor
Hitachi HDG-1111C (Tiger Tablet II)	$998	11 x 11	1000	0.02	150	Summagraphics, mouse	1- or 3-key stylus, 4- and 12-button cursor
Hitachi HDG-1212D (Puma Pro)	$599	11.7 x 11.7	1000	0.02	150	Summagraphics, mouse	1- or 2-key stylus; 1,3,4, and 12-button cursors
Houston Instrument HiPad Plus 9012	$495	12 x 12	2000	0.01	200	CalComp 2000, Summagraphics, GTCO[3], Kurta, Hitachi[3], CalComp Drawing Board	Stylus, 4-button cursor
Houston Instrument HiPad Plus 9018	$795[5]	12 x 18	2000	0.01	200	Same as 9012	Same as 9012
Kurta IS/One	$645[6]	12 x 12	1016	0.035	100	Kurta Series One, Series Two; Microsoft Mouse, Summagraphics, GTCO	1- or 2-switch stylus, 4- or 12-button cursor, cordless stylus and cursor
Kurta IS/One	$995[6]	12 x 17	1016	0.035	100	Same as 12 x 12 model	Same as 12 x 12 model
Numonics 2200-1212	$964	11.8 x 11.8	1000	0.01	200	Summagraphics[8]	Pen; stylus; 1-, 4-, or 16-button cursor; lighted cursor; cursor with LCD
Numonics 2200-1217	$1155	11.8 x 17.7	1000	0.01	200	Same as -1212	Same as -1212
Numonics 2207	$595[5]	12 x 12	1000	0.02	160	Summagraphics, Microsoft Mouse	Stylus, 4-button cursor
Penpad 300	$695	11 x 11	1000	0.001	150	Summagraphics[3], Hitachi[3], GTCO[3], CalComp 2000[3], Numonics, Microsoft Mouse, Mouse Systems Mouse	Stylus, 4- or 16-button cursor
Penpad 320	$1095	11 x 11	1000	0.001	150	Same as 300	Same as 300
Seiko Screenplay DT-3503	$599[5]	11 x 11	1016	0.01	200	Summagraphics, Microsoft Mouse	Stylus, 3- or 4-button cursor
Seiko Screenplay DT-4513	$999[5]	11 x 17	1016	0.01	200	Same as DT-3503	Same as DT-3503
Summagraphics SummaSketch Plus	$599[5]	12 x 12	1016	0.025	121	Microsoft Mouse	Stylus, 4-button cursor
Summagraphics SummaSketch Pro	$999[5]	12 x 18	1016	0.025	121	Same as Plus	Same as Plus

[1] Except where noted, price includes tablet, power supply, interface, and 4-button cursor.
[2] Choice of 16-button cursor or stylus and 4-button cursor.
[3] Output format only; input commands not supported.
[4] Cursor and stylus are optional.
[5] Also includes stylus.
[6] Includes corded 4-button cursor.
[7] Tests run with corded stylus.
[8] Optional emulation; requires firmware replacement.

of the tablets follow. Because of similarities between products distributed by each company, we grouped the tablets by company name.

CalComp

The CalComp 23000 Series combines ease of use with diverse emulations and an ergonomic design. Most applications support the CalComp format. But for those that don't, Summagraphics emulation ensures a wide range of software compatibility. The 23120 ($625) provides a 12-inch by 12-inch drawing surface, while the 23180, at $1125, has a 12-inch by 18-inch work area. Both models offer 1016-lpi selectable resolution and a mediocre accuracy of 0.025 inch.

A proximity light reports when the cursor is within the active area. Our tests revealed an impressive proximity range of 0.875 inch for all the CalComp models (see the BYTE test results in table

Interface	Software	Documentation (pages)	Dimensions (inches)	BYTE tests (all values in inches) Horizontal error	Vertical error	Stylus proximity	Stylus error at 45 degrees
RS-232C	None	41	2.5 x 15.9 x 14.9	0.0208	0.0062	0.875	0.0207
RS-232C	None	41	2.5 x 16.4 x 20.5	0.0124	0.0034	0.875	0.0205
RS-232C	None	106	2.5 x 16 x 21	0.0179	0.0237	0.875	0.0116
PC card	Windows, ADI driver	56	2.1 x 15.6 x 15.6	0.0037	0.0064	0.75	0.0033
PC card	Windows, ADI driver	56	2.1 x 15.6 x 21.6	0.0059	0.0088	0.75	0.0079
RS-232C	Windows, ADI driver	44	0.8 x 17.9 x 15.6	0.0278	0.0005	0.692	0.2631
RS-232C	Hitachi mouse driver	10	2 x 16 x 17	0.0030	0.0040	0.192	0.0512
RS-232C	Hitachi mouse driver	14	1.1 x 15.7 x 16	0.0153	0.0050	0.25	0.0457
RS-232C	None	49	1.2 x 16.9 x 15.2	0.0185	0.0082	0.5	0.0041
RS-232C	None	42	1.3 x 16.8 x 21.3	0.0039	0.0011	0.5	0.0028
RS-232C	ADI, mouse drivers, setup utilities	118	2.8 x 16 x 15	0.0265	0.0478	0.25	0.0797[7]
RS-232C	Same as 12 x 12 model	118	2.8 x 16 x 20	0.0530	0.0274	0.375	0.0716[7]
RS-232C or IEEE-488	None	35	0.8 x 16.1 x 16.1	0.0080	0.0090	0.875	0.1320
RS-232C or IEEE-488	None	35	0.8 x 16.1 x 20.8	0.0052	0.0022	0.875	0.1019
RS-232C	Mouse drivers; setup and diagnostics	12	0.5 x 15.8 x 16.8	0.0098	0.0044	1	0.0858
RS-232C	Mouse driver, setup utilities	34	0.5 x 16 x 17	0.0018	0.0016	1	0.0025
PC card	Driver, test, and setup utilities	176	0.5 x 16 x 17	0.0076	0.0024	1	0.0065
RS-232C	Mouse, ADI driver; setup and diagnostics	37	0.9 x 16 x 16	0.0043	0.0012	0.5	0.0348
RS-232C	Same as DT-3503	37	0.9 x 23 x 19.1	0.0094	0.0027	0.5	0.0144
RS-232C	Mouse, Windows, ADI driver; self-test and reset program	45		0.0166	0.0035	0.5	0.0292
RS-232C	Mouse, Windows, ADI driver; self-test and reset program	50	1.3 x 17 x 22.5	0.0086	0.0074	0.5	0.0102

1). Horizontal and vertical error were better than expected, given average resolution specifications.

The tablets smoothly stepped through our compatibility tests. PC Paintbrush defaulted to a Summagraphics driver even when we chose the CalComp configuration option, but the program booted without a hitch. The tablets displayed reliable, efficient operation.

The CalComp cursor slides cleanly across the pad, and the fine cross hairs allow pinpoint cursor positioning. Unlike most stylus models, the CalComp offering does not include a push button on its barrel. If you need a button on the barrel, CalComp sells a 2-button stylus alternative for $115. The company also offers a 16-button cursor. You can substitute the 16-button model for the standard stylus and 4-button cursor.

The CalComp 25120 ($915) uses the same cursor and stylus on a molded

continued

frame and a darkened 12-inch by 12-inch work space. The design results in a small footprint and a clearly defined drawing area. You configure the 25120 by setting a series of software switches for each emulation and application. A row of LEDs above the active boundary tracks the status of your parameter selections. The menu strip replaces cumbersome DIP switches, letting you step through the configuration by touching selected blocks with the stylus. You can also select eight modes of operation, data output rates, and bit rates via menu soft keys.

The 25120 offers better resolution (1280 lpi) than the 23000 series, while posting identical 0.025-inch accuracy. The $915 price is steep, though, especially since it doesn't include a cursor or stylus.

GTCO

GTCO's digitizers fall into two product groups: the Digi-Pad PC, which features excellent accuracy at a good price, and the less expensive and less powerful Micro Digi-Pad 1212. The 11-inch by 11-inch Digi-Pad PC (the 1111A) is priced at $599, and the 11-inch by 17-inch version (the 1117) is $839.

The Digi-Pad PC's most unusual feature is its reliance on a dedicated PC bus controller card rather than the RS-232C interface favored by most other models. The unit draws power from the bus, eliminating the need for an external power supply.

You can set communications parameters, output mode, and format via three banks of DIP switches at the top of the controller. It's also possible to set the port address with a few jumper selections. Output format is limited to GTCO; no emulations are supported. In addition to the switch settings, you can set options by remote commands sent to the card's port address.

GTCO drivers come with almost every major application package, so the lack of emulations isn't a serious concern. The Digi-Pad PC comes bundled with Windows and an ADI driver. While AutoCAD includes a GTCO driver, GTCO's ADI driver supports a four-button cursor and in general seems to perform better and with fewer hitches than the AutoCAD 2.52 driver.

While both versions of the Digi-Pad PC were able to run through our compatibility tests, we did have some trouble coming up with the correct parameter settings; the documentation includes switch settings for AutoCAD only.

The tablet's average resolution and good accuracy specifications were borne out in our horizontal and vertical error tests. Our only serious problem in using the Digi-Pad PCs was with the rough cloth bottom on the cursor. While the cursor was fine on the hard, smooth surface of the tablet, it tended to grab paper we taped to the pad, resulting in a jerky, inaccurate movement. Nevertheless, the errors were small (less than 0.01 inch), putting the device in a league with digitizers costing far more. Perhaps most impressive, the stylus angle error approached zero.

The HiPad Plus tablets set the standard for resolution at 2000 lpi.

GTCO's low-end model, the 12-inch by 12-inch Micro Digi-Pad 1212 ($540) was far less powerful than the Digi-Pad PC, but it offers simplicity and good performance for its price range.

The unit has no switches; to get up and running, you simply hook up the external power supply and plug the interface cable into a serial port. The power and cursor sockets are even interchangeable, making the configuration completely idiotproof. If you need to change parameters, you can set jumpers located inside the tablet.

The tablet worked flawlessly with all the applications we used for compatibility tests. ADI and Windows drivers are provided with the hardware.

Though the Micro Digi-Pad's simplicity is appealing, it lacks some basic features. The tablet has no markings to indicate where on the 17.9-inch by 15.6-inch surface the 12-inch by 12-inch active area lies. There's also no provision for raising one side of the tablet for a better working angle, a feature found on most other tablets.

Not surprisingly, this low-cost product also has the worst resolution specification at 200 lpi, and its 0.025-inch accuracy is average. Our digitizing accuracy tests showed mixed results, with the horizontal error near what the vendor's accuracy specifications would indicate (0.0278 inch), but the vertical error was virtually zero (0.0005 inch). The vertical error was less than the resolution of the tablet, and we attributed this to a small calibration error and round-off error in the software distance calculation.

These results point out that it's possible to get excellent results even with poor specifications. However, even if we hadn't been lucky enough to align the paper on a sensing point and hit the same point twice, the 0.005-inch minimum resolvable distance is close to the limits of the human ability to resolve lines, so the tablet is suited for most applications.

Hitachi

The Hitachi Tiger Tablet series has enjoyed a good reputation for nearly 5 years, an eternity in the fast-moving peripherals industry. Hitachi's newest Tiger Tablet, the HDG-1111C, adds capability to this venerable line by maintaining compatibility with older models and adding emulations.

The $998 11-inch by 11-inch tablet has a built-in power supply and three banks of DIP switches. Although the system is versatile, you may have a tough time setting it up, because the documentation for the switch settings is very poor. Luckily, Hitachi's technical support is good.

Hitachi provides full firmware emulation for the Summagraphics MM and Bit Pad Series, in addition to the native Tiger Tablet mode. The emulations broaden software support considerably, though the Hitachi output format is compatible with AutoCAD and other major packages. We were able to run AutoCAD using the Tiger Tablet driver and PC Paintbrush with the digitizer in Summagraphics MM mode. Windows applications were not supported, but Hitachi says it will be shipping a Windows driver with the tablets by the time you read this.

Small error values on our horizontal and vertical line tests indicate the system is well suited for precise digitizing. There was a noticeable error caused by holding the pen at an angle less than vertical, but this was small enough to be attributed to pen slippage. One disturbing problem was the tendency of the stylus to send wildly offset points to AutoCAD while tracing, resulting in circles with large "horns." Hitachi assured us that the problem was atypical, and it didn't occur when we used the cursor.

The second Hitachi tablet, the HDG-1212D, supports the same Summagraphics emulations as the HDG-1111C, but it has slightly fewer features and sells for less at $599. The HDG-1212D comes with an outstanding 10-year warranty

continued

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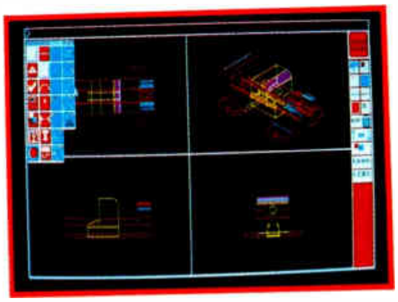

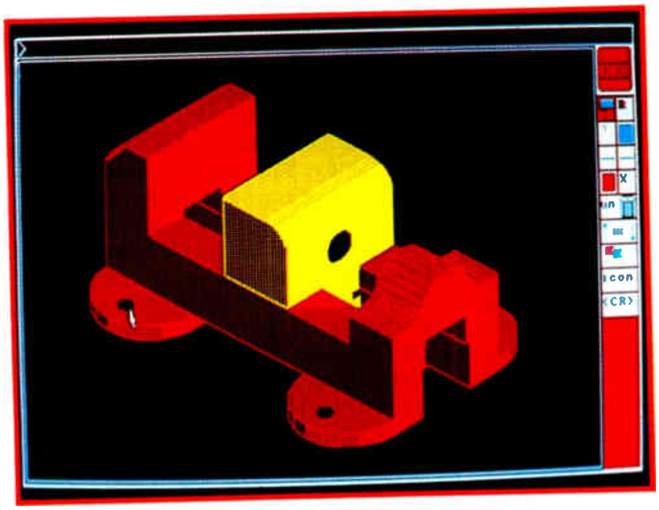

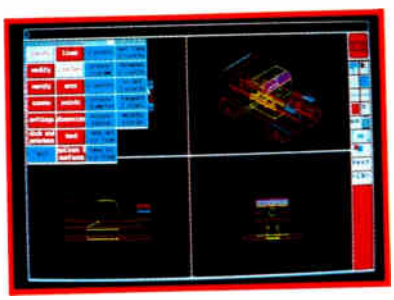

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Photo 1: *Having the lowest price didn't stop the Houston Instrument HiPad Plus 9012 (left) from turning in an excellent performance. The configuration menu on the tablet also makes the unit easy to use.*

Photo 2: *A cordless cursor option and programmable function switches distinguish the Kurta IS/One (below) from the rest of the pack.*

(the HDG-1111C carries a more typical 1-year warranty).

Summagraphics emulation is the default mode, and the HDG-1212D has only one switch bank for changing settings. It also has a native Hitachi mode, compatible with the HICOMSCAN digitizer series. Application support for the two tablets is similar.

PC Paintbrush ran in MM mode without difficulty. Software shipped with the tablet includes a generic mouse emulator that's compatible with most applications.

We ran the HDG-1212D with AutoCAD using AutoCAD's HICOMSCAN driver and had one problem when using the tablet for CAD. The 12-button cursor Hitachi provides has the pick button mapped to the zero key, laid out where it would be on a telephone keypad. The design means that most operations require pressing a button on the back of the cursor, away from the operator's eyes and index finger. Hitachi plans to provide an ADI driver that will correct the problem.

Error test results were only fair, and they were slightly poorer than those for the HDG-1111C. The results are relatively consistent with the two tablets' accuracy specifications.

Houston Instrument

Houston Instrument adds a new series to the field of digitizing tablets by introducing the HiPad Plus 9012 and the HiPad Plus 9018. The company, an established player in the digitizing industry, offers a pair of tablets that deliver impressive performance at a minimum price.

The HiPad Plus 9012 has a 12-inch by 12-inch drawing area, and the $495 price includes a stylus, power supply, and interface cable (see photo 1). The HiPad Plus 9018's $795 price tag includes a stylus and a cursor in addition to the power supply, cable, and pad, and its drawing area measures 12 inches by 18 inches.

Both tablets set the standard for resolution at 2000 lpi, and only the Pencept models surpass their 0.01-inch accuracy figure. These tablets pack tilt-correction firmware that supposedly rivals a cursor's accuracy. Our test results show excellent tilt correction, but a cursor is still the more accurate pointing device. We measured a proximity range of ½ inch for both tablets. The horizontal and vertical errors were low, but not as good as you might expect, given the resolution specification the company provides.

You can set configuration parameters by selecting items from a menu overlay. No software is required. You simply press a button at the rear of the pad before clicking the pointer over a desired item. For quick-and-dirty configuration, you can select from a list of popular emulations at the bottom of the menu. You can also set individual parameters such as binary or ASCII formats, data transfer rate, transfer modes, resolution, and calibration points.

The tablets default to Summagraphics mode, and our compatibility tests verified the emulation. However, only partial emulation is provided for the Hitachi HDG-1111C, the Kurta Series I and IS/One, and the GTCO Digi-Pad 5. Houston Instrument plans to ship a mouse driver with the HDG-1212D.

Digitizers with a Twist

Two new ideas are putting a spin on the traditional digitizer concept: The first involves taking the technology a step further, and the second is to find unusual applications for the current technology.

A series of sonic digitizers from Scientific Accessories is an example of the former. Because coordinate information is calculated using sound information, the stylus requires no special writing surface. The units consist of a cursor and a receiving box that you connect to your system. The cursor generates sound waves; two microphones in the receiver calculate the position of the cursor by triangulation based on the time it takes for the wave front to reach the unit. The GP-7, which has the smallest imageable area at 18 by 24 inches, sells for $1696.

Digitizing in three dimensions is the focus of the Polhemus 3space Digitizer. Using an electromagnetic source, this high-end, $13,900 system is able to accurately digitize solid models. Polhemus uses similar technology to create a tracker capable of analyzing motion in 6 degrees of freedom.

Other firms have opted to take current technology and widen its applications. The ScriptWriter from Data Entry Systems adds character-recognition capability to a portable digitizer tablet to create a clipboard-like data recorder. It's available directly from the company for $1595.

The portable, 4-pound ScriptWriter operates on a 10-hour rechargeable battery. The impedance-sensitive writing surface is configured according to a number of standard forms. You write characters onto the form with a pen, and the device reads the characters into its 96K-byte memory buffer. You can also set up sections of the surface to accept graphics input, like signatures, but the 96K bytes doesn't go far when recording graphics. The RS-232C interface lets you dump data to a microcomputer for further processing.

Jandel Scientific's Sigma Scan is a system for scientific data manipulation. The package includes a digitizing tablet and sophisticated software for calculating and interpolating values based on graphics input. Prices range from $1195 for a 12-inch by 12-inch tablet to $4595 for a 36-inch by 48-inch version. The software is available separately for $495.

Using a cursor, you are able to trace images from sources traditionally requiring graphical analysis, like strip-chart recordings, spectrographs, photos, or x-ray images. Once the data is recorded, it can be transformed mathematically with user-defined equations. Nonlinear interpolation allows the software to transform input points based on previously received data stored in look-up tables. The software automatically calculates statistical descriptions of the input.

Kurta

The Kurta IS/One stands out for ease of use and superior ergonomic features. Both the 12-inch by 12-inch ($645) and 12-inch by 17-inch ($995) versions offer full programmability, function pads, and well-designed cursors and styli (see photo 2).

The standard IS/One configuration includes the tablet, a four-button cursor, and IS/Pensmith driver software. A wealth of options is available, including a cordless cursor and stylus and template software for AutoCAD and Windows.

IS/Pensmith, the standard Kurta driver package, includes ADI and mouse drivers and several useful utilities. The ADI driver is programmable, so you can define tablet areas for menu templates and areas for input. Once you have these set up, you can switch from full tablet mode to menu and input area mode without leaving the application. Other utilities redefine the cursor buttons and link the tablet function keys to keyboard macros. In addition, a save utility stores macros and configuration information to disk, and a setup utility lets you modify driver settings on the fly.

The tablet has an imposing array of three DIP-switch banks, but the tablet is fully programmable, so you'll probably never need to change them. You can activate five soft switches at the top of the tablet with the stylus or the cursor. Each of these change the tablet parameters to activate emulations or other predefined settings. The documentation includes a full list of DIP-switch settings and soft-key settings for most of the applications that the IS/One supports.

Besides the soft keys for configuration changes, the tablet has several definable function switches that you can use to play back keyboard macros. The number of switches varies with the size of the tablet; the 12-inch by 12-inch version has 13 switches, and the 12-inch by 17-inch version has 23.

Optional cordless, battery-operated pointing devices function almost as well as their corded cousins, and they are far easier to manipulate. They cost about $80 more than the standard version. The cordless stylus allows more natural writing and drawing than any other input device. Stylus angle tests resulted in an average error when the stylus was held at a less than vertical position.

The Kurta's excellent features don't, however, guarantee smooth operation. One problem is the sheer volume of emulations: We were able to use the ADI driver with AutoCAD but could access only a 12-inch by 12-inch square on the 12-inch by 17-inch tablet; Kurta recommended using the AutoCAD Series One driver and Series One emulation. When we did so, the problem disappeared.

PC Paintbrush ran without a hitch using Series One emulation, but when we failed to reconfigure the tablet before using the optional Windows driver, our Windows pointer ran upside down. After a few tries, we were able to get all our compatibility test software up and running smoothly.

In the error tests, the Kurta tablets fared poorly. This points out the impor-

continued

tance of the accuracy specification: The IS/One had the worst rating at 0.035 inch. Though that didn't affect the benchmark results, the tablets seem to be unusually sensitive to electromagnetic interference; any metal object (including drafting equipment) near the pointers made them unreliable.

Numonics

We tested two 2200-series tablets from Numonics: the $964 11.8-inch by 11.8-inch version (the 2200-1212) and the $1155 11.8-inch by 17.7-inch version (the 2200-1217). Both tablets support the Summagraphics MM standard as their main mode of operation. We also tested the 2207, a low-end tablet that's in a class by itself.

Emulations are built into the firmware of the 2200-series tablets. Changing command sets or output formats (beyond switching between ASCII and binary) requires changing a PROM. The units that we tested were configured to operate in MM mode only, and they behaved to the applications software exactly like a SummaSketch tablet.

One DIP switch allows changes in communications parameters, mode, and ASCII and binary formats. Host commands for remote parameter setting are also supported. Both units provide two sockets for pointing devices, one each for the stylus and the cursor, so you can use both at the same time. Another interesting feature is that the tablets' surfaces are flat, rather than slightly inclined.

Both AutoCAD and PC Paintbrush ran using the Summagraphics MM driver provided with each application. There is no Windows support.

The 2200-series tablets' good accuracy rating contributed to a better-than-average performance on our horizontal and vertical error tests, putting the tablet on a par with other digitizers with the same performance specs. On the other hand, stylus angle performance was unusually poor, displacing the line by over 0.1 inch for tablets of both sizes.

Our third Numonics unit, the 2207, looked at first to be a stripped-down, low-cost alternative to the 2200-series line; but that's not the case. In addition to Summagraphics output format emulation, the tablet comes with a mouse driver, and Numonics plans to ship a Windows driver. Macintosh support software is also included as a part of the standard package.

An additional software utility lets you set communications parameters and output format. On the outside, the tablet is remarkably thin and easy to handle, with a height of only ½ inch.

As with the 2200-series tablets, we were able to run AutoCAD and PC Paintbrush using the MM output format. Windows applications aren't supported.

The 2207 turned in good numbers on both our horizontal and vertical error tests. Stylus angle error was slightly worse than average, but not as bad as that of the 2200 series.

Considering the power, versatility, and convenience of the 2207, it's hard to understand why it's priced so far below the 2200 series at $595. While the 2200 tablets boast better input speed and accuracy specifications and have more interface and pointing device options, the

Digitizing by Numbers

As testing editors, we're accustomed to generating benchmarks that yield hard numbers. We like to see a product's performance boiled down to a few critical values that let you make clear, across-the-board comparisons. Digitizing tablets, however, don't readily lend themselves to such tests. Furthermore, as a user interface, the wealth of features offered by most designs simply outstrips human capability, making the user the ultimate limitation in performance.

A good example is resolution. While specifications ranged from a low of 200 lines per inch to a high of 2000 lpi for the tablets we tested, we were unable to distinguish distances of less than about 0.005 inch. Your eyes may be more discerning, but our experience points up the difficulty in testing most of these devices at the limits of their capability.

In the digitizer industry itself, there are no standard tests. Short of test rigs using robotic arms to gauge precision, there's no clear-cut method for testing these devices. Our tests attempted to examine the interaction of the system as a whole: tablet, monitor, applications software, and user. As much as possible, we tried to keep the digitizer the only variable factor.

Line Error

We created four tests that measure horizontal error, vertical error, stylus error, and stylus proximity. Our test system consisted of a Compaq 386/20 with a high-resolution NEC MultiSync monitor and adapter card in a typical PC CAD configuration. Then, running AutoCAD 2.52, we digitized a standard test pattern and printed it on a 300-dot-per-inch laser printer, which gave us line resolutions of about 0.01 inch. The test pattern included two calibration points that ensured that tablet and software dimensions were equivalent.

Each pattern had two horizontal and two vertical lines. We digitized the endpoints of each line and used AutoCAD to tell us the distance between each point. Our horizontal error measurement is the average difference between the known lengths of the two horizontal lines and their digitized images. We recorded only the distance along the x axis. Similarly, our vertical error measurement characterizes the differences we found in digitizing vertical lines of known length. These accuracy tests include errors generated in every part of the digitizing subsystem; cursor cross-hair thickness and surface friction contributed inaccuracies not accounted for in rated resolution specifications.

Stylus Error

The stylus, though a natural interface, is often less accurate than the flat, steady cursor. We measured the offset caused by using a stylus at a 45 degree angle by tracing two lines on the test pattern, one with the stylus held vertical and one with the stylus at 45 degrees. We compared these images with lines digitized by the cursor, again using an AutoCAD function to compute the distances. Both stylus lines were slightly off the cursor lines; the difference between the vertical offset and 45 degree offset was reported as 45 degree error.

As an additional stylus test, we measured the maximum distance you could move the stylus away from the tablet and still have it function. Some vendors list this value as stylus proximity. Tablets with a high rating for stylus proximity are useful in digitizing patterns from thick media.

Our test pattern also included a circle that we traced with a template as a qualitative test for measuring overall distortion. Finally, we tested compatibility with five popular applications that rely heavily on graphics input: AutoCAD, PC Paintbrush, Microsoft Windows, PageMaker, and Microsoft Excel. Our tests confirmed the manufacturers' compatibility claims and gave us a feel for the tablets' performance outside the traditional CAD environment.

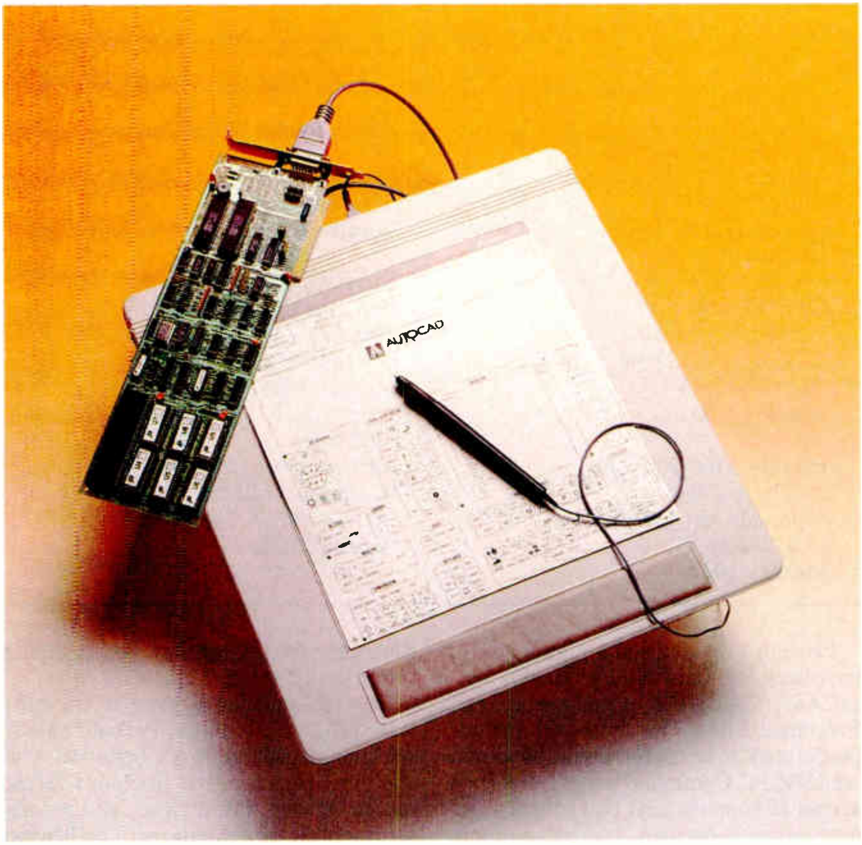

Photo 3: *The performance crown goes to Pencept's Penpad 320 (right), which also boasts character recognition and a sophisticated macro capability.*

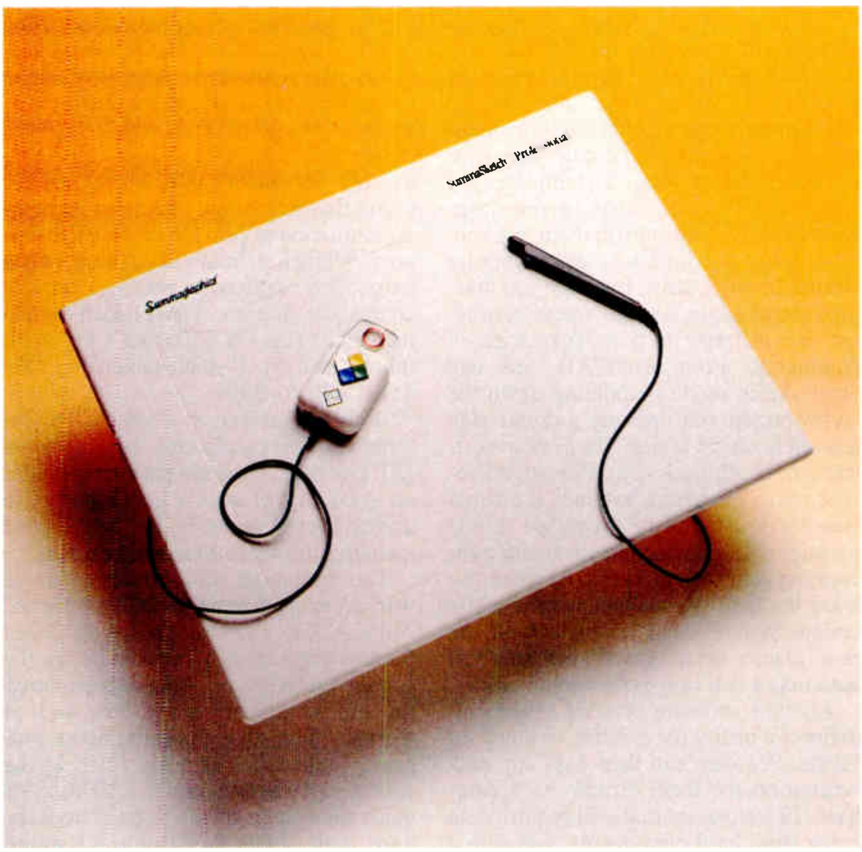

Photo 4: *The Summagraphics SummaSketch Plus (below) makes system setup a plug-and-go proposition.*

2207 turns in a performance that makes it nearly as well suited for high-precision applications.

Pencept

The Penpad 320 takes digitizing tablets to a new level of performance. While the Penpad 300 is a solid product, it's the Penpad 320 that affirms Pencept as the digitizer technology heavyweight.

Both Pencept models use the same tablet, a 16-inch by 17-inch pad with an 11-inch by 11-inch drawing area. The Penpad 320 draws its performance punch and its AC power from a full-length interface card that slides into your PC (see photo 3). The Penpad 300 uses a standard AC power adapter. In our tests, the stylus registered a full inch of proximity range, though the pen tip did seem too sensitive at times. Using it can get frustrating if you inadvertently activate or deactivate the tip while trying to draw. The design demands an easy touch.

The Penpad 300 looks bland when compared to its glamorous cousin. But when compared with other digitizing tablets of its class, the Penpad 300 stacks up very well. At $695, it offers average 1000-lpi resolution and outstanding accuracy at 0.001 inch. Our tests show an exceptional proximity range and effective tilt correction. In fact, the Penpad 300's pen posted the lowest error at a 45 degree angle, and the ASCII format can include numeric data to further compensate for stylus tilt. Emulations abound, covering the CalComp 2000, GTCO Digi-Pad 5, Hitachi Tiger, Microsoft Mouse, Mouse Systems Mouse, Numonics 2200, and Summagraphics Bit Pad One.

To create the $1095 Penpad 320, Pencept built upon the Penpad 300's impressive specifications by adding some unique features, like character recognition and a liberal dose of application-specific macros. The result is a digitizing tablet in a realm all its own. You've got to open your PC to install the interface card, and the special features require some practice, but a disk-based tutorial and clear documentation guide you along.

continued

Company Information

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2411 West La Palma Ave.
Anaheim, CA 92801
(800) 225-2667
(714) 821-2000
Inquiry 1020.

GTCO Corp.
7125 Riverwood Dr.
Columbia, MD 21046
(301) 381-6688
Inquiry 1021.

Hitachi America, Ltd.
950 Benicia Ave.
Sunnyvale, CA 94086
(408) 773-8833
Inquiry 1022.

Houston Instrument
8500 Cameron Rd.
Austin, TX 78753
(800) 444-3425
Inquiry 1023.

Kurta Corp.
3007 East Chambers St.
Phoenix, AZ 85040
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Inquiry 1024.

Numonics
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Montgomeryville, PA 18936
(800) 247-4517
Inquiry 1025.

Pencept, Inc.
460 Totten Pond Rd.
Waltham, MA 02154
(617) 890-8877
Inquiry 1026.

Seiko Instruments U.S.A.
1130 Ringwood Court
San Jose, CA 95131
(800) 255-7617
Inquiry 1027.

Summagraphics Corp.
60 Silvermine Rd.
Seymour, CT 06483
(203) 881-2000
Inquiry 1028.

Pencept provides some highly useful templates for AutoCAD, Windows, VersaCAD, CADKEY, CADvance, and Freelance Plus. The templates include predefined macros for common tasks. An IBM PC Command template lets you access 10 function keys that let you negotiate cursor movement and process control sequences directly from the pad. Other touch blocks trigger calibration routines and changes to the character set. A 10-character scratchpad enables printed DOS commands. The Penpad 320 almost makes your IBM keyboard obsolete. You can also create your own macros or design your own template.

For the Penpad tablets to recognize characters, you must print them in a specific way; for instance, zeros require slashes through them. But once you master the technique, a single traced character can generate a powerful series of commands. From AutoCAD, you can enter sketch mode by holding down the stylus button and drawing a dollar sign anywhere on the tablet. The Pencad software makes this possible. Pencad, a Pencept utility program, expands the functionality of many popular CAD packages. It also includes a facility for creating your own macros, and when you leave the facility, you can automatically update your Pencad template with the new macro definitions. This lets you automate a full range of common tasks.

Another software offering, Penform, delivers a utility for creating customized forms. Penform can then pass any data written on the form directly to a database. In businesses that still require data entry from hard-copy forms, you skip a step, thereby saving time and avoiding transcription errors.

Pencept includes any one of the software programs with the Penpad tablets. Additional programs are optional. The standard package also includes DOS, mouse drivers, the tutorial, and a software toolkit for developers. The Penpad 320 attains top-of-the-line status by combining adequate resolution, outstanding accuracy, and a wealth of powerful features. In a field where innovation is the exception, Pencept steals the show.

Seiko

Seiko's Screenplay tablets are another group that rely heavily on Summagraphics emulation to provide application support. While a standard Seiko data format exists, few application packages provide compatible drivers. The 11-inch by 11-inch tablet (the DT-3503) sells for $599; the 11-inch by 17-inch tablet (the DT-4513) sells for $999.

Both tablets feature a switchable, external power supply and configuration DIP switches. The total package includes an ADI driver and a generic mouse driver; Seiko plans to ship additional menuing software as an enhancement.

The Summagraphics-emulation mode worked as expected with PC Paintbrush. AutoCAD ran just as well with either Summagraphics MM emulation or the supplied ADI driver. We also tried to run the mouse driver to see how well it worked: The driver's installation program locked the system. Putting the driver's .SYS file into CONFIG.SYS made the system refuse to boot from the hard disk. LCS Telegraphics, which writes driver software for Seiko, attributed the problem to a bad batch of software it had shipped. LCS sent us a new driver that functioned properly.

Cursor design was excellent. Its outlined, rather than filled, cross hairs made it possible to accurately choose a fine point. The buttons were also positioned comfortably. Cursor performance was a deciding factor in the tablet's outstanding error test results; the numbers were far better than those for similar tablets with 1000-lpi resolution and 0.01-inch accuracy.

While the cursor enhanced the tablet's overall capability, the stylus detracted from it. The tip switch, which is far too sensitive, sent spurious "pen up" and "pen down" messages to the system while the pen was in contact with the tablet. There was also no tactile response whatsoever from the stylus, so it was impossible to tell by feel whether the switch was activated or not. The problem occurred in styli sent with tablets of both sizes. Our 45 degree error measurement, though average, would have been far better if it weren't for the great inaccuracies caused by the temperamental stylus.

Summagraphics

A pioneer in the digitizer field, Summagraphics remains an omnipresent standard. For a setup routine, you just plug it in and go at it: It's that simple. You'll still have to configure your applications software, but if it supports digitizing tablets, it will support Summagraphics. Hardware switches set the configuration parameters.

continued

Princeton's UltraSync. The clear winner!

PC MAGAZINE **Editor's Choice Winner***
*May 31, 1988**
Dec. 22, 1987

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PERSONAL COMPUTING
THE PERSONAL SYSTEMS MAGAZINE
May 1988

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August 1988

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PC Resource
September 1988

"...very crisp display ...its colors are better than those on NEC's Multisync II."

Circle 214 on Reader Service Card

The $599 SummaSketch Plus has a 12-inch by 12-inch drawing area with 1016-lpi resolution and 0.025-inch accuracy (see photo 4). The SummaSketch Professional sells for $999 and shares the basic specifications of the Plus. Both support a two-button stylus and a four-button cursor. Unfortunately, the cursor's rough underside sometimes causes jerky movement across the pad, which prevents you from consistently pinpointing a desired position.

Our compatibility tests just barely scratched the surface of available applications software for the Summagraphics line. Our other tests revealed an adequate proximity range and above-average tilt correction. Accuracy measurements were average. The included software provides a generic ADI driver, a mouse driver, and Windows drivers. All worked flawlessly. The Windows driver adds a facility for mapping the tablet to the entire screen or to a designated portion. A third option matches a region of the drawing area to the screen while maintaining a uniform aspect ratio. A batch file can automatically load terminate-and-stay-resident drivers for AutoCAD and for Microsoft Mouse emulation.

Summagraphics also throws in a few useful utilities. One program resets the digitizer; another displays the complete set of data compiled by the tablet.

The Last Word

In general, the digitizing tablets we tested are consistent and reliable. The new Houston Instrument series breaks from the pack with considerable performance at the lowest price. The HiPad Plus tablets offer the best resolution of all the products reviewed, excellent accuracy specifications, and a hassle-free setup routine using a menu template—all at a price lower than those of tablets offering half as much.

But if you crave the very best or desire the full complement of state-of-the-art features, Pencept's Penpad 320 stands alone. The tablet can compete against the others on the merits of its specifications, and our tests confirmed its stellar performance. Add to that a bundle of extras like character recognition, data-entry forms, a variety of applications templates, a DOS interface, predefined macros, and highly useful software, and you end up with a digitizing tablet that no other vendor can match. ■

Stanford Diehl and Steve Apiki are BYTE Lab testing editors. They can be reached on BIX as "sdiehl" and "apiki."

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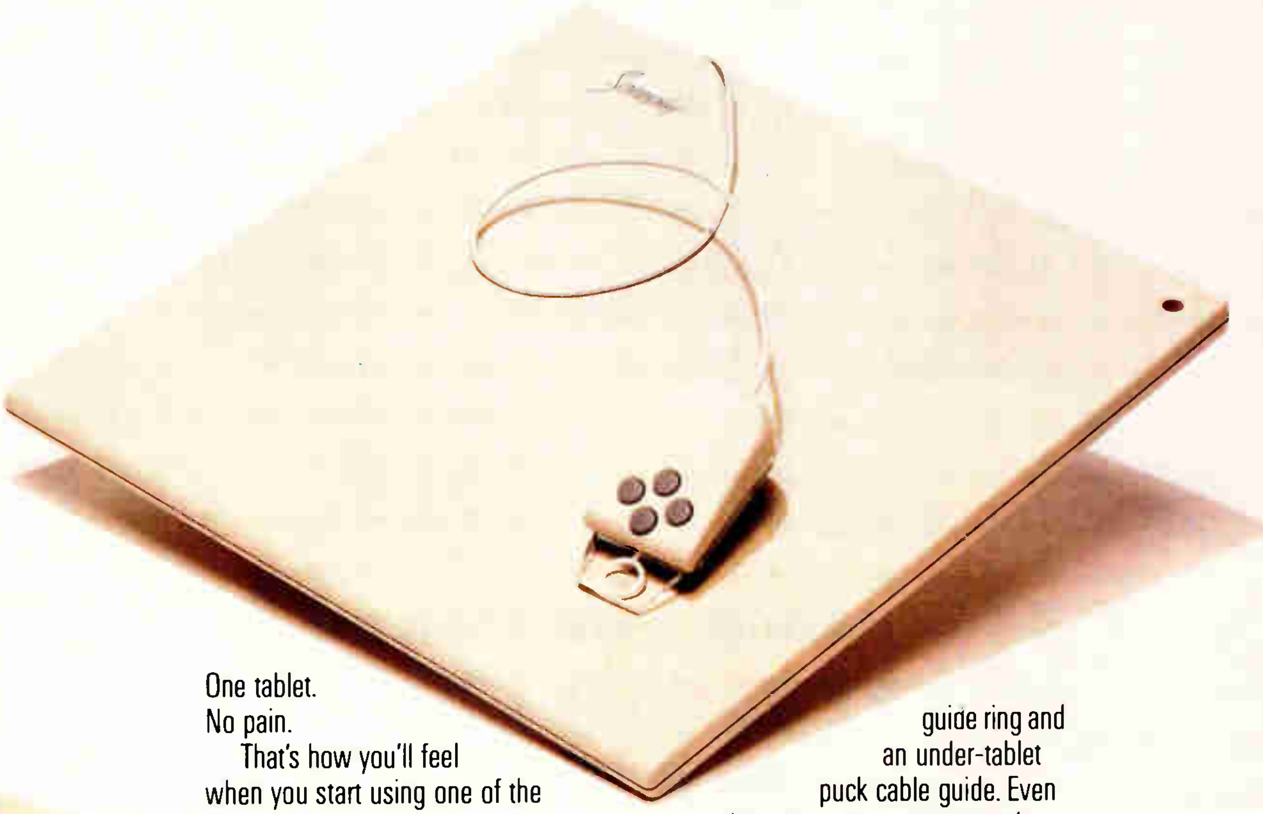

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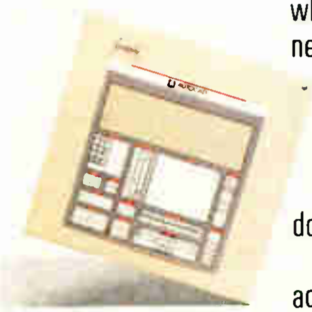

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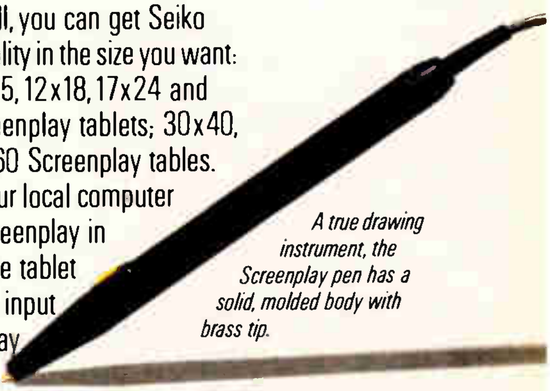

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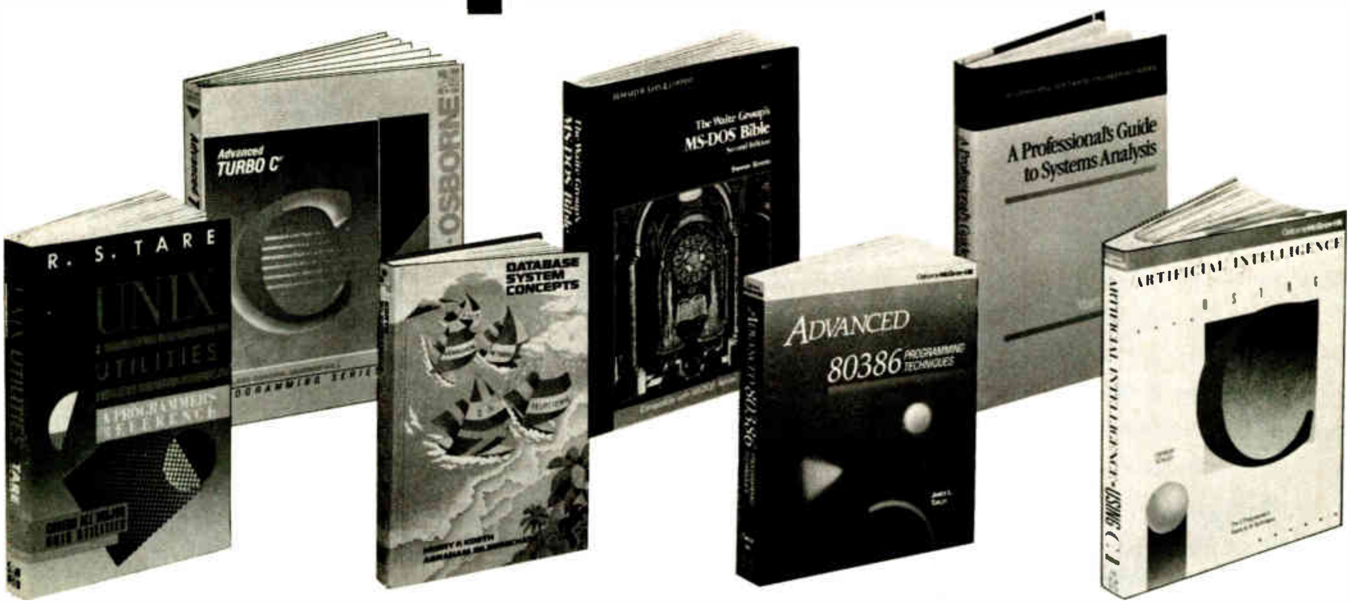

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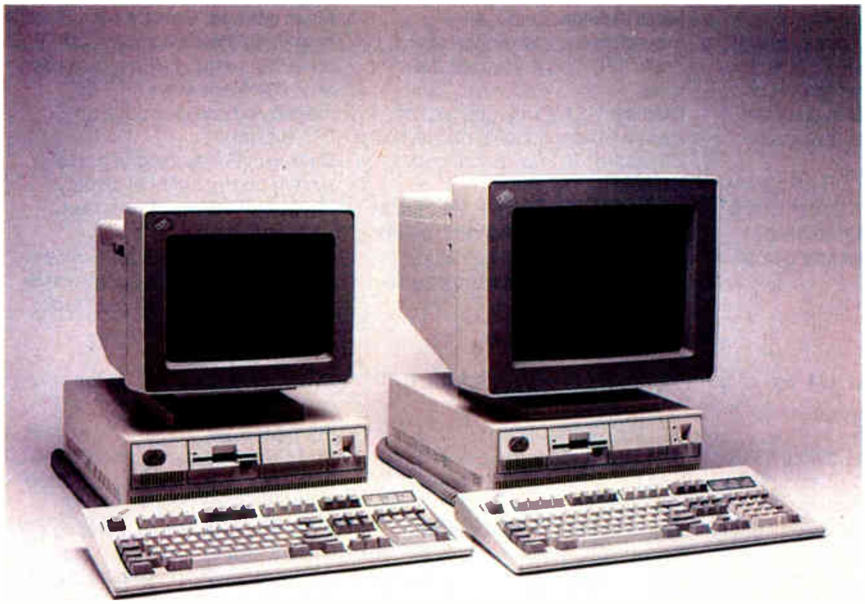


The PS/2 Model 70-E61 (left) and Model 70-121.

The new IBM PS/2 Models 70-E61 and 70-121 mean more support for the Micro Channel architecture

Caroline Halliday

Aside from their smaller size and weight, the PS/2 Models 70-E61 and 70-121 seem to fit right in with their older siblings; there is little difference between the machines. The Model 70s are equivalent in performance to the Model 80-071 and Model 80-111, respectively, and act as desktop equivalents of these floor-mounted machines.

Family Resemblance

The Model 70 machines, in their various versions, provide 32-bit processing power on the desktop. The Model 70-E61 ($5995) is a 16-MHz 80386-based machine with a 60-megabyte enhanced-small-device-interface hard disk drive and 1 megabyte of system-board RAM in its standard configuration. The Model 70-121 ($7995) runs at 20 MHz and has a 120-megabyte ESDI hard disk drive and 2 megabytes of system-board RAM as standard. These prices are, surprisingly for IBM, very competitive. A comparably equipped 20-MHz 80386-based Compaq Deskpro 386/20e with a 110-megabyte hard disk drive and 2 megabytes of RAM has a list price of $9397, and the closest equivalent AST Premium/386 is $9795.

The reviewed systems were the standard configuration with the optional 16-MHz ($795) and 20-MHz ($1195) 80387 math coprocessors installed in the respective machines. I used the 8514 ($1550) and 8513 ($750) color displays with the reviewed systems.

Aside from the size of the hard disk drive, the processor speed, and the standard quantity of RAM, the different versions of the Model 70 are physically similar. The 101-key Enhanced keyboard is supplied with the system unit. The VGA display subsystem is an integral part of the system board. The machines have a single 1.44-megabyte 3½-inch floppy disk drive, with room for a second drive. The system board can accommodate up to 6 megabytes of RAM, and total system memory can be as much as 16 megabytes. The large amount of system-board RAM is one of the major selling points of this machine.

RAM to Spare

Until recently, the IBM personal computers have usually been in single-tasking environments with DOS as the dominant operating system. This has changed with the coming of OS/2 and renewed interest in other multitasking operating systems. As the operating systems become more sophisticated, they need more RAM to support the multiple tasks. The Model 70's 6 megabytes of system-board RAM should be an ample amount for OS/2-based applications.

The system-board memory is paged, as on the 20-MHz Model 80. For successive memory accesses within the 2K-byte page, the memory is accessed at zero wait states. Accesses outside the current

continued

	Model 70-E61	Model 70-121	Model 50 Z
Company	IBM Corp. 900 King St. Rye Brook, NY 10573 (800) 426-2468	IBM Corp. 900 King St. Rye Brook, NY 10573 (800) 426-2468	IBM Corp. 900 King St. Rye Brook, NY 10573 (800) 426-2468
Components	**Processor:** 16-MHz 32-bit 80386; socket for optional 16-MHz 80387 math coprocessor **Memory:** 1 megabyte of 85-ns RAM, expandable to 6 megabytes maximum on system board and 16 megabytes maximum in the system **Mass storage:** One 1.44-megabyte 3½-inch floppy disk drive; 60-megabyte hard disk drive **Display:** VGA as integral part of system board; optional displays **Keyboard:** 101-key Enhanced keyboard **I/O interfaces:** One DB-25 parallel port; one DB-25 serial port; one 6-pin DIN mouse port; two 32-bit MCA expansion slots and one 16-bit MCA slot	**Processor:** 20-MHz 32-bit 80386; socket for optional 20-MHz 80387 math coprocessor **Memory:** 2 megabytes of 85-ns RAM, expandable to 6 megabytes maximum on system board and 16 megabytes maximum in the system **Mass storage:** One 1.44-megabyte 3½-inch floppy disk drive; 120-megabyte hard disk drive **Display:** VGA as integral part of system board; optional displays **Keyboard:** 101-key Enhanced keyboard **I/O interfaces:** One DB-25 parallel port; one DB-25 serial port; one 6-pin DIN mouse port; two 32-bit MCA expansion slots and one 16-bit MCA slot	**Processor:** 10-MHz 16-bit 80286; socket for optional 10-MHz 80287 math coprocessor **Memory:** 1 megabyte of zero-wait-state, 85-ns RAM, expandable to 2 megabytes maximum on system board and 16 megabytes maximum in the system **Mass storage:** One 1.44-megabyte 3½-inch floppy disk drive; 30-megabyte hard disk drive on Z-031 (review system); 60-megabyte hard disk drive on Z-061 system **Display:** VGA as integral part of system board; optional displays **Keyboard:** 101-key Enhanced keyboard **I/O interfaces:** One DB-25 parallel port; one DB-25 serial port; one 6-pin DIN mouse port; three 16-bit MCA expansion slots
Size	5½ × 14 × 16½ ins.; 21 lbs.	5½ × 14 × 16½ ins.; 21 lbs.	5½ × 14 × 16½ ins.; 21 lbs.
Options	PC-DOS 3.30: $125 IBM OS/2 Standard Edition: $340 IBM OS/2 Extended Edition: $830 IBM Advanced Interactive Executive (AIX) PS/2 Operating System: $624 8503 monochrome display: $275 8512 color display: $595 8513 color display: $750 8514 color display: $1550 2- to 8-megabyte memory-expansion option: $1695 1-megabyte memory module kit: $695 2-megabyte memory module kit: $1395	PC-DOS 3.30: $125 IBM OS/2 Standard Edition: $340 IBM OS/2 Extended Edition: $830 IBM Advanced Interactive Executive (AIX) PS/2 Operating System: $624 8503 monochrome display: $275 8512 color display: $595 8513 color display: $750 8514 color display: $1550 2- to 8-megabyte memory-expansion option: $1695 1-megabyte memory module kit: $695 2-megabyte memory module kit: $1395	PC-DOS 3.30: $125 IBM OS/2 Standard Edition: $340 IBM OS/2 Extended Edition: $830 IBM Advanced Interactive Executive (AIX) PS/2 Operating System: $624 8503 monochrome display: $275 8512 color display: $595 8513 color display: $750 8514 color display: $1550 2-megabyte memory module kit: $1395
Documentation	PS/2 Model 70 Quick Reference and Reference Disk	PS/2 Model 70 Quick Reference and Reference Disk	PS/2 Model 50 Quick Reference and Reference Disk
Price	$5995	$7995	Model 50 Z-031: $3995 Model 50 Z-061: $4595
	Inquiry 851.	**Inquiry 852.**	**Inquiry 853.**

page require two wait states. On the Model 70-E61, this corresponds to two and four 62.5-nanosecond clock cycles (125 ns and 250 ns) for read accesses in and out of the page, respectively. On the Model 70-121, the corresponding cycle times are 100 ns and 200 ns. In a typical application, this paged-memory arrangement gives a performance improvement over more conventional linear memory, as memory accesses are more often sequential or closely clustered rather than random. The paged-memory system improved the performance of the Model 70 in the CPU portion of the benchmark results.

In addition, the Model 70 can copy the ROM BIOS to 32-bit RAM. ROMs are slower devices compared to high-speed RAM, but because the BIOS is copied to RAM, the ROMs are accessed only during the power-on self test (POST), when the copying occurs. This "shadow RAM" method is used by other manufacturers, including Compaq and AST.

The spare 384K bytes from the 1 megabyte of system-board RAM is addressed immediately below the 16-megabyte system limit. The top 128K bytes of

continued

Revamped PS/2 Model 50 Z

Early assessments of the PS/2 family were quick to criticize the slow hard disk drive on the Model 50. It was so slow that the mediocre performance of the rest of the machine was overshadowed. Many PC AT–compatible machines had higher performance and a better price. The introduction of the Model 50 Z with its zero-wait-state memory and reasonably fast hard disk drive may assuage some of the critics, but not all.

The Model 50 Z is available in two standard versions. The Z-031 ($3995) has a 30-megabyte hard disk drive (as reviewed), and the Z-061 ($4595) has a 60-megabyte hard disk drive. Except for the variation in hard disk capacity, the machines have similar characteristics.

The Model 50 Z uses a 10-MHz 80286 microprocessor with a socket for an optional 80287 math coprocessor. The 1 megabyte of 85-nanosecond RAM on the system board can be upgraded to a maximum of 2 megabytes on the system board and up to 16 megabytes using the expansion slots. The system-board memory can run at zero wait states, which greatly improves the Model 50's performance.

The 50 Z has a single 1.44-megabyte 3½-inch floppy disk drive as standard, and there's room for a second. The system includes many features found on other PS/2 machines, such as a parallel port, a serial port, and a mouse port. The VGA is an integral part of the system board. A 101-key Enhanced keyboard comes with the system.

Three 16-bit Micro Channel architecture (MCA) expansion slots are available on the system board; one has a video extension connector for installing an alternate video board.

Internal Image

The styling of the Model 50 Z is identical to that of the Model 70 machines; the case is approximately 35 percent smaller than the IBM PC AT. As on other PS/2 machines, the power switch and disk drives are all located on the front panel. A small touch that system managers will appreciate is that the model number is also on the front panel.

The cover is held on with two thumbscrews at the rear. The interior is similar to the Model 50's. Only one cable is used in the Model 50 Z system, linking the speaker assembly to the system board. This modification is necessary since the system board itself is only two-thirds the size of the original Model 50 and is located in the rear of the case. The rest of the system elements are linked to the system board via circuit-board edge connectors.

The plastic frame over the Model 50 Z system board holds the disk drives and the speaker assembly. The hard disk drive includes the disk controller, so the circuit board used to link it with the system board is only a physical adapter (unlike the Model 50's circuit board, which is a disk controller). The floppy disk drives are linked to the system board via another circuit board sitting centrally in the rigid frame.

Access to the system-board RAM is not as easy on the Model 50 Z as on the Model 70. The whole mounting frame has to be removed (along with the clock battery). Once removed, the 1-megabyte single in-line memory module standard memory can be replaced with a 2-megabyte SIMM. Additional memory must be added to the MCA expansion bus; it will operate more slowly due to bus restrictions, and it will reduce the number of available slots. There are only three expansion slots to start with, and the system-board capacity of 2 megabytes of zero-wait-state RAM is not extensive.

Measuring Up

The Model 50 Z improves on the performance of the Models 50 and 60, but only enough to make it competitive with other high-quality 80286-based machines. The full suite of BYTE benchmarks were run on the Model 50 Z. The results show the Model 50 Z performing as its architecture would predict: at the high end of the AT class of machines, but not as well as an 80386-based machine. The improvement in the hard disk drive is obvious from the Disk I/O results. There is approximately a 25 percent improvement in performance over the IBM PC AT, and an even more substantial improvement over the Model 50 with its notoriously slow hard disk drive.

The effect of the zero-wait-state RAM is evidenced throughout the rest of the low-level benchmarks. The CPU tests give a 30 percent improvement over the Model 50, which runs with one wait state. The marginal improvement in floating-point and video results is also attributable to the RAM architecture. The actual timing differences measured on the floating-point and video tests are on the order of 1 second, so no significant difference between the Model 50 and Model 50 Z is apparent.

The improvement in the floating-point performance of the Model 50 over the AT is due to the speed of the coprocessor. On the Model 50, the 80287 runs at 10 MHz—the CPU speed; on the AT, the coprocessor runs at only 5.33 MHz—two-thirds the CPU speed. This small architectural difference has a substantial effect on performance.

The applications portion of the benchmarks reflects the results of the low-level tests. The zero-wait-state RAM has a dramatic effect on the scientific/engineering results and is also seen in the spreadsheet tests. The faster hard disk drive affects the database results in particular, as well as improving the spreadsheet index.

Old Bottle, New Wine

As would be expected, the Model 50 Z is a fully software-compatible AT-class machine. Its 10-MHz, zero-wait-state architecture gives it a zippy performance for its class, but its $4000 price tag may be too high for some. The MCA expansion slots and the use of 3½-inch disk drives may be a major factor in its suitability for a particular environment.

Overall, it is a well-engineered machine with a strong heritage. The Model 50 Z provides ample computing power for many applications, but it suffers from limited memory and expansion capabilities.

IBM PS/2 Model 70-121, Model 70-E61, Model 50 Z

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING	Model 70-121	Model 70-E61	Model 50 Z
XyWrite III+ 3.52	Med./Lrg.	Med./Lrg.	Med./Lrg.
Load (large)	:13	:14	:15
Word count	:03/:20	:03/:25	:05/:34
Search/replace	:05/:23	:06/:28	:08/:33
End of document	:02/:14	:02/:17	:02/:20
Block moves	:09/:09	:10/:10	:12/:11
Spelling check	:08/1:00	:10/1:17	:14/1:49
Microsoft Word 4.0			
Forward delete	:13	:17	:23
Aldus PageMaker 1.0a			
Load document	:07	:09	:12
Change/bold	:27	:34	:43
Align right	:22	:24	:36
Cut 10 pages	:18	:20	:27
Place graphic	:05	:05	:07
Print to file	2:01	2:17	3:06
☐ **Index:**	**2.63**	**2.28**	**1.76**

SPREADSHEET	Model 70-121	Model 70-E61	Model 50 Z
Lotus 1-2-3 2.01			
Block copy	:03	:04	:05
Recalc	:01	:02	:02
Load Monte Carlo	:16	:28	:29
Recalc Monte Carlo	:05	:06	:08
Load rlarge3	:05	:07	:07
Recalc rlarge3	:01	:01	:01
Recalc Goal-seek	:03	:04	:05
Microsoft Excel 2.0			
Fill right	:05	:06	:09
Undo fill	1:57	2:26	3:11
Recalc	:02	:02	:03
Load rlarge3	:25	:33	:38
Recalc rlarge3	:01	:01	:02
☐ **Index:**	**2.74**	**2.18**	**1.72**

DATABASE	Model 70-121	Model 70-E61	Model 50 Z
dBASE III+ 1.1			
Copy	:58	1:07	1:33
Index	:19	:20	:20
List	1:33	1:44	2:02
Append	1:55	2:14	2:39
Delete	:02	:02	:03
Pack	1:51	2:06	1:56
Count	:17	:17	:17
Sort	1:19	1:24	1:37
☐ **Index:**	**1.46**	**1.35**	**1.17**

SCIENTIFIC/ENGINEERING	Model 70-121	Model 70-E61	Model 50 Z
AutoCAD 2.52			
Load SoftWest	:46	:57	1:22
Regen SoftWest	:33	:55	1:06
Load StPauls	:10	:12	:17
Regen StPauls	:06	:07	:12
Hide/redraw	11:18	14:10	21:25
STATA 1.5			
Graphics	:28	:34	:48
ANOVA	:12	:14	:21
MathCAD 2.0			
IFS 800 pts.	:14	:18	:28
FFT/IFFT 1024 pts.	:14	:19	:30
☐ **Index:**	**3.75**	**2.94**	**2.00**

COMPILERS	Model 70-121	Model 70-E61	Model 50 Z
Microsoft C 5.0			
XLisp compile	4:01	4:49	6:32
Turbo Pascal 4.0			
Pascal S compile	:06	:07	:08
☐ **Index:**	**2.15**	**1.78**	**1.47**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT = 1.

LOW-LEVEL PERFORMANCE[1]

CPU	Model 70-121	Model 70-E61	Model 50 Z
Matrix	4.43	5.55	7.67
String Move			
Byte-wide	41.80	52.84	42.90
Word-wide:			
Odd-bnd.	35.17	44.32	42.91
Even-bnd.	20.81	26.48	21.48
Doubleword-wide:			
Odd-bnd.	26.12	32.95	N/A
Even-bnd.	10.47	13.23	N/A
Sieve	21.53	27.24	44.73
Sort	18.20	22.94	34.93
☐ **Index:**	**2.66**	**2.11**	**1.85**

FLOATING POINT	Model 70-121	Model 70-E61	Model 50 Z
Math	7.93	9.88	25.38
Error[2]			
Sine(x)	2.36	2.97	11.13
Error			
e^x	2.67	3.29	9.65
Error			
☐ **Index:**	**6.84**	**5.50**	**1.80**

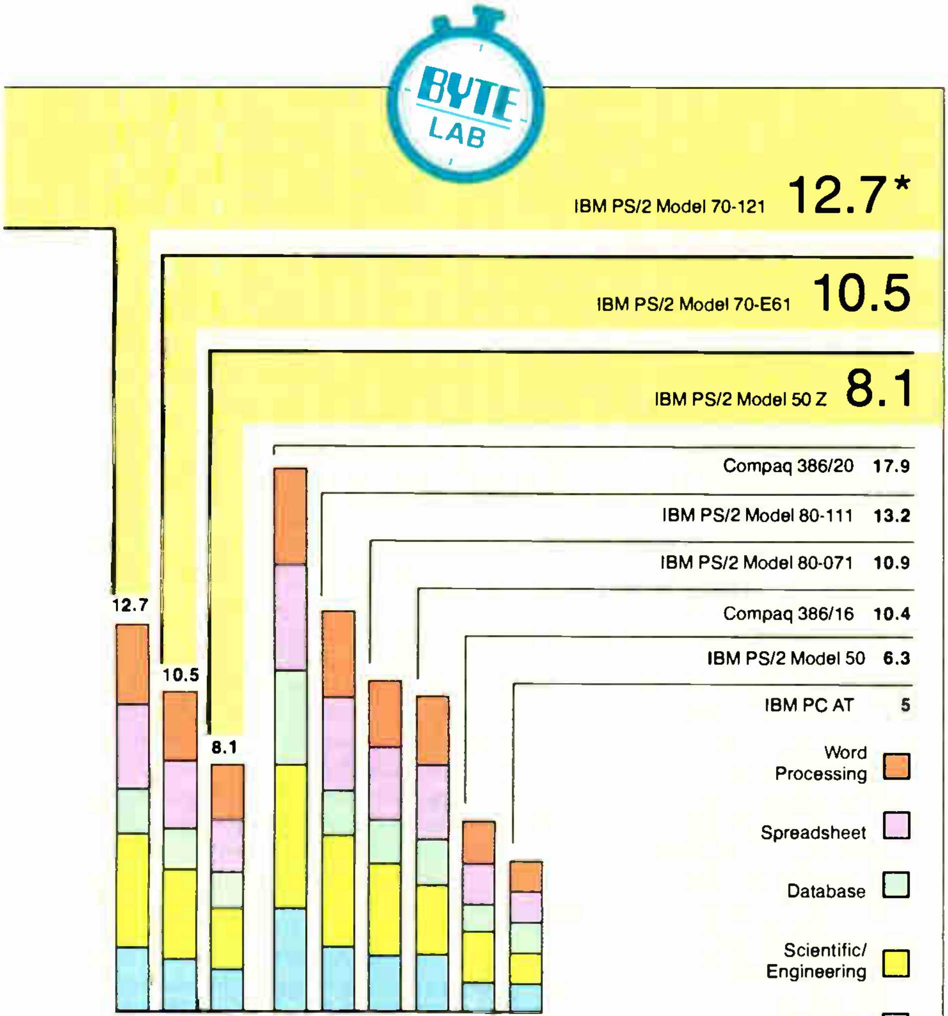
DISK I/O	Model 70-121	Model 70-E61	Model 50 Z
Hard Seek[3]			
Outer track	5.01	5.00	3.31
Inner track	5.00	4.98	4.40
Half platter	7.36	9.65	13.31
Full platter	9.72	10.05	16.68
Average	6.77	7.42	9.43
DOS Seek			
1-sector	12.97	16.41	22.35
32-sector	25.61	30.90	40.64
File I/O[4]			
Seek	0.13	0.19	0.17
Read	1.05	1.19	1.28
Write	1.08	1.14	1.23
1-megabyte			
Write	5.58	5.73	4.67
Read	4.72	5.09	5.31
☐ **Index:**	**1.57**	**1.36**	**1.25**

VIDEO	Model 70-121	Model 70-E61	Model 50 Z
Text			
Mode 0	3.83	4.61	6.37
Mode 1	3.83	4.61	6.37
Mode 2	4.10	4.85	6.59
Mode 3	4.08	4.87	6.59
Mode 7	N/A	N/A	N/A
Graphics			
CGA:			
Mode 4	1.83	2.27	3.24
Mode 5	1.83	2.29	3.24
Mode 6	2.01	2.47	3.56
EGA:			
Mode 13	3.11	3.86	4.94
Mode 14	3.61	4.39	5.73
Mode 15	N/A	N/A	N/A
Mode 16	3.57	4.34	5.71
VGA:			
Mode 18	3.75	4.56	6.04
Mode 19	2.00	2.47	3.57
Hercules	N/A	N/A	N/A
☐ **Index:**	**2.34**	**1.93**	**1.42**

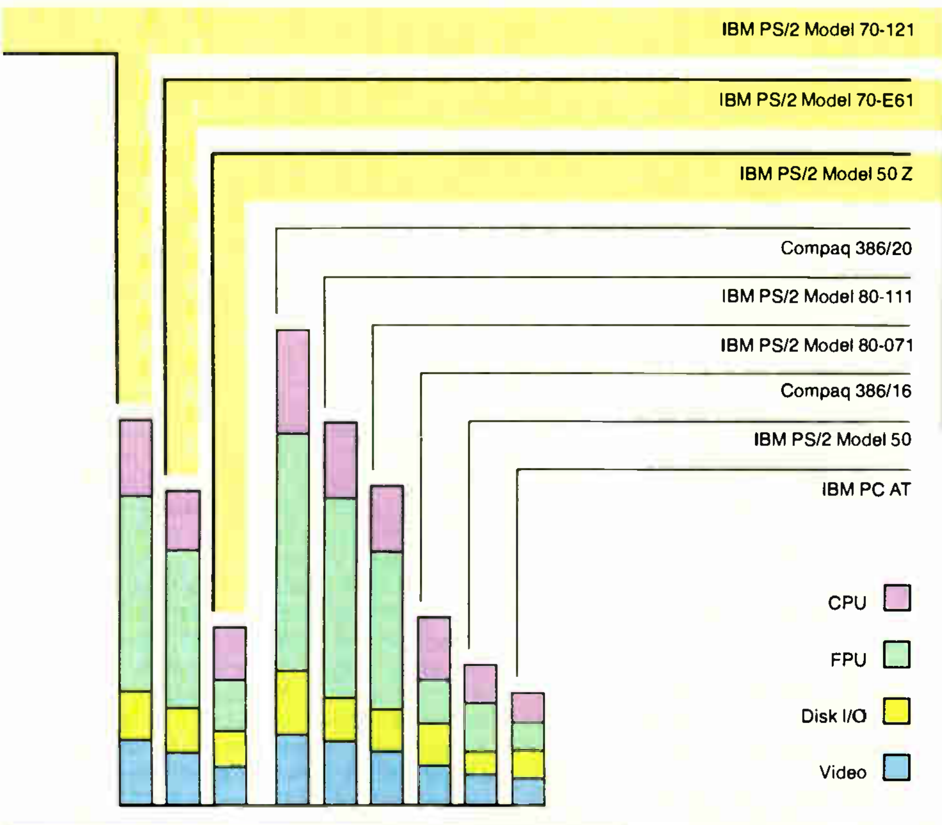
CONVENTIONAL BENCHMARKS	Model 70-121	Model 70-E61	Model 50 Z
LINPACK	198.28	249.80	572.43
Livermore Loops[5] (MFLOPS)	0.14	0.11	0.04
Dhrystone (MS C 5.0) (Dhry/sec)	5000	3974	2836

N/A = Not applicable.
[1] All times are in seconds. Figures were generated using the 8088/8086 and 80386 versions (1.1) of Small-C.
[2] The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.
[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).
[4] Read and write times for File I/O are in seconds per 64K bytes.
[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.



*Cumulative applications index. Graphs are based on indexes at left and show relative performance.



this memory is normally remapped to create a write-protected copy of the ROM BIOS at the appropriate address for DOS, just below the 1-megabyte point.

The disadvantage of this shadow RAM method is that with 128K bytes of RAM set aside for the BIOS, only 256K bytes remains besides the 640K-byte base DOS memory for any disk-cache program, RAM disk, or extended-memory needs. Adding a second megabyte of memory is highly desirable even if OS/2 isn't going to be used.

Video Capabilities

The VGA display subsystem is an integral part of the system board. The review units came with the 8513 and 8514 color monitors. The 8513 unit displays a crisp image on a 14-inch screen. The 8514 monitor, when used in association with the 8514/A Display Adapter, can display a resolution of 1024 by 768 pixels.

An optional 8503 monochrome monitor can display text and graphics in green on a black background. The 256 color modes possible on the VGA are displayed as 64 shades of gray.

The VGA itself can be considered an extension of the EGA standard. The CGA and EGA video standards are fully supported, and as a consequence, the MDA is supported via EGA emulation. Additional modes are offered on the VGA, including a 320- by 200-pixel, 256-color graphics mode; a 640- by 480-pixel, 16-color graphics mode; a 720- by 400-pixel mode in 16 colors or monochrome; and a 360- by 400-pixel, 16-color text mode.

The compatibility of the VGA implementation on the Model 70 is perfect. However, other manufacturers, such as Paradise Systems, Compaq (using the Paradise chip set), and Video Seven, have implemented a 16-bit version of the VGA that provides better performance in many circumstances than the 8-bit IBM version.

Micro Channel Architecture

The Model 70 includes two 32-bit Micro Channel architecture (MCA) expansion slots and a single 16-bit slot. The 16-bit slot has the video extension portion in addition to the standard 16-bit connections. An additional video board can use this extension to, for example, enable and disable the VGA on the system board, or to gain access to the VGA's video DAC (D/A converter). The 8514/A PS/2 Display Adapter uses this extension to route the output from the VGA to the 8514/A's external connector, allowing

continued

the user to switch between the two display systems.

The 32-bit slots include the Matched Memory cycle (MMC) extension found on the Model 80. A 16-MHz Model 80 can use this extension to allow a memory board to request a faster bus cycle, thus speeding memory accesses from the expansion bus. However, as on the 20-MHz Model 80, this extension is not used on the Model 70s and is a physical connection only. Only the -MMC CMD signal line is driven by the system board; it is the same as the -CMD signal on the 16-bit section of the expansion channel. Boards that request an MMC will operate, but not at the faster rate.

Physical Attraction

The Model 70s are packaged in a compact, if slightly too deep, system unit that measures 5½ by 14 by 16½ inches. A slightly wider machine that was not as deep would help economize on space in modular computer furniture, allowing more room for the keyboard.

Setting up a new machine is relatively easy: Simply plug in the display, keyboard, and power cables, and turn it on. You use the Model 70/80 Reference Disk to run the Setup program to configure the system.

Installing additional expansion boards or other options is also easy in the Model 70. Turn two thumbscrews to release the cover. Slide it forward about an inch before you lift it off. The expansion slots are on the left side of the unit, as is the math coprocessor socket. You may need to temporarily remove any installed expansion boards to insert the math coprocessor, but otherwise installation is straightforward.

An expansion board may include adapter description files as part of its configuration requirements. These files, which are supplied on a disk with the expansion option, should be copied to the working copy of the Reference Disk.

The inside of the Model 70 is similar to that of the original Model 50; there are no cables linking the system elements. The power supply is on the right side, the system board lies on the bottom of the case, and the hard disk drive, floppy disk drive, and speaker assembly are all mounted on a rigid frame over the system board.

The mounting frame is sturdy, molded plastic with mounting rails for the disk drives. A single printed circuit board mounted vertically contains the connectors used to link the disk drives to the system board. On the Model 50 and Model 50 Z, two circuit boards are used.

The hard disk drives in the review units are impressive. Despite their large capacity (60 megabytes and 120 megabytes), each has only 3½-inch diameter platters, instead of the more typical 5¼-inch. The rails in the molding suggest that a 5¼-inch version could be accommodated, however. As the hard disk controller is also an integral part of the hard disk drive, this may allow a larger-capacity hard disk (as yet unannounced) to be installed at a later date.

The system RAM is mounted on the system board via single in-line memory module connectors located under the disk drives. You can install or remove RAM by removing the second disk drive (if installed) and plugging in the SIMMs. The system can use either 1- or 2-megabyte SIMMs. Each Model 70 has three memory connectors. Six megabytes of system-board memory requires three 2-megabyte SIMMs, so upgrading the 70-E61 requires removing the standard 1-megabyte SIMM.

Sitting on the Bench

I tested the Model 70s with all the BYTE benchmarks. As expected, I found no incompatibilities with the IBM standard.

I compared the 16-MHz Model 70-E61 to the IBM PC AT, PS/2 Model 80-071, and Compaq 386/16. No software disk cache was installed on any of the machines. The Model 80-071 had a 70-megabyte ESDI hard disk drive, and the Compaq 386/16 had an 80287 math coprocessor rather than an 80387.

I compared the Model 70-121 with the IBM PC AT, the PS/2 Model 80-111, and the Compaq 386/20. Again, no software disk cache was installed on any of the machines. The Model 80-111 had a 115-megabyte ESDI hard disk drive.

The low-level benchmark results from the 16-MHz machines were most interesting in the CPU area. The difference between the paged-memory subsystem and a linear approach were obvious when I compared the Model 70-E61 and the Model 80-071. The byte-wide and word-wide String Move tests took similar amounts of time on the linear system (Model 80-071), whereas the Model 70-E61 showed improvement in performance of fetch in and out of a page. The Compaq 386/16 gave results very similar to those of the Model 70-E61, showing its similar paged-memory system. The effect of using a different math coprocessor was also apparent in the floating-point results, where the 80387 in the Model 70-E61 gave over three times the performance of the Compaq's 80287.

continued

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MS DOS w/GW Basic
$1895.00
16 Mhz 286 EGA
1 Meg 70NS Ram
0 Wait State (S.I. 17.3)
1.2 Meg 5¼" Drive
1.44 Meg 3.5" Drive
40 Meg Hard Drive (28 MS)
1 to 1 Interleave
EVEREX EGA Board
14" EGA Monitor
1 Parallel / 2 Serial Ports
101 Key Keyboard
MS DOS w/GW Basic
$2395.00
New
386 SX $2695.00
(Same configuration as above)
25 Mhz 386 VGA
1 Meg 60NS Ram
Expandable to 8 Megs on MB
32 Bit Slot Open
1.2 Meg 5¼" Drive
1.44 Meg 3.5" Drive
80 Meg Hard Drive (28 MS)
1 to 1 Interleave
16 Bit PARADISE VGA Board
NEC MULTI SYNCH II
1 Parallel / 2 Serial Ports
101 Key Keyboard
MS DOS w/GW Basic
80387 and Weitek Sockets
Vertical Style Case
$3995.00
Same 386 as shown
but 20 Mhz mono desktop.
$2795.00
BYTE LAB
Steve Apiki & Stanford Diehl
Oct. 1988, BYTE
Review of 20 386's
• "Emerging as truly exceptional..."
• "The Gateway delivers speed without sacrificing features."
• "The system ran without a glitch."
• "We were truly surprised to see a system of this caliber selling for less than $3000."
• "When evaluating the whole package, The GATEWAY 386 surpasses all the others!"
GATEWAY 2000
Gateway 2000 • P.O. Box 2000 • Sgt. Bluff, IA. 51054
800-233-8472/712-943-2000
All systems have a 30 day Money Back Guarantee and 1 Year Warranty.
Due to the Volatility in the DRAM Market all prices subject to change.
World Radio History

The 16-MHz Model 70-E61's performance on the application benchmarks showed slightly slower performance than the 16-MHz Model 80-071, due to slight differences in the hard disk performances. The data transfer rate of the 60-megabyte drive in the Model 70-E61 is 8.4 megabits per second with an average access time of 27 milliseconds, and the Model 80-071's drive had a data transfer rate of 10 Mbps. This was especially noticeable in the spreadsheet and database tests, which are disk I/O-intensive. The difference in the compiler index was not as significant as the index numbers would indicate because the actual timing difference between the two machines was only 1 second.

The performance differences between the Compaq Deskpro 386/16 and the Model 70-E61 were due to the Compaq's faster hard disk drive, reflected in the database results, and the Compaq's 80287 math coprocessor, reflected in the scientific/engineering results.

The comparison of the 20-MHz machines showed a difference between the IBM MCA and the Compaq architecture. The memory cache controller on the Compaq Deskpro 386/20 gave dramatically faster results for the CPU test than either the Model 70-121 or the Model 80-111. The faster hard disk drive of the Compaq machine was also evidenced in the Disk I/O tests.

When the 20-MHz machines were compared using application benchmarks, there was little difference in the performance of the IBM machines. The difference in the timed results was on the order of only 1 second, with the particular Model 80 tested being the marginally faster machine. The Compaq 386/20 outperformed the Model 70-121, however, due to its memory cache controller system and faster hard disk drive. The Model 70-121's hard disk drive has a data transfer rate of 10.2 Mbps with an average access time of 23 ms. The Compaq 386/20 was over 35 percent faster in the application tests. The difference in architecture was particularly apparent in the disk-intensive tests.

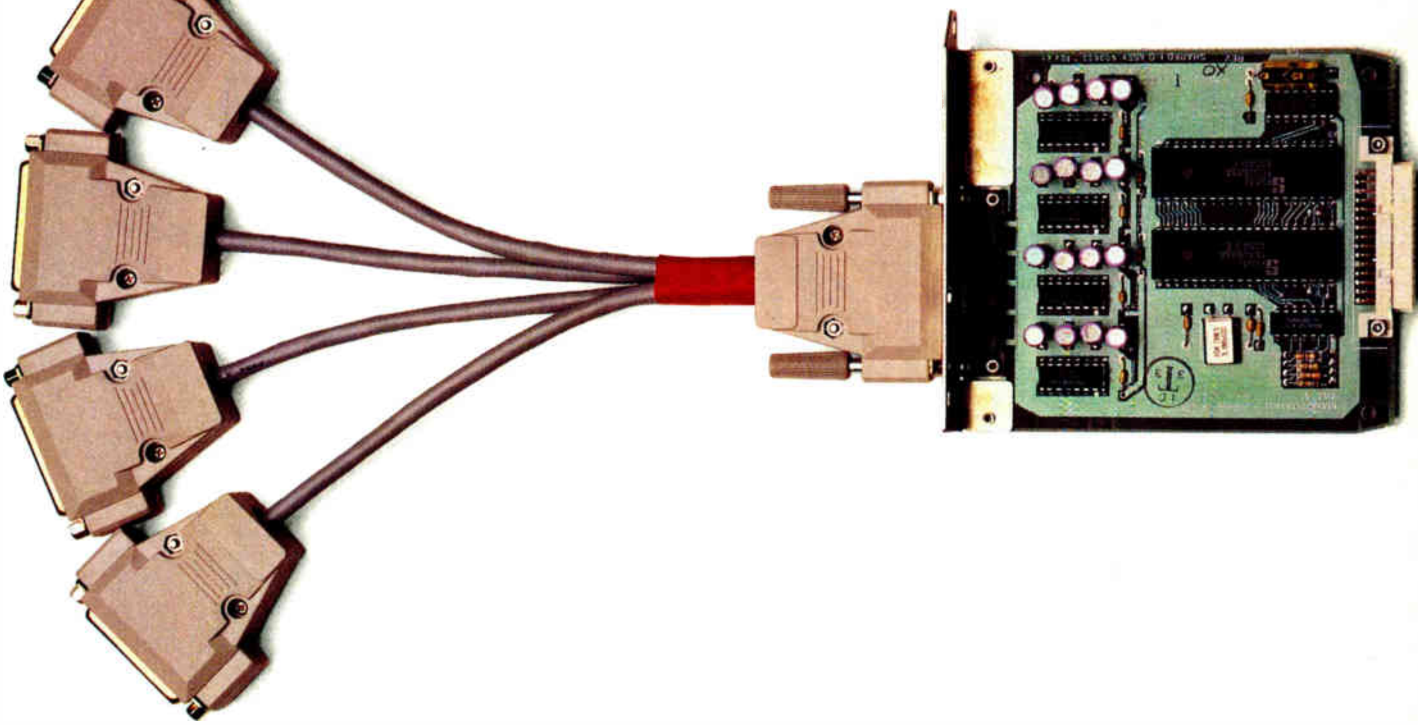
The use of a software disk cache, which is supplied as standard with both the IBM and Compaq machines, will further improve their performance.

Down-Sized Model 80

The Model 70 is a much smaller system than the Model 80 and has fewer expansion slots. This might not be a penalty since the system unit has a serial port, a mouse port, and a parallel port as standard. The disk controller and the VGA are integral parts of the system board. Expansion slots might be needed for connectivity purposes—for example, network boards or internal modems. But unless you need large amounts of RAM (over 6 megabytes), the Model 70 has adequate expansion capacity with its two 32-bit and single 16-bit MCA slots. The 3½-inch floppy disk drives may be a disadvantage to some users.

The Model 70s are truly competitive machines in terms of price and performance. They offer good performance compared to other machines in their class. Their small size makes for a convenient desktop package. Overall, these machines are worth considering. ■

Caroline Halliday owns High Tech Aid, a consulting firm in Ellicot City, Maryland, that specializes in technical documentation and teaching for the PC environment. She can be reached on BIX c/o "editors."



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A Portable with Punch

Quick and expandable, Dolch's P.A.C. 386-20C strives to be the premier "luggable"

Mark L. Van Name

For a long time, Compaq's Portable 386 was the most powerful of the "luggable" portable PCs. Now a new contender, the Dolch P.A.C. 386-20C, has stolen the performance crown from Compaq. The unit needs some refining, however, before it can match Compaq's overall quality.

The Dolch P.A.C. (for Portable Add-in Computer) 386-20C, like the Compaq Portable 386, has a 20-MHz 80386 CPU. Unlike the Compaq, however, the 386-20C has a cache: 64K bytes of 35-nanosecond static RAM (SRAM) that lets the 80386 run without wait states over 90 percent of the time. Dolch uses a combination of an Austek cache-controller chip and some other support logic to control this cache, rather than the more common Intel 82385 cache controller, but this cache system still increases the system's performance noticeably.

Dolch delivers all this performance in what looks like a gray lunch box. Standard equipment includes the 20-MHz 80386, the SRAM cache, a socket for a 20-MHz 80387, 1 megabyte of 100-ns dynamic RAM (DRAM), a 1.2-megabyte 5¼-inch floppy disk drive, a 20-megabyte hard disk drive, two serial ports, one parallel port, and an electroluminescent (EL) CGA-compatible display.

My evaluation unit also included some extras: a 20-MHz 80387, a second megabyte of memory, a 40-megabyte hard disk drive, and an internal 300-/1200-bit-per-second modem. To use it, you also need MS-DOS; Dolch sells version 3.30. My unit also came with a carrying case, which is almost de rigueur for portables.

The 386-20C's power doesn't come cheap: At $7995, the standard 386-20C costs more than many desktop systems and slightly more than Compaq's Portable 386. My review system, with all the goodies, lists for $10,840: a portable in five figures.

Dolch offers two slower versions of the Dolch P.A.C. for those with less cash. The Models 386-16 ($6495) and 386-20 ($6995) use a 16-MHz and 20-MHz 80386, respectively, but without the SRAM cache. Otherwise, all three models are similarly equipped.

Room to Grow

The 386-20C also includes a welcome treat in any portable: six expansion slots, two of which are empty in the standard unit. You get to these slots by removing the rear cover of the machine. One slot is dedicated to the system's 32-bit memory board. Four others accept standard AT-style expansion cards, although only two have room for full-length cards. The remaining slot can hold a half-length, XT-style expansion card.

If that's not enough growth space, Dolch will also offer an optional Back-Pac expansion chassis. Though the chassis is not yet available, Dolch says it will connect to an edge connector underneath the rear cover of 386-20C production systems. The Back-Pac chassis will include its own power supply and fan, and it will be able to hold up to three AT-style expansion cards.

continued

Dolch P.A.C. 386-20C

Company
Dolch Computer Systems
(a division of Dolch American Instruments, Inc.)
2029 O'Toole Ave.
San Jose, CA 95131
(800) 538-7506
(800) 223-2077 (in California)

Components
Processor: 20-MHz 32-bit 80386 with compatibility speed of 6 MHz; socket for 20-MHz 80387 coprocessor
Memory: 1 megabyte of 32-bit 100-ns DRAM on system memory board or expansion card, expandable to 10 megabytes; 64K bytes of 35-ns SRAM cache; 256K bytes of BIOS ROM
Mass storage: 1.2-megabyte 5¼-inch floppy disk drive; 20-megabyte hard disk drive
Display: Electroluminescent CGA-compatible with four gray scales
Keyboard: 86-key modified PC AT-type layout; indicator lights for Caps Lock, Num Lock, and Scroll Lock
I/O interfaces: RS-232C serial port with DB-9 connector; DB-25 parallel port; RGB monitor port with DB-9 connector; DIN external keyboard connector; 32-bit expansion slot for proprietary system memory card; one 8-bit half-size expansion slot; two 16-bit full-size expansion slots; two 16-bit half-size expansion slots

Size
15½ × 8 × 9½ inches; 22 pounds

Software
None

Options
2-megabyte RAM expansion: $995
6-megabyte RAM expansion: $3795
10-megabyte RAM expansion: $5995
20-MHz 80387 math coprocessor: $1195
40-megabyte hard disk drive: $225
80-megabyte hard disk drive: $995
170-megabyte hard disk drive: $2495
Substitute 1.44-megabyte 3½-inch floppy disk drive: $50
Internal 1200-bps modem: $130
Internal 2400-bps modem: $240
Carrying case: $150
MS-DOS 3.30 with GWBASIC: $150
EGA resolution subsystem: $995

Documentation
50-page operation manual

Price
P.A.C. 386-16: $6495
P.A.C. 386-20: $6995
P.A.C. 386-20C: $7995
System as reviewed: $10,840

Inquiry 854.

If that's still not enough space, you can chain up to five of these Back-Pac chassis together for a total of 17 possible expansion slots. But each expansion chassis will weigh about 5 pounds without any cards in it, so you aren't likely to carry them around.

The 386-20C is also expandable in other ways. You can add memory to its system memory board via daughterboards, up to the current system maximum of 10 megabytes. You can also replace the standard 20-megabyte hard disk drive with optional 40-megabyte, 80-megabyte, or 170-megabyte drives.

By combining these expansion options with the expansion chassis, you can have a PC that you can take on the road and that still has enough power to be your main desktop system.

Using It

Part of the appeal of any portable is that you can take it with you. But you pay a price for all the 386-20C's power when you take it on the road: It's heavy. The evaluation unit weighed a hair over 22 pounds, 2 pounds more than the Compaq Portable 386. The carrying case adds a couple more pounds.

Once you've got where you're going, however, the system's display and keyboard have to be reasonable to use. Overall, although its keyboard leaves something to be desired, the 386-20C is more than acceptable.

A big attraction is its screen, which offers a 9¼-inch diagonal viewing area and a backlit EL display that shows yellow characters on a dark gray background. The EL technology gives a contrast ratio of up to 20 to 1, so the screen is readable in any light. The display simulates CGA colors with four gray scales, and the screen tilts to give you a comfortable viewing angle. You can flip a switch on the screen to reverse the colors, but I thought the yellow background was too strong.

About the only thing wrong with this display is that its aspect ratio is slightly off, so true circles, like pie charts, appear a bit oval. On balance, however, EL technology is a step forward from the current portable liquid crystal display and gas-plasma standards. You can probably expect to see many other portable manufacturers adopt it in the future.

The card that controls the EL screen will also support an external CGA or monochrome monitor. You even get Hercules emulation with a monochrome monitor, and an EGA option will work with both the internal EL screen and any EGA-compatible external monitor.

Unlike the display, the keyboard is nothing special. On the good side, it detaches from the front of the unit, where it protects the screen, and it's nearly full-size. The 86 keys are in the standard AT arrangement, except that there are 12 function keys, not 10, and they run across the top of the keyboard rather than down the left side.

The real problem with this keyboard is its feel. It seems insubstantial, almost as if the keys are hollow. Fortunately, it plugs into a standard keyboard connector that will work with any AT-compatible keyboard. I suggest buying a keyboard you like for desktop use and putting up with this one when you're on the road.

Fastest Portable

Once you're past the keyboard and display, the main issues for a portable are the same as for any desktop system: speed and compatibility.

The 386-20C wins the portable speed race—at least for now. With the exception of the Graphics and Floating-Point tests, the 386-20C surpassed the Compaq Portable 386 in BYTE's low-level benchmarks, and its overall application index is about 7 percent faster.

Regarding compatibility, on the software side, the news is good. I threw a lot of programs at the 386-20C, including Borland's Reflex 1.14, SideKick Plus 1.0, SuperKey 1.16A, Turbo Basic 1.1, Turbo C 2.0, and Turbo Pascal 4.0; Digitalk's Smalltalk/V 1.2; Kermit 2.30; Lotus 1-2-3 version 2.0; MicroPro's WordStar 3.3 and 4.0; Microsoft's PC Paintbrush 2.0, Windows/386 2.03, and Word 4.0; Norton Utilities 3.0; Quarterdeck's DESQview 2.0, with its Expanded Memory Manager 386 version 1.10; and Symantec's Q&A 1.1. They all worked.

However, I did encounter two minor problems during the software tests. The first occurred when the 386-20C would not pass 1-2-3's keydisk copy-protection check. I had to slow the system to its compatibility speed of 6 MHz before I could run 1-2-3, something that happens fairly often with the newer high-speed PCs. Unfortunately, the only way to slow the unit was with a SETSPEED program that I could invoke only from MS-DOS.

A call to Dolch revealed that the company was replacing my test machine's ROM BIOS (Phoenix ROM BIOS 1.10 B2) with the AMI ROM BIOS 5.0, which lets you change processor speeds from the keyboard. The ROM BIOS wasn't the only component that Dolch was changing; the I/O board, keyboard controller, and internal modem were all different.

continued

Dolch P.A.C. 386-20C

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING

XyWrite III+ 3.52	Medium/Large
Load (large)	:11
Word count	:02/:16
Search/replace	:05/:21
End of document	:01/:13
Block move	:10/:10
Spelling check	:08/:50
Microsoft Word 4.0	
Forward delete	:11
Aldus PageMaker 1.0a	
Load document	:12
Change/bold	:24
Align right	:17
Cut 10 pages	:15
Place graphic	:04
Print to file	1:54
☐ **Index:**	**2.96**

SPREADSHEET

Lotus 1-2-3 2.01	
Block copy	:03
Recalc	:01
Load Monte Carlo	:17
Recalc Monte Carlo	:04
Load rlarge3	:04
Recalc rlarge3	:01
Recalc Goal-seek	:07
Microsoft Excel 2.0	
Fill right	:04
Undo fill	1:29
Recalc	:02
Load rlarge3	:19
Recalc rlarge3	:01
☐ **Index:**	**2.78**

DATABASE

dBASE III+ 1.1	
Copy	:50
Index	:21
List	1:51
Append	:46
Delete	:02
Pack	1:16
Count	:18
Sort	1:18
☐ **Index:**	**1.68**

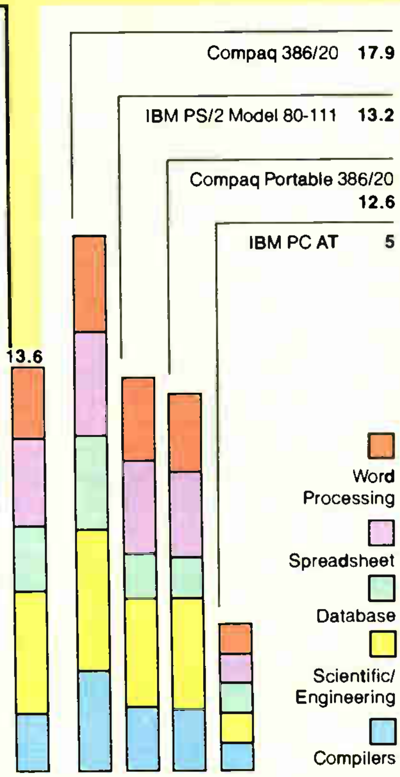
SCIENTIFIC/ENGINEERING

AutoCAD 2.52	
Load SoftWest	:44
Regen SoftWest	:33
Load StPauls	:10
Regen StPauls	:05
Hide/redraw	9.22
STATA 1.5	
Graphics	:23
ANOVA	:18
MathCAD 2.0	
IFS 800 pts.	:15
FFT/IFFT 1024 pts.	:15
☐ **Index:**	**3.79**

COMPILERS

Microsoft C 5.0	
XLisp compile	3:58
Turbo Pascal 4.0	
Pascal S compile	:05
☐ **Index:**	**2.37**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.



*Cumulative applications index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE[1]

CPU

Matrix	3.55
String Move	
Byte-wide	31.36
Word-wide:	
Odd-bnd.	31.25
Even-bnd.	15.69
Doubleword-wide:	
Odd-bnd.	23.45
Even-bnd.	7.86
Sieve	18.84
Sort	14.34
☐ **Index:**	**3.30**

FLOATING POINT

Math	12.08
Error[2]	0.00E+00
Sine(x)	2.80
Error	2.00E–09
e^x	3.09
Error	1.00E–09
☐ **Index:**	**5.35**

DISK I/O

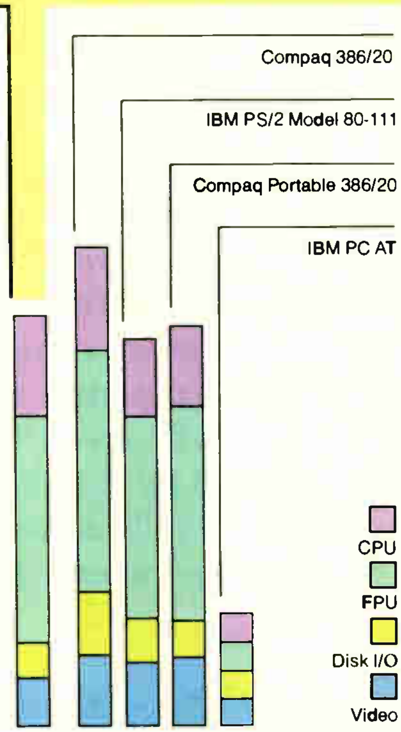
Hard Seek[3]	
Outer track	3.27
Inner track	3.35
Half platter	10.00
Full platter	16.64
Average	8.32
DOS Seek	
1-sector	15.16
32-sector	44.56
File I/O[4]	
Seek	.08
Read	1.07
Write	.97
1-megabyte	
Write	6.12
Read	7.25
☐ **Index:**	**1.41**

VIDEO

Text	
Mode 0	6.22
Mode 1	6.26
Mode 2	7.91
Mode 3	7.91
Mode 7	N/A
Graphics	
CGA:	
Mode 4	1.65
Mode 5	1.64
Mode 6	1.76
EGA:	
Mode 13	N/A
Mode 14	N/A
Mode 15	N/A
Mode 16	N/A
VGA:	
Mode 18	N/A
Mode 19	N/A
Hercules	N/A
☐ **Index:**	**2.23**

CONVENTIONAL BENCHMARKS

LINPACK	243.96
Livermore Loops[5] (MFLOPS)	.09
Dhrystone (MS C 5.0) (Dhry/sec)	5952



N/A=Not supported by graphics adapter.

1 All times are in seconds. Figures were generated using the 8088/8086 and 80386 versions (1.1) of Small-C.

2 The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

3 Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

4 Read and write times for File I/O are in seconds per 64K bytes.

5 For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

The company sent a new unit, which the BYTE Lab benchmarked for this review.

My other software problem was inherent in the system's use of gray scales to mimic colors. Some products that make extensive use of colors in their operational displays, such as Borland's compilers, often produced barely readable screens. Dolch says that you can get around this problem by getting the offending software to use different colors, but that's a less-than-ideal solution. Another option is to buy the EGA option, but that further runs up the cost of an already expensive machine.

In my hardware tests, the machine didn't fare as well. My Microsoft Serial Mouse and Everex Evercom II internal 2400-bps modem worked fine, but I had problems with the modem that came with the unit and with an Intel Above Board AT memory-expansion board. Dolch says it has switched to Everex internal modems, and the modem in the updated machine functioned properly. The company was unaware of any problems with the Intel Above Board, and I was unable to test it in the new machine in time for this review.

Far more annoying was that the evaluation unit lost track of its keyboard just about every time I rebooted. The only way to get it to recognize the keyboard was to reboot over and over until the keyboard started working. I guessed that a faulty Phoenix keyboard controller was responsible, as did a Dolch spokesperson. The second unit, with its new keyboard controller, had a similar problem after the BYTE testing editors loaded a file in AutoCAD 2.52, but otherwise it worked satisfactorily.

Follow-up

While investigating these problems, I had several long chats with Dolch's support people, who were always cheerful, knowledgeable, and helpful. Dolch prefers that you call your dealer for support. But if you must call Dolch, the company has a toll-free number.

In contrast to Dolch's technical support, the 386-20C's documentation was nearly useless. If you're a novice user, you might like the MS-DOS introduction and beginner's glossary, but how many novices are going to buy a portable computer at this price? Most users will find the slim 50-page manual sorely lacking.

If you have a problem that neither the documentation nor Dolch's support group can solve, you can take advantage of the 386-20C's 1-year parts and labor warranty. You pay shipping to San Jose, and Dolch pays for the return trip.

Power to Go

On balance, I liked the 386-20C. It offers a lot of power and room to grow in a package that's heavy but still luggable. Unfortunately, my evaluation unit seemed less than finished. It had several hardware problems, and Dolch was replacing the keyboard controller, I/O board, ROM BIOS, and internal modem as this review went to press.

I also disliked the keyboard, but the EL screen is great. And the 386-20C sure is fast. If Dolch stabilizes this machine, it could be a good alternative for those who want a luggable—and are willing to pay for it. ■

Mark L. Van Name is a freelance writer and computer consultant living in Durham, North Carolina. He can be reached on BIX c/o "editors."

PC MAGAZINE

"The Dataworld 286 [12MHz] AT compatible...[is]... the fastest machine of the nine tested in that review [July 1988]." (September 27, 1988).
and
... speed and excellent compatibility... hundreds of dollars less expensive than other AT compatible.

PC MAGAZINE EDITOR'S CHOICE

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(October 11, 1988)

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DATA-286 12MHz

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512KB of RAM, expandable to 1MB on board
Socket for 80287-8, -10
200W power supply
Real-time clock with battery backup
1.2MB floppy disk drive
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(1:1 interleave controllers available)
101-key keyboard with "click"
Mono card w/parallel port (720x348)
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80286 running at 8/12Mhz, 0/1 wait state
Phoenix BIOS std. (Award BIOS opt.)
512KB of RAM, expandable to 1MB on board
Socket for 80287-8, -10
Real-time clock with battery backup
1.44MB 3.5" floppy disk drive
20MB, 39ms, self-parking hard drive
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Supertwist backlit LCD, 640x400 res.
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Weighs under 20 Lbs.
1.2MB external floppy drive opt.
Carrying case available

$1975

DATA-286 20MHz

80286 running at 10/20Mhz
AWARD BIOS std.
1MB of RAM, exp. to 2MB on board
EMS 4.0 support for memory over 1MB
Socket for 80287
200W power supply
Real-time clock with battery backup
1.2MB floppy disk drive
1:1 interleave floppy/hard disk controller
101-key keyboard with "click"
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4.77/6/8/16MHz (20MHz opt.)
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220W power supply
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101-key keyboard with "click"
Five 16 and two 8-bit slots
Mono card and monitor **$1995**

Portacomp I

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200W power supply
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5 expansion slots
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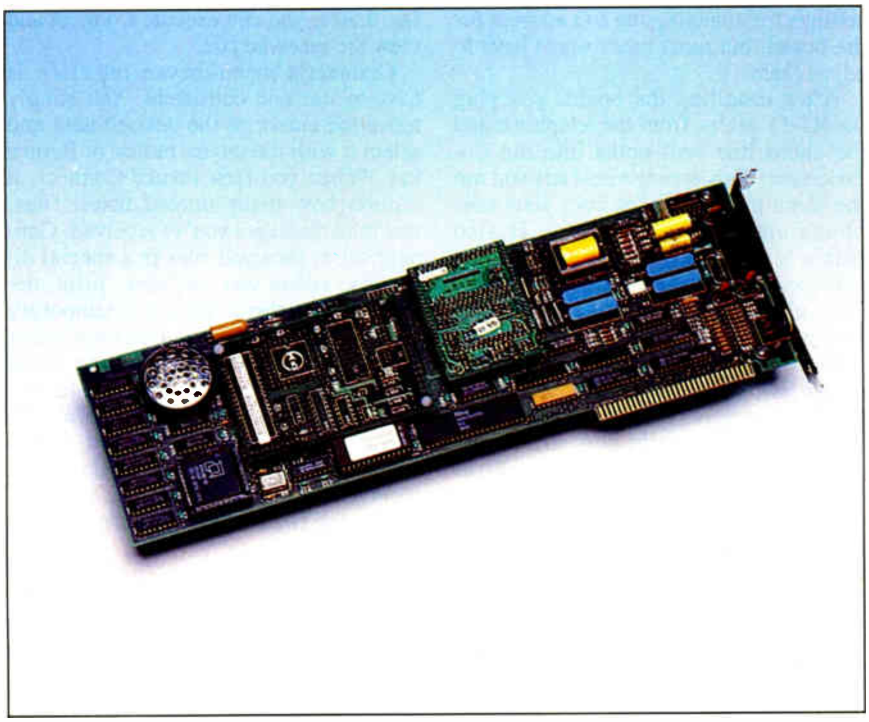


Intel's Connection CoProcessor offers fax, file transfer, and E-mail capabilities on one board

Nick Baran

Intel may be a little late to the party with its Connection CoProcessor PC facsimile board, but it has delivered a solid product. This $995 full-length add-on fax board features a 10-MHz 80188 microprocessor, 256K bytes of memory, and an expansion socket for adding an optional 2400-bit-per-second Hayes-compatible modem card.

The board's most powerful feature is its on-board microprocessor, which can send or receive fax images, text, or binary files in the background while you continue working in other applications. But the board is also of interest because it supports the new Intel/DCA Communicating Applications Specification.

CAS is an application-programming interface that Intel hopes software developers will use to provide transparent fax communications via the Connection CoProcessor from within their applications. Intel provides the underlying hardware and software to support the interface. Users will then be able to send and receive files or faxes without leaving their current application. Intel says that several developers, including WordPerfect, Microsoft, and Symantec, plan to incorporate CAS into their applications, but no products were available in time for this review.

The CoProcessor supports Group III fax and binary-file transmission between CoProcessor boards at 9600 bps. While fax transmissions support the CCITT Group III standard, high-speed binary-file transfers require a Connection CoProcessor on each end.

The CoProcessor's Connect software accepts PCX, DCX, and PIC graphics files (when incorporated into DCX files) for faxing. The software stores incoming fax transmissions in PCX format. You can view or print these images, or save them for use with the CoProcessor's graphics editor, which is a version of Z-Soft's PC Paintbrush.

From Fax to E-Mail

Connect, the CoProcessor's menu-driven communications software, lets you send and receive files, faxes, and electronic mail messages, and a set of utilities lets you edit PCX files, maintain phone books, log transmissions and events, poll other CoProcessors, and maintain files. The main menu also displays information on how many faxes, files, or E-mail messages are waiting.

Connect's Mail module is actually a file-transfer utility that lets you create, edit, and send text messages between CoProcessors. You can also attach binary files to a mail message. The Mail function works only with other CoProcessor boards, however.

If you have a scanner, Connect has an option for loading scanned files for use in fax or file transmissions. However, it doesn't include optical character-recog-

continued

Connection CoProcessor

Type
Add-on fax board and software

Company
Intel PCEO
5200 Northeast Elam Young Pkwy.
Hillsboro, OR 97124
(800) 538-3373

Features
On-board 10-MHz 80188 microprocessor with 256K bytes of RAM; Group III fax transmission or 9600-bps half-duplex file transfers between CoProcessors; menu-driven Connect software with fax, E-mail, and file-transfer modules; graphics editor based on PC Paintbrush; software available on four 5¼-inch or 3½-inch floppy disks

Hardware Needed
IBM PC, XT, AT, or compatible with 640K bytes of RAM, graphics adapter and monitor (CGA, EGA, or VGA), and hard disk drive; mouse recommended

Software Needed
MS-DOS 3.0 or higher

Option
2400-bps modem daughterboard: $295

Documentation
Installation booklet; 100-page User's Manual; 100-page Graphics Editor Manual

Price
$995

Inquiry 856.

nition software for converting text-based fax images to ASCII text format. As a result, you're limited to viewing and editing them with the graphics editor.

Intel says it's working with OCR vendors and will eventually provide upgraded software that will let you edit faxed documents as text files. In the meantime, the best alternative is to simply print out fax documents. To do so, however, you'll need a graphics-mode printer.

Setup's a Snap

I tested the Connection CoProcessor with the 2400-bps modem option on an IBM PC XT with an 80286 accelerator card, EGA graphics, an expansion unit, and an Above Board with 1.5 megabytes of expanded memory, which the CoProcessor automatically uses. The software that I used was version 1.0.

The Connection CoProcessor comes with a separate installation guide and two spiral-bound manuals—a general user's guide for the board and Connect software, and a guide for the graphics editor. As with other Intel products I've used, the installation documentation and procedures were easy to follow and straightforward. You install the modem card in the expansion socket on the CoProcessor board, set a DIP switch on the board specifying the serial port number (COM1 or COM2), and plug the board into the PC. There are also DIP switch settings for changing the I/O address for the board, but most users won't have to adjust them.

After installing the board, you plug the RJ-11 cables from the telephone and the phone-line wall outlet into the CoProcessor. This arrangement lets you use the same phone line for both your telephone and the CoProcessor. It also makes it possible to send files between CoProcessors during a voice-initiated call, although the procedure is rather involved.

Since I was using an expansion unit, I didn't have to worry about overloading the power supply. The CoProcessor consumes close to 3 amps at 5 volts, however, and the installation guide warns that the power supply on an old IBM PC or Compaq portable may not be adequate. If you have a machine with a 60-watt power supply, you may need to upgrade to a heftier power supply when you install the CoProcessor.

Software installation involves following a menu-driven installation program that updates your AUTOEXEC.BAT and CONFIG.SYS files and lets you configure the CoProcessor for your printer, graphics display, and input device. The CoProcessor software works fine with just the keyboard, but you should have a mouse for use with the graphics editor. The installation procedure also provides options for changing the communications parameters (e.g., number of rings or number of dialing attempts), but most users won't need to alter these settings.

Sending a Fax

Once the Connection CoProcessor is installed, you're ready to send your first fax. Sending faxes and files is simple. First, you execute the Connect program, which brings up the main CoProcessor menu. You select Fax from the main menu if you want to send faxes, or Transfer if you want to send files to other CoProcessors. Then you select the phone number (or a group of phone numbers) from your phone directory, select the file (or files) to send, and then either start the transmission immediately or specify the time at which you want it to occur. You can then exit from the program, and the CoProcessor takes care of the rest automatically.

In automatic answer mode, the CoProcessor is ready at any time to receive file or fax transmissions. You may be working away in your word processor, for example, and hear a beep signaling that the CoProcessor has received a call. As you work, the hard disk drive light will come on as the CoProcessor saves the file or fax. Later, you can execute Connect and view the received file.

Connect's menu-driven interface is easy to use and consistent: You simply move the cursor to the desired item and select it with the mouse button or Return key. When you first invoke Connect, it reports how many unread faxes, files, and mail messages you've received. Connect stores received files in a special directory, where you can view, print, delete, or save them. This is a temporary storage area, however, so you must select Save for all files you want to keep. If the received file is a text or binary file, you must save it before you can use it with other applications software (or before you can run it, if it's an .EXE file). If the received file is a fax image, saving it makes the file available for use with the graphics editor.

Connect maintains an internal log of files it receives, so you should always use Connect's file management utilities when deleting received files. If you fail to do this, you may have to completely reinstall the software.

One problem with Connect is that it's extremely slow when calling up a received fax image for viewing or editing; the process can take a couple of minutes for a complex image. An Intel spokesperson said that the company plans to address this problem in its next release.

Also, since there's more than one way to feed an image into a stand-alone fax, you may receive images upside down. You can use the graphics editor to rotate the image, but this takes time to accomplish and only works if the entire image fits on one screen. There is a similar problem with faxes that are oriented horizontally (landscape orientation). The only way to properly view such fax images is to print them.

You can also use the graphics editor to design cover pages for your fax transmissions or to create graphical images for conversion to fax image format. The edi-

continued

tor, which is a version of PC Paintbrush, has features for zooming, changing font styles, cutting and pasting, drawing patterns, and so on. The editor can also merge PIC files so that you can include Lotus or Symphony graphs in your documents.

The Phonebook utility is convenient for maintaining numbers of other fax machines. You can specify a group of phone numbers to which you want to send a fax, which is handy if you regularly send the same fax to several other fax machines. You can also create multiple phonebooks, though most users will probably require only one.

Other utilities include polling, which lets your CoProcessor automatically call other CoProcessors or fax machines to request file or fax transmissions. The polling feature conforms to the Group III standard, so you can use it with virtually any fax machine that supports polling. Polling lets you receive files at night when phone charges are lower, or receive a batch of daily transmittals from other offices at a specified time. You can also configure your CoProcessor to send a fax when polled by another fax machine.

The Hayes modem option includes an installation guide and a Hayes modem guide. It works like any other 2400-bps Hayes-compatible modem, but it fits onto the CoProcessor board instead of taking up an extra slot in your PC. You can't connect an external modem to the CoProcessor board, however.

Comparative Worth

The advantage of the Connection CoProcessor and other fax boards is their ability to fax text or graphics to offices that may not have a computer and modem but do have a fax machine. An additional benefit is that faxes received directly from a computer are much more readable than faxes sent from one fax machine to another, because they eliminate the need to print and scan an image into a fax machine before sending it.

The Connection CoProcessor is a well-designed and useful product. At $995, it's priced competitively with other fax boards that include a microprocessor, such as Panasonic's Fax Partner. If your remote offices have a CoProcessor, the 9600-bps binary-file transmission and E-mail capabilities are handy, and the board's optional 2400-bps modem saves valuable slot space.

The CoProcessor is also a good choice if you plan to use it extensively in background mode and can't afford any degradation in your system's performance. On the other hand, the CoProcessor accepts only PCX and ASCII text for faxes. If you want to fax TIFF, Dr. HALO, Microsoft Windows, Paint, or AutoCAD files, you'll have to look elsewhere (see "Fax Board Faire" by Brock N. Meeks, September 1988 BYTE).

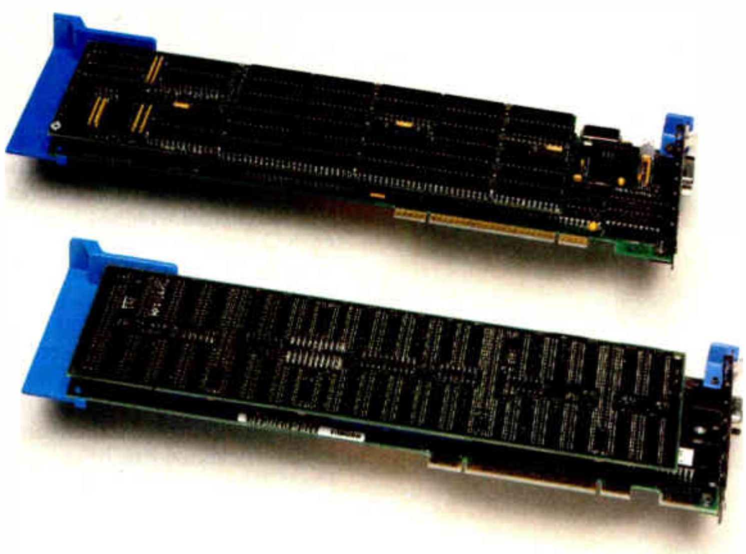
If CAS becomes widely supported, it could eventually be a strong plus for the Connection CoProcessor. Intel has lined up several major software vendors who plan to incorporate it into their applications. But the specification's success also depends on whether Intel opens CAS to other hardware developers.

CAS aside, however, the CoProcessor holds its own against other fax boards. It's elegantly designed and competitively priced, and it performs well. ■

Nick Baran is a BYTE senior technical editor based in San Francisco. He can be reached on BIX as "nickbaran."

Circle 240 on Reader Service Card

Pixels on the March



The Artist 10 MC (top) and IBM 8514/A (bottom).

The 8514/A and Artist 10 MC graphics coprocessor boards for the IBM PS/2s

Bradley Dyck Kliewer

Fast, high-resolution graphics systems were once the domain of computer-aided drafting and design (CADD) and specialized image-processing workstations for science and engineering. However, the past few years have shown advances in desktop publishing, multitasking systems, and business graphics, and these advances are pushing the limits of personal computer graphics standards. The current set of standard graphics adapters (CGA, EGA, and VGA) requires the software to individually calculate and plot each point (or pixel) on a graphics screen.

At the highest CGA resolutions (640 by 200 pixels), a graphics screen consists of 128,000 pixels—not an unreasonably large number for a reasonably fast computer. But at EGA resolutions (640 by 350 pixels), the number increases to 224,000, and VGA resolutions (640 by 480) have a total of 307,200 pixels. Not only is the pixel count greater, but with the additional colors available on the EGA and VGA, the memory requirements are drastically increased—from 16K bytes on the CGA to nearly 154K bytes on the VGA. Managing this ever-increasing memory load requires ever-greater processing time from the computer's CPU (the 8088, 80286, or 80386 for IBM PC compatibles)—time that is no longer available for other important computational tasks.

Graphics coprocessors (specialized graphics adapters with dedicated graphics microcomputers on-board) can help ease the burden on the CPU. Instead of calculating the position of every point on a line, the CPU tells the graphics coprocessor to draw a line from point A to point B. While the graphics coprocessor calculates and plots the pixels, the CPU is free to continue with other work.

In this review, I'll look at two graphics coprocessors for the IBM PS/2 Micro Channel architecture (MCA) computers. The system I used was a 16-MHz IBM PS/2 Model 80-071 running IBM DOS 3.3. Benchmark programs were written with BYTE's version of Small-C 1.0. I also ran standard BYTE graphics applications when the adapters supported them (since both of these adapters are fairly new, neither one has full support for all graphics-based packages).

8514/A

The 8514/A is IBM's graphics coprocessor board, based on a proprietary IBM chip set. The 8514/A is not particularly powerful, but its low price ($1350) makes it an attractive entry-level coprocessor. Installation is very easy: Simply plug the card into the correct slot (a special slot is available for video cards in the PS/2s) and run the automatic configuration software. The 8514/A has a piggyback memory card that makes it thicker

continued

IBM 8514/A

Type
IBM PS/2 graphics adapter

Company
IBM Corp.
900 King St.
Rye Brook, NY 10573
(800) 426-2468

Features
1024 by 768 interlaced pixels with an 8514 color display; 640 by 480 pixels with the 8503 monochrome, 8512 color, or 8513 color displays; 512K-byte graphics memory; 16 colors from a palette of 262,144

Size
11½ by 3½ inches

Hardware Required
IBM PS/2 with Micro Channel bus

Options
Additional 512K-byte adapter memory (brings total colors to 256): $270
Display Adapter 8514/A Technical Reference: $10
Display Adapter 8514/A Adapter Interface Application Developer's Guide: $25

Documentation
16-page Installation Guide

Price
$1350

Inquiry 857.

Artist 10 MC

Type
IBM PS/2 graphics adapter

Company
Control Systems
2675 Patton Rd.
P.O. Box 64750
St. Paul, MN 55164
(612) 631-7800

Features
Up to 1024 by 768 noninterlaced pixels; variable scan rate; 256 colors from a palette of 16.7 million; ADI drivers for use with AutoCAD release 9 and AutoShade

Size
11½ by 3½ inches

Hardware Required
IBM PS/2 with Micro Channel bus

Options
Graphics Controller Technical Reference Manual: free if ordered with Artist 10 MC; $30 if ordered subsequently

Documentation
40-page User's Guide
48-page ADI Drivers User's Guide

Price
256-color version: $3995
16-color version: $3695

Inquiry 858.

than a standard Micro Channel card. A clear plastic sheet covers the back of the piggyback card, preventing short circuits with neighboring cards.

The 8514/A provides four basic coprocessing services: drawing lines (including polylines, polygons, and boxes), filling areas, moving areas (BITBLT), and writing alphanumeric data. Another feature, which OS/2 will probably exploit, is the ability to save the adapter state (e.g., palette, default color, and current cursor position) for several concurrently running programs. With this feature, the adapter can switch the display between programs without side effects.

The adapter does not support circles, ellipses, arcs, or programmable modes. It does support user-defined proportionally spaced character sets. Unfortunately, the characters are not scalable, and you can load only one at a time; this severely restricts its potential for use in desktop publishing systems.

The 8514/A adapter includes 512K bytes of graphics memory (unlike memory on the CGA, EGA, and VGA, the computer cannot directly address memory on the 8514/A adapter). With 512K bytes, the adapter supports 16 simultaneous colors at either 640 by 480 pixels or 1024 by 768 pixels. You can add an additional 512K bytes of graphics memory to support 256 simultaneous colors. With either configuration, you select the displayable colors from a palette of 262,144. The 8514/A that I reviewed had a full 1 megabyte of RAM. The adapter also comes with a memory-resident program called the Adapter Interface.

The Adapter Interface permanently occupies 16,320 bytes of RAM. All drawing commands are sent to the Adapter Interface; thus, graphics programming remains independent of the actual hardware configuration. IBM does not publish the hardware interface, forcing developers to use the device driver. However, Microsoft obtained a copy under a special agreement and will use direct hardware control in its operating-system products. To date, only Microsoft Windows/286 uses the direct hardware interface; an 8514/A driver for Windows/386 was not available as of this writing.

The 8514/A is obviously faster than the VGA, but how you see the improvement may vary. The Small-C programs run much faster. Windows applications also have a slight edge, but the speed difference is much less dramatic. At first I was surprised that Windows did not show substantial improvement, but after I worked with the adapter, it became obvious that Windows' emphasis of bit-mapped graphics does not match the adapter's functions very well.

There is more to the 8514/A than speed; the additional resolution is a welcome enhancement. PageMaker could display two full, readable pages on the 8514 (although the characters were a bit small), and you can see larger portions of Excel spreadsheets (or larger portions of hidden windows if you don't increase the size of the current window).

At the highest resolution (1024 by 780 pixels), the 8514/A sends an interlaced signal to the display. This means that each time the electron beam scans the face of the display, every second line is drawn. On the next pass, the lines missed on the previous pass are filled in. This method of updating the screen can lead to annoying flicker on fine lines.

The IBM 8514 display compensates for the interlace with longer-persistence phosphors. This means that each colored dot on the face of the monitor glows a bit longer than on a typical, noninterlaced monitor—long enough so that it does not fade before the next pass, and the flicker is not noticeable (the phosphors are not as persistent as on the IBM monochrome monitor). Nevertheless, the 8514 display I used did not have a very sharp picture, and viewing it for extended periods became annoying. If I were in the market for an 8514/A, I would shop carefully for a monitor that gives a sharp picture without noticeable flicker.

Programming Video

The function calls are simple to use, thanks to a uniform calling convention, but the 8514/A has a very awkward command set. For example, it makes no provisions for plotting single pixels. Setting the current location or defining a line of a single point will not set a pixel. The only option is to make a 2-pixel line.

Filling areas is also a problem. Rather than selecting a point and filling to sur-

continued

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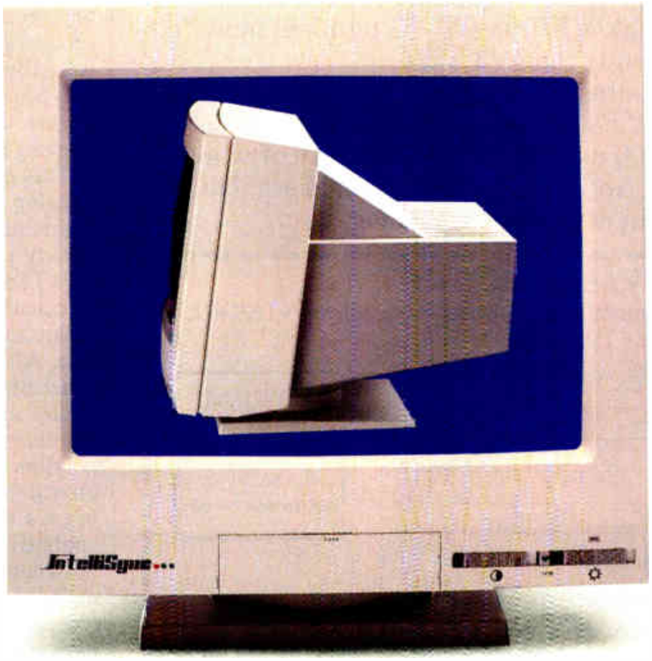

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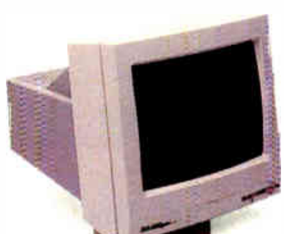

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Auto Vertical Frequencies	45–120 Hz	50–80 Hz
Inverse Video Option in MDA Mode	Yes	No
Selection of Text Color	Auto	Manual
Color Text Options	7	3
Dimensions (mm)	341(w) 346(h) 386(d)	369(w) 357(h) 406(d)
Weight	29(lbs)	31(lbs)
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Circle 9 on Reader Service Card

rounding borders, you must send a begin-area command, outline the area, and send an end-area command. This in itself would not be much of a problem, but each polygon or polyline defines an area. You cannot use multiple calls to the line-drawing routine to define a single area.

This created a problem for the circle drawing benchmark. [Editor's note: *The benchmark programs are available in a variety of formats. See page 3 for details.*] To fill the circle, all points have to be calculated, sorted in order around the circumference, and plotted with a single line. Also, filling the area between two concentric circles is very difficult (both circles and a line connecting their circumferences are plotted with a single polyline command). I took a simpler approach (which some might call cheating, but it's the way I would design such an application) by drawing lines across each horizontal chord. By working from the outside circle inward, I could have gotten a doughnut effect, although it would not have affected the times.

In a second test, I modified the circle routine to draw hexagons. This gave me a chance to test the automated filling algorithms against those of the Artist 10 MC. Again, the whole hexagon is filled, rather than the area between the hexagons. This probably explains the better fill times for the 8514/A versus the Artist 10 MC. The two adapters take very different approaches to area fills, making a true comparison difficult.

The Display Adapter 8514/A Technical Reference describes the 59 adapter commands. The manual does not incorporate any examples of program code, although it comes with a demonstration program and C language interface code (including source code for the demonstration program) on a disk. Information about the adapter hardware is sketchy; only the software interface is described in detail. The only hardware details given are lists of the memory and I/O addresses, with no indication of function.

The 8514/A passes VGA graphics through to the connected monitor unless an 8514/A program is running. Thus, software written for the EGA and VGA will work on the system. If you connect a second monitor to the VGA output, the VGA display continues normal output during 8514/A graphics execution. I used this feature for very effective debugging sessions (the debugger output continued on the VGA while the graphs were displayed on the 8514/A).

This feature could also be useful for other applications, such as CADD (menus on the VGA, drawing on the

8514/A) and spreadsheets (worksheets on the VGA, graphs on the 8514/A). Unlike the old CGA/monochrome combinations, both adapters can use graphics modes simultaneously.

Artist 10 MC

In contrast to the 8514/A, Control Systems' Artist 10 MC is a much more powerful (and, at $3695 and $3995, much more expensive) graphics coprocessor for MCA machines. It's based on the Hitachi ACRTC controller. Unlike the 8514/A, versions of the Artist 10 MC are available for PC, XT, and AT compatibles. Although the Artist 10 MC can run at the same resolutions as the 8514/A (in fact, the adapter I received was configured for the 8514 display), it is not compatible with the 8514/A.

With the right monitor, the Artist 10 MC supports 1024 by 768 pixels noninterlaced, and up to 1024 by 1024 pixels interlaced. The adapter is available in two versions: a 16-color 512K-byte model and a 256-color 1-megabyte model (the reviewed configuration). The colors are selectable from a palette of 16.7 million. Control Systems does not make a 16- to 256-color upgrade kit.

At this time, the only software packages the Artist 10 MC supports are AutoCAD release 9 and VersaCAD. According to Control Systems, drivers for Microsoft Windows are under development, but they were not yet available at the time this review was written. The Artist 10 MC is clearly targeted for the CADD market, and its abilities are well suited to the demands of CADD. The complete hardware interface is fully documented in the 300-page Graphics Controller Technical Reference Manual.

Like the 8514/A, the Artist 10 MC has hardware support for lines, area fills, and BITBLT. It also supports zooming, multiple virtual displays with programmable dimensions and bit planes, single pixel plotting, circles, ellipses, and arcs. The Artist 10 MC can also copy memory blocks between the adapter memory and machine RAM via the host machine's direct-memory-access controllers (these DMA controllers can copy memory from one location to another much more quickly than the CPU can).

Installing the Artist 10 MC is a bit more involved than installing the 8514/A. Because the Artist 10 MC is designed to work with a variety of high-resolution monitors, you must make sure the adapter is set properly for your monitor. This involves checking the oscillator crystal frequency (stamped on the metal

continued

Table 1: *Benchmark data. All times are in seconds (N/A = not applicable).*

	VGA	8514/A	Artist
Resize PageMaker to full screen*	1.44	1.92	N/A
Resize PageMaker to approximately 640 by 480 pixels*	1.44	1.26	N/A
Small-C circles (100 iterations)	430.56	15.27	12.74
Hexagons (100 iterations)	N/A	4.50	11.70

*Timed with stopwatch, average of 10 trials.

package), ensuring the correct programmable-array-logic (PAL) chip is installed (this is an issue with the 8514 display only), and setting a jumper for the location of the SYNC signals. You can also set a jumper for single- or dual-monitor configurations (which allows/disallows VGA signals to pass through to the Artist 10 MC's display). Software can override the jumper settings, but you must make sure the crystal and PAL are correct. Like the 8514/A, the Artist 10 MC also uses a piggyback card. A thoughtful layout keeps the jumpers accessible when the piggyback card is installed.

Synchronization and scanning frequencies can vary from monitor to monitor, so you must match the setup parameters to your particular monitor; improperly matched parameters can make the display unreadable or off-center. The Artist 10 MC includes 57 monitor initialization files, one for each mode of every supported monitor. Each time you run the supplied demonstration programs, you are prompted for your monitor type and mode (you can restrict the list by deleting unnecessary files). Fortunately, the Artist 10 MC includes an installation program for AutoCAD that builds a driver file based on one initialization file; this keeps the program from prompting for a monitor every time AutoCAD starts. If you write your own programs, you can also make a more permanent record of the initialization file.

Programming the Artist 10 MC

Control Systems' Technical Reference manual covers its family of Artist 10 Series of graphics controllers. The manual thoroughly covers the hardware details, but it falls short as a programming reference. The only source code in the manual covers DMA transfers with the host system.

The manual's information is sometimes out of date with regard to the Artist 10 MC. For example, the address of the FIFO register (through which all drawing commands and data pass) is incorrect. Fortunately, some portions of the demonstration program loop through hundreds of drawing commands, and I was able to find the correct address with the aid of a debugger.

Control Systems also supplies a handy

Circle 82 on Reader Service Card

program called HITDUMP, which dumps the contents of the ACRTC registers. The most reliable method for determining correct mode-parameter settings requires running the demonstration program under a debugger, breaking execution during the drawing commands, returning to DOS, and then running HITDUMP. If you are interested in programming the Artist 10 MC, you may want to have a copy of the BYTE benchmark programs handy to fill in the gaps in the documentation.

Because the adapter has no standard call interface or mode settings, it is the programmer's responsibility to set all the relevant parameters (e.g., starting address, dimensions, and timing data). This makes setting the mode a very complicated task. Fortunately, the monitor initialization files are a handy and easy-to-read source for the required information, but writing the program to set all the registers is still an arduous task.

On the other hand, sorting through all the data is a good learning experience and can reveal interesting details about the adapter. For example, a bit in the operation mode register, normally set only during initialization, can limit drawing to the horizontal retrace period (a method that eliminates flicker when images are rapidly changing) or allow updates at any time during the display cycle (which speeds operations).

Unfortunately, I was not able to get a copy of AutoCAD release 9 in time to test the drivers. However, I did adapt the BYTE Small-C graphics benchmarks (see table 1). Note the improved time for drawing circles—under the times for both the VGA and the 8514/A. The Artist 10 MC does a true flood fill (the hardware scans for color boundaries while filling), which requires more overhead than IBM's method. But having the circle computations built into the hardware more than offsets the time lost in filling. Support for arcs, circles, and ellipses makes the Artist 10 MC a good choice for CADD applications.

Like the 8514/A, the Artist 10 MC can pass VGA through to the high-resolution monitor. When the Artist 10 MC is in its resident-graphics modes, the PS/2's VGA output continues to display. Once again, I was able to view the debugger on the VGA while running Artist 10 MC graphics programs (this was even more important on the Artist 10 MC, since getting the mode parameters correct was crucial for obtaining a readable display).

Different Emphasis

Programmers will find either of these cards easier to program than bit-mapped graphics adapters. If you program the 8514/A, you will spend most of your time writing programs that work around its limitations. With the Artist 10 MC, you'll probably find a built-in command that provides the necessary function, but it will be more difficult to implement (of course, you can gradually build a library of functions to support later programs; the BYTE benchmarks might make a good starting point).

Because the Artist 10 MC has no preprogrammed modes, writing the first program is about as difficult as a typical EGA or VGA program. Once you have a library, it's much easier to write code for the Artist 10 MC than for the 8514/A. With either adapter, you should have a second monitor for the VGA.

From the perspective of an end user,

continued

the IBM 8514/A and Artist 10 MC really seem targeted at vastly different audiences. The 8514/A seems best-suited for budget-conscious people who need a little more resolution or a bit faster performance than the VGA provides. Despite the lack of substantial speed improvements, the 8514/A seems best-suited for Windows applications where lines are straight, boxes are filled, and windows are moved more than average. It does not seem to be designed for CADD applications. Coming from IBM, the 8514/A is likely to set a standard for entry-level graphics coprocessors.

Just as other manufacturers have expanded the EGA and VGA specifications, I expect to see 8514/A-compatible adapters that add to IBM's functions. Again, like the EGA and VGA, probably two levels of compatibility will surface: software interface (which could easily be adapted to many coprocessors currently on the market), and register-level compatibility (which would require a special design effort from the manufacturer).

The Artist 10 MC is clearly aimed at the CADD market. Its two existing drivers are for the best-selling PC CADD programs (and its price brings the entire system into the graphics workstation range). It is also a very well documented adapter, although it would be nice to have a software library, especially for setting the mode. Programmers with large budgets and little concern for PC standard graphics might like this card.

Both adapters allow VGA to pass through to the primary display, and both allow the use of a VGA as a secondary display. This is a significant point, since neither adapter forsakes programs written for the EGA or VGA.

It wouldn't hurt to try running some of your applications on the adapter to see whether it feels any faster or will speed your typical operations. Windows may move around the screen a bit faster, but how often do you move windows? You might also find the added resolution worth the price. With the 8514/A, larger portions of windows are visible, and full, readable pages can be displayed; both could be advantages if you frequently work with large layouts or spreadsheets. However, before purchasing a graphics coprocessor, you should make sure your software supports the adapter. ■

Bradley Dyck Kliewer is the author of EGA/VGA: A Programmer's Reference Guide *(New York: McGraw-Hill, 1988) and owner of DK Micro Consultants, a microcomputer consulting business. He can be reached on BIX as "bkliewer."*

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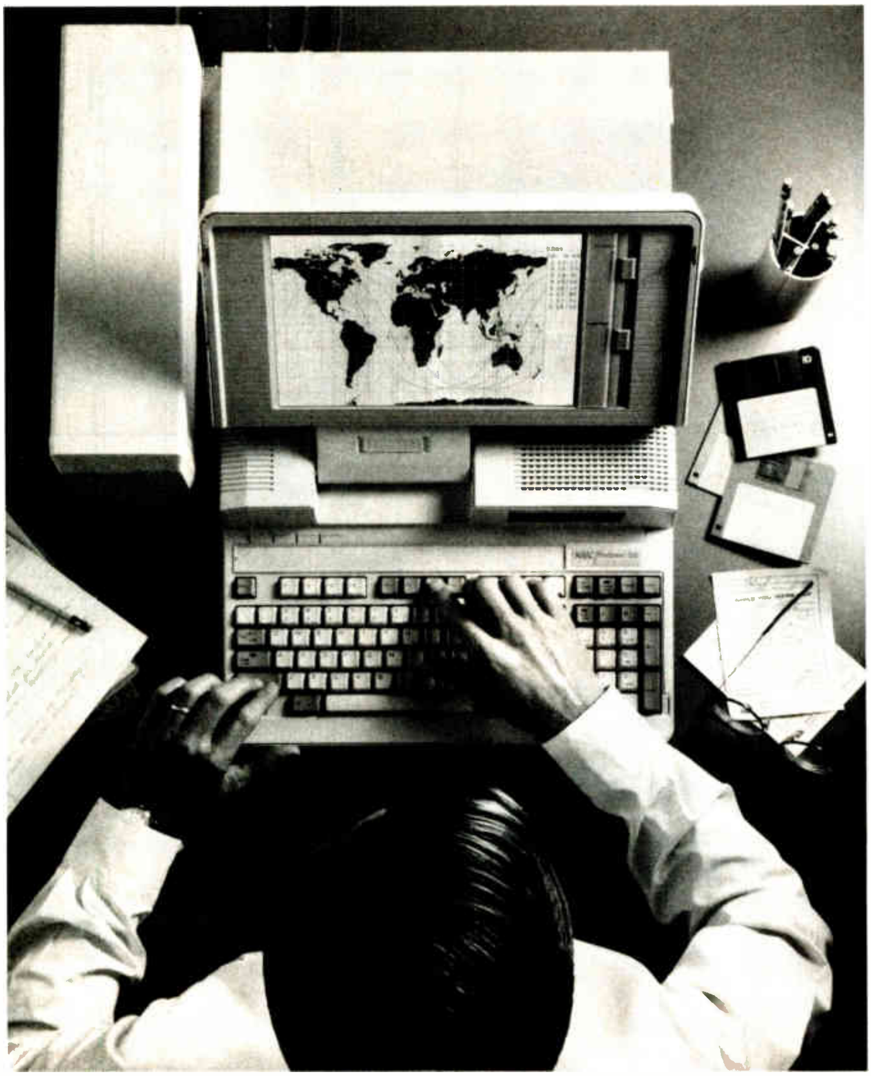

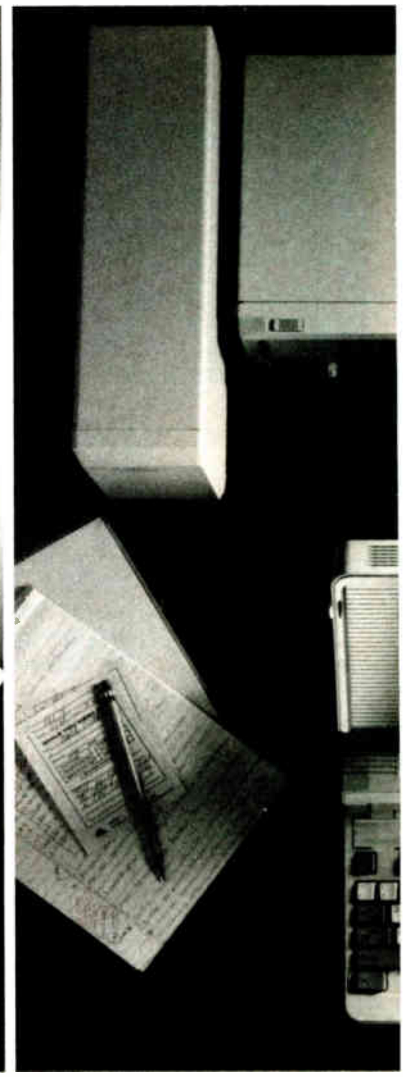

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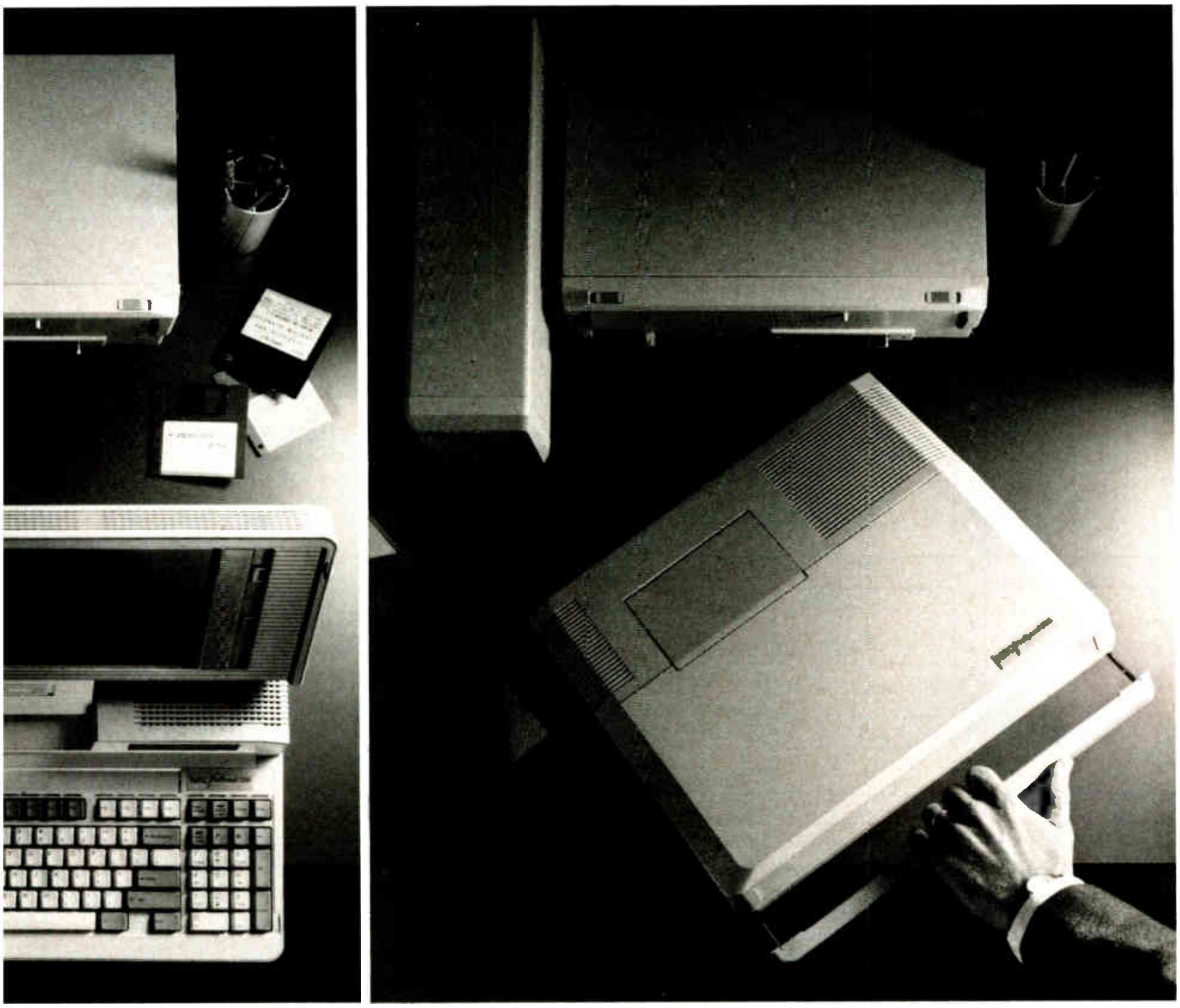

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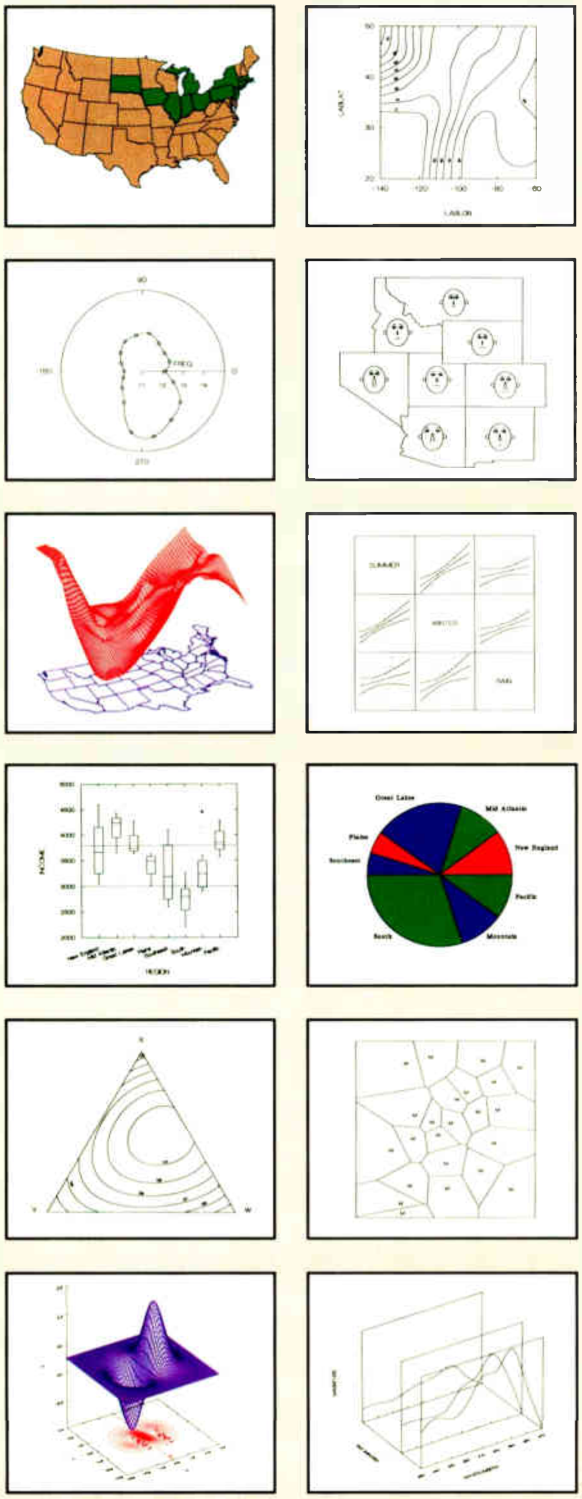

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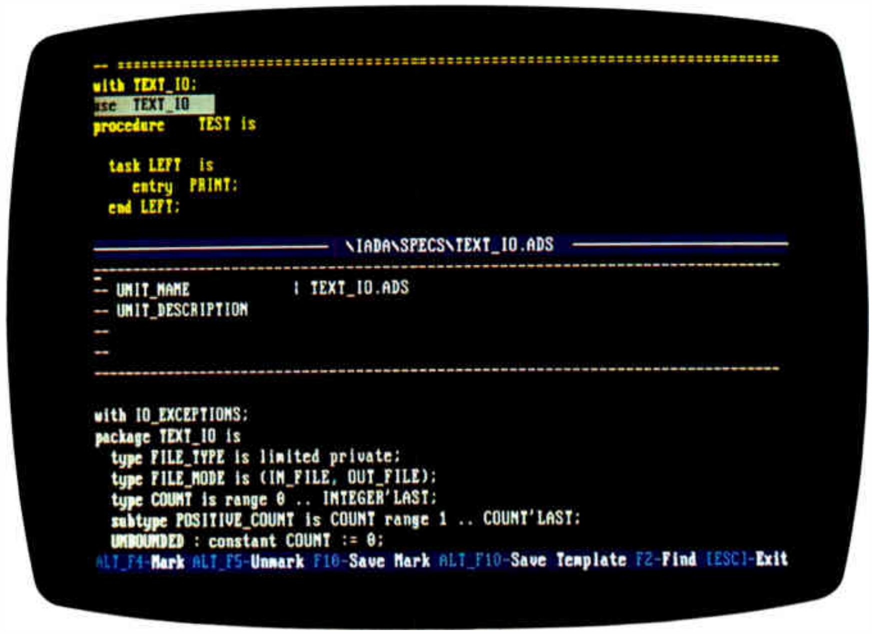
IntegrAda

An Ada Programming Support Environment for the PC

Karl Nyberg and Jon Udell



IntegrAda from AETECH is a PC-based Ada Programming Support Environment. In a document entitled "Stoneman" (1980), the Department of Defense outlined its vision of an APSE. That document calls for a toolset that supports the complete software life cycle from design to maintenance. A compiler and a linker (binder) are obviously required; additional tools that "Stoneman" calls for include a database, a text editor (preferably Ada-oriented), a pretty-printer (a source code reformatter), a static program analyzer (a cross-referencer), a debugger, and a file administrator.

In comparison, the IntegrAda 4.0 environment features an Ada-oriented editor that constitutes the interface to a compiler, a binder, some of the recommended APSE tools, and a tutorial on Ada programming. The APSE tools include a syntax checker, a pretty-printer, and a library browser.

IntegrAda's compiler is licensed from RR Software, maker of the Janus Ada compiler. The binder and syntax checker are also RR products. AETECH packages these tools with its editor to create an integrated programming environment that invites comparison with the Borland language products in that you can compile, bind, and execute an Ada program without leaving the editor.

IntegrAda will run on any 8086, 80286, or 80386 computer equipped with a hard disk. It requires a full 640K bytes of memory and needs all of it—you can't run memory-resident utilities while using IntegrAda. The installation program worked smoothly, copying the contents of the eight 5¼-inch floppy disks to directories that it creates on the hard disk. It transfers the files into two directory structures located at the root of directory C:. There's no option to locate these structures in a subdirectory of C: or on another drive. The installed system consumes slightly more than 3 megabytes of your hard disk.

Getting Started

You invoke IntegrAda at the DOS command line with the command `iada`. The editor prompts for your name and the name of a file to edit and then loads that file into a buffer (or presents an empty buffer if the file is new). The basic editing functions are bound to two sets of keys. One set of bindings emulates WordPerfect, and the other (following Borland) emulates WordStar. Unlike the Borland products, IntegrAda doesn't provide a mechanism for altering the key bindings; unless you're already a WordPerfect or WordStar user, you'll have some learning to do.

A menu-driven help facility attached to F3 documents the basic editing keys and the keys that invoke tools like the compiler, syntax checker, and binder. We loaded TEST.ADA, a demonstration program, and worked through the process of compiling and running it. Control-F4 runs the syntax checker—a parser that can find simple mistakes like missing semicolons and misspelled keywords much faster than the full-blown compiler can. Each time it finds an error, it returns control to the editor; the editor highlights the error, displays an appropriate message, and puts you at the right spot to fix it. We ran the syntax checker a few times to find and fix the errors intentionally placed in TEST-.ADA, then tried the pretty-printer at-

continued

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tached to Control-F8.

The pretty-printer supports three styles: Program Structure, MIL-STD-1815A, and First Letter Capitalized. The Program Structure style uses indentation to show logical structure and vertical lines to match the beginning and end of case, if, loop, and record statements. The MIL-STD-1815A style converts reserved words to lowercase and all user-defined identifiers (e.g., procedure and function names, variables) to uppercase. The First Letter Capitalized style, as its name suggests, capitalizes the first letter of all reserved words and identifiers. IntegrAda displays the reformatted text in a separate buffer; in the case of the latter two styles, you can replace the original text with the pretty-printed version.

The pretty-printer didn't work properly on TEST.ADA; it got confused by the task bodies contained in the program and displayed the wrong logical structure. AETECH has acknowledged the bug and promises to fix it in a forthcoming release. We subsequently found that the pretty-printer does work properly on most Ada constructs.

Next we used Control-F6 to invoke the compiler. The program compiled with no difficulty, but we found that the editor/compiler interface has some annoying peculiarities. When the compile finished, the editor told us so but didn't say whether or not there had been errors. We had to use Control-L to view the compiler's output and then had to confirm that TEST.LST was the file we really wanted to view. The editor then displayed a lengthy report from the compiler. At the end of nearly a page of messages from the various phases of the compiler, we found what we were looking for: "Compilation Successful." You can use Control-F5 to locate and fix errors, but it's frustrating to have to view the compiler's output to determine whether or not there are, in fact, errors to fix.

The binder, attached to Control-F7, works like the compiler. It too requires that you view a report to determine whether binding was successful. We ran the binder, checked the results, and then used Control-F9 to run the sample program; it simply echoed some text to the screen.

An Ada-Oriented Editor

The editor has three modes: text, Ada-sensitive, and design. There should be an indication of the current mode somewhere on the screen, but there isn't. In text mode the editor works like a simple text editor—albeit one that doesn't handle lines longer than 80 characters. Ada-sensitive mode—the default—is the standard mode for Ada programming. In this mode the editor adjusts its level of indentation in an attempt to show the program structure. Unfortunately, the results aren't always what you expect.

Listing 1 shows the beginning of TEXT2_IO.ADS, the specification for the alternate TEXT_IO package provided by AETECH. Listing 2 shows what happens when you type that text under control of the IntegrAda editor. The keyword package indents for no apparent reason. The type declarations indent properly, but the extra line between the type and subtype declarations ends the declarative region prematurely; the subtype declarations, which belong logically at the same level as the type declarations, end up flush left. AETECH acknowledged that indentation following a `with` isn't correct. The problem with the indentation of the subtype declarations was the extra line of space; the editor is sensitive only to a single line of previous context.

A more useful feature of Ada-sensitive mode is the editor's ability to supply templates for common Ada constructs: packages; all the standard type declarations; procedures; functions; tasks; and loop, if, and case statements. These templates are attached to the Control-F1 and Control-F2 keys. Listing 3 shows what happens when you construct the beginning of TEXT2_IO.ADS using templates for the package specification, the type declarations, and the procedure declaration. For example, to declare the subtype POSITIVE_COUNT, you select `derived` from one of the template menus and supply the name POSITIVE_COUNT. IntegrAda inserts the declaration and positions the cursor in the right spot for filling in the range constraints. This method works better than manual text entry—there's less typing, and program structure falls naturally into place.

Note that IntegrAda automatically instantiates the appropriate generic I/O package for integer and enumeration types that you declare. That might be useful in some contexts, but in this case the instantiations aren't needed.

The Ada-oriented mode of the editor works in conjunction with a tool that browses through the specifications (.ADS files) in the library (one or more directories on your path). Some background: Ada programs are organized into packages. A package has a specification, which can include what ANSI C calls function prototypes, and a body that implements functions named (exported) in the specification. When you want to write a call to a procedure or function exported by some package in the library, you can review the appropriate specification and capture a portion of it. Say you need to write a call to GET_LINE in the TEXT_IO package. You invoke the browser and select TEXT_IO. The editor splits the screen horizontally and puts your Ada program in the top window and TEXT_IO.ADS in the bottom window.

At this point, you're supposed to be able to use the editor's search function, bound to F2, to locate GET_LINE's declaration. We found that F2 didn't work in this context (AETECH acknowledged the bug and said it will be fixed in a forthcoming release), but we were able to locate GET_LINE by scrolling through the buffer. Once you've found the declaration, you mark its extent, save it to a temporary file with Alt-F10 (which returns you to your original buffer), then recall it with Alt-F10. IntegrAda transforms the declaration into a call, names the formal parameters, supplies TBD

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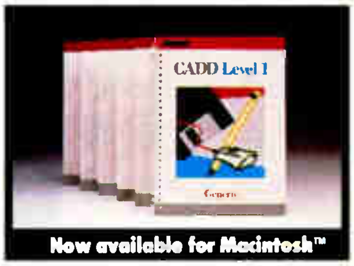

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ment. Oddly, the IntegrAda manual makes no mention of RR or its compiler; the only reference to it appears in a copyright notice at the beginning of all the compiler's outputs. AETECH seems to want to hide the identity of the resident compiler. You'd think it would be proud of the foundation of its product—particularly since the Janus Ada compiler, originally criticized for implementing only a subset of Ada, has matured and has recently received good reviews as a credible, low-cost Ada compiler. At times AETECH's contortions are almost comical, as when the IntegrAda manual defines .JRL files (Janus relocatable) as "IntegrAda compiler relocatable."

You can set compiler/binder switches from within IntegrAda. One switch governs the use of a virtual disk, in conjunction with VDISK.SYS. Others govern optimization, generation of debugging code, and the elimination of unused subprograms. You can set the target machine—it's an 8086 by default, but the compiler can produce 80186-, 80286-, or 80386-specific code. The compiler can generate emulator- or coprocessor-based floating-point code; it's an either/or situation, though, and you can't create a single executable program that will use the coprocessor (if one is present) and emulate otherwise.

A compilation can create three kinds of object files. In general, package specifications produce two outputs: an .SYM (symbol) file that transmits information about the package to other compilation units and an .SRL (specification relocatable) file that contains the specification's code. Package bodies—which other compilation units don't refer to directly—produce code only, in the form of a .JRL file. The compiler derives the root name for these files from the name of the package or main subprogram you're compiling.

DOS, of course, limits the filename to eight characters, but Ada imposes no such limitation on the names of Ada entities. The compiler tries to use the first eight characters of an Ada name but in case of conflict will use the first five characters, a dollar sign, and two arbitrary characters. To avoid conflicts, it would probably be best to limit the length of Ada names that will map to DOS filenames.

The binder operates on a file that contains a parameterless main procedure. It collects all objects named in that unit and (transitively) all units on which the main unit depends, then binds them into an executable program. It doesn't use the name of the main procedure's file as the root of the .EXE name that it creates; rather, it prompts for the name of the main procedure. Again, Ada doesn't require that you restrict that name to eight characters, but in practice you probably should.

The IntegrAda implementation of an Ada program library is minimal; the nature of it isn't immediately obvious and isn't spelled out in the manual. The library is simply the collection of .SYM, .SRL, and .JRL files in the directory C:\IADA\COMPILER. The compiler and binder can access the library because the tool that invokes IntegrAda sets a DOS path that includes that directory. That's slightly odd; normal DOS convention is to use the path to name directories that contain programs and to use other environment variables (e.g., `lib`) to name directories that contain data. To create a new library, you make a directory, add it to the path, and copy compilation results

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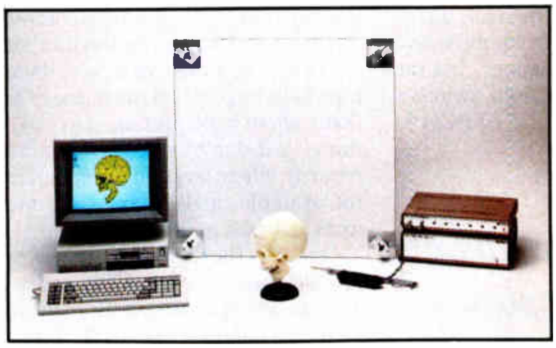

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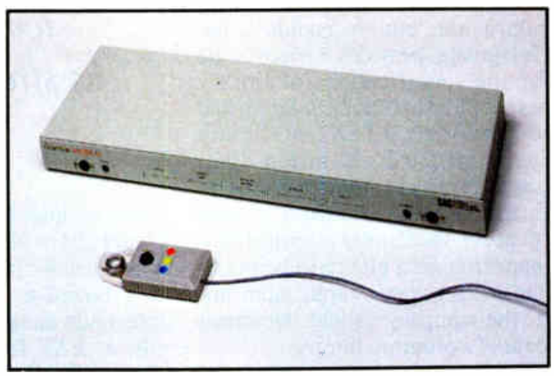

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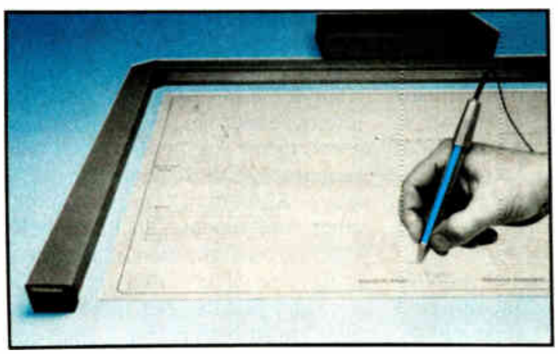

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to it. There's no mechanism for aggregating the contents of a library into a single object. You can, of course, use an ARC utility to bundle library files for transport, but IntegrAda itself requires loose files.

The notion that such a collection of files constitutes a program library takes getting used to. When we first started using the system, we recompiled the package specification for TEXT_IO. We copied the resulting files to C:\IADA\COMPILER—replacing the originals—then started looking for the library tool. Of course there wasn't one, and we'd just succeeded in corrupting our program library. Here's why. Ada enforces compilation dependencies. The package body (TEXT_IO.ADB) depends on its specification (TEXT_IO.ADS). Since we'd updated the specification, and since the body depends on it, we'd have needed to recompile it too, but we couldn't, because IntegrAda provides source code only for the specifications of library packages, not for their bodies. So we had to retrieve the original TEXT_IO library modules from the installation disk, where, as it turns out, they're stored in ARC format. AETECH should at least write-protect the library modules—which appear at first glance to be modifiable but in fact aren't—and, more important, the company should document its concept of a program library.

IntegrAda provides the source code for specifications solely for use by the library browser. It knows about the directory structure in which the .ADS files are stored and presents a nice menu-oriented interface to them in support of the editor's template-capture facility. Unfortunately, that structure is hard-coded. You can't modify the directory structure that the browser accesses to include new directories with specifications that you write. It will, however, find specifications in your current working directory, and you can also import specifications from a directory that you've named explicitly.

Documentation and On-Line Help

The IntegrAda manual is poorly organized, typographically shoddy, and full of errors. Concepts critical to an understanding of the product—such as Ada design language, program libraries, and template-oriented program editing—are introduced in a roundabout manner or completely ignored. There is no index. Reference and tutorial sections appear in apparently random order. Examples in tutorial sections don't match what you actually see on the screen. The term "Ada Workstation Environment" appears several times, but the manual never defines what that means. AETECH promises to upgrade the manual in a forthcoming release, but it has a long way to go to meet minimal expectations.

Particularly annoying is the manual's failure to deal accurately with the underlying technology licensed from RR Software. Near the end of the manual, a section explains how to use the compiler and binder in a stand-alone manner, but the documentation of the required switches is incorrect; we had to call AETECH to find out how to run the compiler and binder from the DOS command line. And when we invoked a function supposedly bound to Control-F10—which the IntegrAda manual says will enable you to edit a .BAT file that automates stand-alone compilation—nothing happened; as it turns out, the file (COMP.BAT) doesn't exist. The section on manual operation of the binder refers to a linker manual (presumably RR Software's) which, again, AETECH has failed to provide. In another section, there's a reference to CORDER, a compilation-order tool from RR, but AETECH didn't bundle that tool with IntegrAda.

The editor's ability to import templates is its strongest asset.

The on-line help is considerably better than the printed manual. You can find out about all the program's functions by poking around in the menu-driven help facility. There's also a tutorial on Ada, called the Ada Training Environment, which presents a series of brief but informative lessons on basic Ada programming concepts. You could easily overlook this tutorial, though; it's not highlighted in the manual, and we just stumbled upon it while poking around in the product.

Ada for the Rest of Us?

IntegrAda aims to do for Ada what the Borland language products have done for Pascal, C, and Prolog—namely, provide an effective integrated programming environment. IntegrAda does implement an integrated environment, but one that falls far short of the standard Borland has set. The editor is not reconfigurable, so you're stuck with the default key bindings. In Ada-sensitive mode it's often unclear what rules of indentation the editor is applying. The editor's ability to import templates is its strongest asset, but here too you tend to get strangely formatted results. The editor/compiler interface is awkward; you shouldn't have to ask to see the results of a compilation and then have to confirm the name of the file that's about to be presented to you. Some things just don't work—you can't search for text when browsing a specification, for example, and the pretty-printer formats task bodies incorrectly.

Despite these flaws, however, the product can be used to compile, bind, and execute Ada programs in an environment that shields the user from DOS. The syntax checker speeds development significantly. These qualities, in conjunction with a reasonable price and a useful Ada tutorial, may qualify IntegrAda for use in educational settings, particularly when students are new to both Ada and DOS (although AETECH's main competition in this market is, ironically, RR Software).

But the product as it stands has serious limitations. The absence of a compilation-order tool (which the manual frustratingly alludes to but AETECH didn't license from RR) is one major drawback. Unlike other languages, Ada requires that you submit compilation units to the compiler in an order that reflects their interdependencies. When an Ada system grows to any substantial size, it's hard to keep track of those dependencies. That's why "Stoneman" recommends (and other Ada vendors, including RR, provide) a configuration manager—something like Unix `make` or the Borland `project` feature, but more complex in that it must both derive a legal compilation order for a group of units and then execute a script that compiles them. The minimalistic program library is another big drawback; "Stoneman" calls for a database more sophisticated than the DOS file system. Because IntegrAda doesn't provide these kinds of APSE tools it's a poor choice for large Ada programming projects. ■

Karl Nyberg is founder and president of Grebyn Corp., an Ada and Unix consulting firm in Vienna, Virginia. You can reach him on BIX c/o "editors."

Jon Udell is a technical editor for BYTE. He can be contacted on BIX as "judell."

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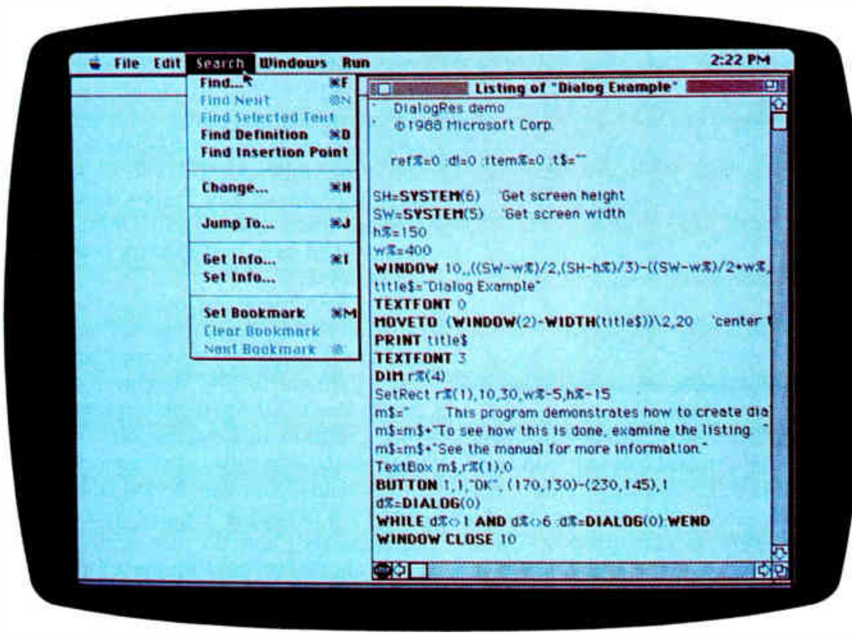
QuickBASIC Comes to the Macintosh



A handy tool for exploring the Toolbox and building Macintosh applications

Namir Clement Shammas

Microsoft has united two popular Macintosh language products—its BASIC interpreter (version 3.0) and its BASIC compiler (1.0)—to form an integrated environment for programming the Mac. The result: QuickBASIC for the Macintosh ($99).

But don't confuse this BASIC with its IBM PC cousin, QuickBASIC 4.0. The two BASICs differ in fundamental ways. Applications written in one dialect aren't likely to port to the other without extensive recoding. And the Mac version of QuickBASIC I tested here implements a less sophisticated dialect of BASIC than does the PC version.

However, once you've sorted out its lineage, Macintosh QuickBASIC 1.0 emerges as a fast and flexible tool for building real Macintosh applications. To use it, you'll need at least a Mac Plus. Microsoft provides two versions of the program. One supports binary arithmetic, and the other supports slower but more precise binary-coded decimal (BCD) arithmetic.

Not Created Equal?

There are many implementations of BASIC. To give you a feel for this one, I'll enumerate some of its features; check table 1 for a feature-by-feature comparison of the Mac and PC QuickBASICs.

Macintosh QuickBASIC supports strings, integers, long integers, and both single- and double-precision reals. It doesn't support constants, though you can emulate a constant with a function that simply returns the desired value. You use DIM to dimension an array, or you can use an array variable that you haven't explicitly created by simply referring to it—QuickBASIC automatically allocates 10 elements per dimension.

The OPTION BASE (lowest array index) is 0 by default; you can change it to 1. The predefined functions LBOUND and UBOUND return the lower and upper boundaries of a specified dimension of an array.

Branching constructs are single-line IF, multiline IF (with optional ELSEIF clauses), and SELECT CASE. With SELECT CASE, a CASE label can take an individual constant (e.g., CASE 1), a range of constants (e.g., CASE 1 to 4), or a list of constants and ranges (e.g., CASE 1 to 4, 5, 7 to 9). The looping constructs are FOR...NEXT and WHILE...WEND.

There are three calling mechanisms: functions, subroutines you can branch to, and subroutines you can call. DEF FN creates a one-line function. The GOSUB...RETURN pair implements the classic BASIC subroutine—a branch to a label (or line number).

SUB, END SUB, EXIT SUB, and CALL implement a true structured subroutine capability. SUB and END SUB define the extent of a subprogram. EXIT SUB effects a return. CALL invokes a subprogram (actually, it's optional; CALL SQUARE(X) and SQUARE X are equivalent).

QuickBASIC passes arguments by reference, so a called subprogram can alter its arguments. You can get call-by-value by wrapping parentheses around an argument; that transforms the argument into an expression and forces QuickBASIC to send the subprogram a copy of it. To protect a number from an errant SQUARE

continued

Table 1: *A comparison of Macintosh QuickBASIC 1.0 and IBM PC QuickBASIC 4.0. The IBM PC version of QuickBASIC provides many advanced features that you won't find in the Macintosh version.*

Language feature	Macintosh QuickBASIC	IBM PC QuickBASIC
Long integers	Yes	Yes
User-defined structures	No	Yes
Constants	No	Yes
Static/dynamic arrays	Yes (compiler)	Yes
Loops		
FOR...NEXT	Yes	Yes
WHILE...WEND	Yes	Yes
DO...LOOP	No	Yes
DO WHILE...LOOP	No	Yes
DO...UNTIL	No	Yes
Decision making		
Multiline IF	Yes	Yes
SELECT CASE	Yes	Yes
CASE with expressions	No	Yes
Multiline DEF FN	No	Yes
FUNCTIONs	No	Yes
CALLable SUBs	Yes	Yes
LBOUND and UBOUND	Yes	Yes

function, you could write CALL SQUARE((X)).

QuickBASIC supports sequential and random-access file I/O. Filenames must follow the Hierarchical File System (HFS) naming convention. Predefined I/O devices include SCRN:, KYBD:, LPT1:, COM1:, and CLIP: (the Clipboard). The Clipboard is particularly interesting. You can use it to write QuickBASIC programs that export text or graphics for use by other applications or that import text or graphics for their own use.

In QuickBASIC you gain access to external libraries using the LIBRARY statement. You can use up to eight external libraries at once and CLOSE them when they're no longer needed. The manual does a good job of describing how to create your own libraries in C or assembly; the distribution package includes sample library material written in MPW C, Lightspeed C, MPW Pascal, and assembly language. QuickBASIC provides a collection of support routines for developing external libraries; they facilitate, among other things, the communication of arguments between QuickBASIC and your routines.

The QuickBASIC Environment

When you launch QuickBASIC from the Macintosh desktop, you enter the interpreter. Its top-level menu contains, in addition to the standard File and Edit selections, Search, Windows, and Run selections. Two windows appear. The active window is connected to QuickBASIC's built-in editor; that's where you write, edit, and debug your program. The other window—at first inactive—is the one that receives your program's output.

You can open a third window by way of the Windows selection on the menu bar; it contains a command line that you can use to interactively execute single BASIC statements.

The editor is syntax-oriented—which here means that it maintains your current level of indentation within blocks and displays BASIC keywords in boldface. When you're editing a program, the Search menu supports a variety of navigational aids. You use Find and Find Next to locate a text string. If you're positioned on a call to a subroutine, you can use Find Definition to locate that subroutine's definition, and Find Insertion Point to jump back to your original position. Jump To takes you to a specified line in your file. Finally, you can use Set Bookmark to mark places in a file that you can then jump to with Next Bookmark.

QuickBASIC provides an interesting form of on-line help. If you're positioned on a BASIC keyword (a language construct like WHILE, or a library routine like CIRCLE), you can use another selection on the Search menu, Get Info, to view a short description of the term. It's particularly useful as a quick way to find out the order and types of arguments to library functions.

However, I'd like to see more information; function prototypes are helpful, but examples would be a welcome addition. You can extend the help system with Set Info, adding one-line descriptions of your own BASIC subroutines. It's a nice feature, though I'd like to be able to write longer descriptions.

Once you've written your code, you can invoke the QuickBASIC interpreter from the Run menu. If there's an error, the interpreter and editor conspire to locate it, frame it, and position the text cursor at the right spot to fix it. Otherwise the program simply runs—slowly, of course, since QuickBASIC must interpret it—and its output appears in the output window.

The Run menu provides several debugging tools. Run Program does what I've just described. Step frames and executes a single BASIC statement. If you toggle Trace All on, the interpreter runs your program in slow motion, framing each statement it executes; you can stop things with Command-Period and toggle Trace All off again. Finally, you can set breakpoints. You do this with Breakpoint On/Off on the Run menu; clicking on it makes a Stop icon appear or disappear at the beginning of the current line. Alternatively, you can drag a copy of the Stop icon that lives at the bottom of the edit window to the line at which you want to break. When execution reaches the breakpoint, the interpreter sounds an alert and frames the breakpoint icon. You can select Continue from the Run menu to proceed to the next breakpoint.

QuickBASIC doesn't support watch variables, but you can use the command window to examine variables. Whenever the program is quiescent—that is, you've explicitly stopped it, it's between steps in single-step mode, or it's halted because of a breakpoint—you can open the command window (or bring it to the foreground if it's open but not active) and use BASIC's PRINT statement to print the value of your variable. Since you're inserting the PRINT statement into the flow of your program, the output goes to the same window that your program is using and can cause a conflict.

But the command window is a powerful tool. From it, you can execute any

continued

Macintosh QuickBASIC 1.0

Type
BASIC interpreter and compiler

Company
Microsoft Corp.
16011 Northeast 36th Way
Box 97017
Redmond, WA 98073
(206) 882-8089

Format
Two 800K-byte 3½-inch floppy disks

Language
Assembly

Hardware Needed
Mac Plus, SE, II, or IIx with one 800K-byte disk drive; hard disk drive recommended

Software Needed
System 4.1 or higher; Finder 5.5 or higher

Documentation
570-page manual

Price
$99

Inquiry 1200.

BASIC statement—not just PRINT. You can therefore open another window—one that doesn't occlude the output window—and print your output there.

QuickBASIC doesn't update the output window the way typical Mac applications should. For example, while running a window-drag demo, I reduced the size of the output window to a minimum and then expanded it. I ended up with a blank window, even though the program was still running. Actions that bring up a dialog box on top of the output window have the same effect.

Compiler versus Interpreter

Compiling a QuickBASIC program is an easy one-step process. The Run selection in the main menu offers three compiler selections. The first, Options, lets you set compilation switches and run-time options. Among the compile options are those that include the run-time code (and create stand-alone applications), make all arrays static, generate 68020 code, generate calls to the 68881 coprocessor library, create a program list file, create an error list file, and produce a symbol table.

Run-time options enable you to use the default window and menu, process run-time events, ignore breaks, use long addressing, and disable the File Not Found dialog box. The compiled program appears as a launchable Macintosh application.

The QuickBASIC compiler supports a number of directives (called *metacommands*) that enable you to fine-tune the way the compiler works. You embed these in the source code.

The CHECK metacommand enables or disables the checking of array indexes, file numbers, arguments to the functions ASC() and CHR$(), arguments to certain Macintosh Toolbox functions, and the arguments to the LBOUND() and UBOUND() functions. IGNORE supports conditional compilation of certain code portions.

INCLUDE permits you to include additional source code from other files. QuickBASIC doesn't support nested INCLUDEs.

The LONG metacommand instructs the compiler to generate long (32-bit) addresses; you won't need to do that unless your program gets very large. PAGE inserts a page break into the listing file.

Because QuickBASIC's compiler and interpreter originated as separate products, there are some significant differences between the two. For example, the interpreter doesn't support static arrays, though the compiler does. The interpreter permits subroutines anywhere in the program's text, but the compiler requires that all subroutines appear either before or after the main program. The compiler supports recursion, but the interpreter doesn't.

The differences aren't crippling, but they do weaken the appeal of QuickBASIC as a fully integrated development system that lets you prototype in an interpretive mode and then seamlessly switch to compiled mode.

Accessing the Macintosh Toolbox

QuickBASIC supports Macintosh-style programming in two ways. A number of the Toolbox routines are implemented as QuickBASIC functions and commands. Those that aren't are accessible by way of the TOOLBOX statement—a direct gateway from QuickBASIC to the Macintosh ROM routines.

All the essential event-handling routines are directly accessible as QuickBASIC functions and statements. These include BUTTON, MENU, MOUSE, DIALOG, and WINDOW. For example, the BUTTON function returns the state of a specified button; the BUTTON statement can display a button at a specific location and with a particular message. Buttons, like files, have numbers that act as handles. The BUTTON CLOSE statement enables you to close all the buttons or a specific one. You monitor the user's interaction with buttons with the DIALOG function. Menu interaction works in a similar way. The MENU function returns information about a menu; the MENU statement performs menu-related actions.

The manual outlines two techniques for building a Macintosh-style interface. The first relies on event trapping. For example, you can enable the trapping of menu events with the MENU ON statement. That works in conjunction with the ON MENU GOSUB construct, which you use to build a menu-event handler that evaluates the event and dispatches to an appropriate subroutine.

The second method relies on polling—that is, instead of relying on the system to trap events, you poll for them yourself. Multiple concurrent event traps can cause subtle bugs; in these situations, polling may be preferable.

The event-oriented QuickBASIC constructs work well, but to use them you have to learn a set of nonmnemonic codes. For example, the MOUSE function takes a single integer argument specifying the kind of mouse-related information you need. MOUSE(0) returns a status indicator (itself an integer that you need to decode), MOUSE(1) returns the current *x* coordinate, and so on.

The same situation applies to the BUTTON, MENU, DIALOG, and WINDOW constructs. I'd much prefer to see descriptive names (for example, `mouseDown`) rather than the integer codes that QuickBASIC uses.

One of QuickBASIC's nicest features is the TOOLBOX statement. It takes the trap number of a Toolbox routine, its calling convention (register- or stack-based), and the routine's arguments, and executes the routine. This works especially well in the command window: You can interactively experiment with the Toolbox and very quickly get a feel for its capabilities.

How Quick Is QuickBASIC?

I ran a series of benchmark tests on my Mac Plus; the machine has 1 megabyte of memory, a 20-megabyte hard disk, and internal and external 3½-inch floppy disk drives. QuickBASIC ran from the hard disk. I disabled all forms of checking and made all arrays static.

Table 2 shows the benchmark results for the binary and decimal interpreters.

continued

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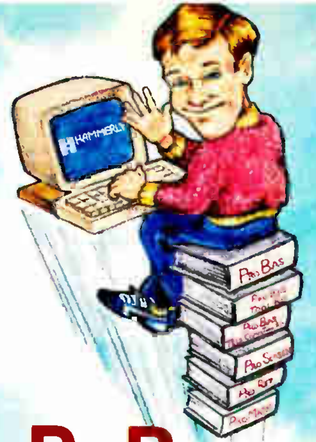

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The table contains only the run times and the ratios between the binary and decimal versions.

The results show—as you'd expect—that the decimal version runs slower than the binary version on tests that involve floating-point calculations. The ratio of the two varies from 1.39 to 3.05 with no math function calls, and from 3.50 to 14.67 with math function calls. So if you need to use the decimal version and the math functions, you'll probably want a coprocessor. On the other benchmarks, the binary and decimal versions peg about equal.

The results for the binary and decimal compilers appear in table 3. The compilers produce files of equal sizes (rounded to the nearest kilobyte) and take about the same time to compile. As with the interpreters, the math tests are about four times slower when done decimally; other tests come out roughly equal.

Table 2: *Benchmark results for the QuickBASIC binary and decimal interpreters. Math and floating-point operations are slower in the decimal version; other operations are about the same.*

Test	Iterations	Binary version run time (seconds)	Decimal version run time (seconds)	Decimal/binary ratio
Float	—	21	64	3.05
Inv. matrix	—	38	53	1.39
Math				
SQR	1	3	44	14.67
LOG	—	11	49	4.45
EXP	—	7	32	4.57
ATN	—	8	36	4.50
SIN	—	6	21	3.50
Write	—	15	16	1.07
Read	—	13	14	1.08
Sieve	1	61	60	0.98
Sort	1	151	141	0.93
String	1000	40	40	1.00

QuickBASIC 1.0 for the Macintosh unites the Microsoft BASIC interpreter and compiler into a single integrated environment. It's a first release, and there are some problems that I'd like to see Microsoft fix—notably, the differences between the interpreter and the compiler, the sparse information in the on-line help, the non-mnemonic event codes, and the failure to update the output window.

More generally, I'd like to see Macintosh QuickBASIC support the more advanced language constructs that QuickBASIC 4.0 for the PC provides—constants, user-defined structure types, the DO...LOOP construct, multiline functions, and modules.

The QuickBASIC environment will be especially useful to beginning Macintosh programmers. The many program examples included with the distribution disks are very good; you can use them to learn a lot about BASIC and about how to build Macintosh applications. QuickBASIC's ability to use external libraries developed in other languages makes it suitable for rapid prototyping. I recommend the product and look forward to future improvements. ■

Editor's note: *Benchmark listings are available in a variety of formats. See page 3 for details.*

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Table 3: *Benchmark results for the QuickBASIC binary and decimal compilers. Raw times are much faster than with the interpreters. The decimal/binary ratio is comparable.*

		Binary			Decimal			
Test	Source file (K bytes)	Compiled file (K bytes)	Compile time (seconds)	Run time (seconds)	Compiled file (K bytes)	Compile time (seconds)	Run time (seconds)	Decimal/binary ratio
Float	2	46	13	4	46	12	32	8.00
Inv. matrix	2	47	11	5	47	13	18	3.60
Math (10 iterations)	3	49	14	—	49	14	—	—
SQR	—	—	—	36	—	—	178	4.94
LOG	—	—	—	65	—	—	330	5.08
EXP	—	—	—	55	—	—	230	4.18
ATN	—	—	—	65	—	—	250	3.85
SIN	—	—	—	42	—	—	210	5.00
Write	2	46	12	15	46	11	16	1.07
Read	2	46	11	18	46	3	9	.06
Sieve (10 iterations)	2	46	14	8	46	12	8	1.00
Sort (10 iterations)	3	4	3	19	4	2	18	0.95
String (1000 iterations)	2	46	12	16	46	13	16	1.00

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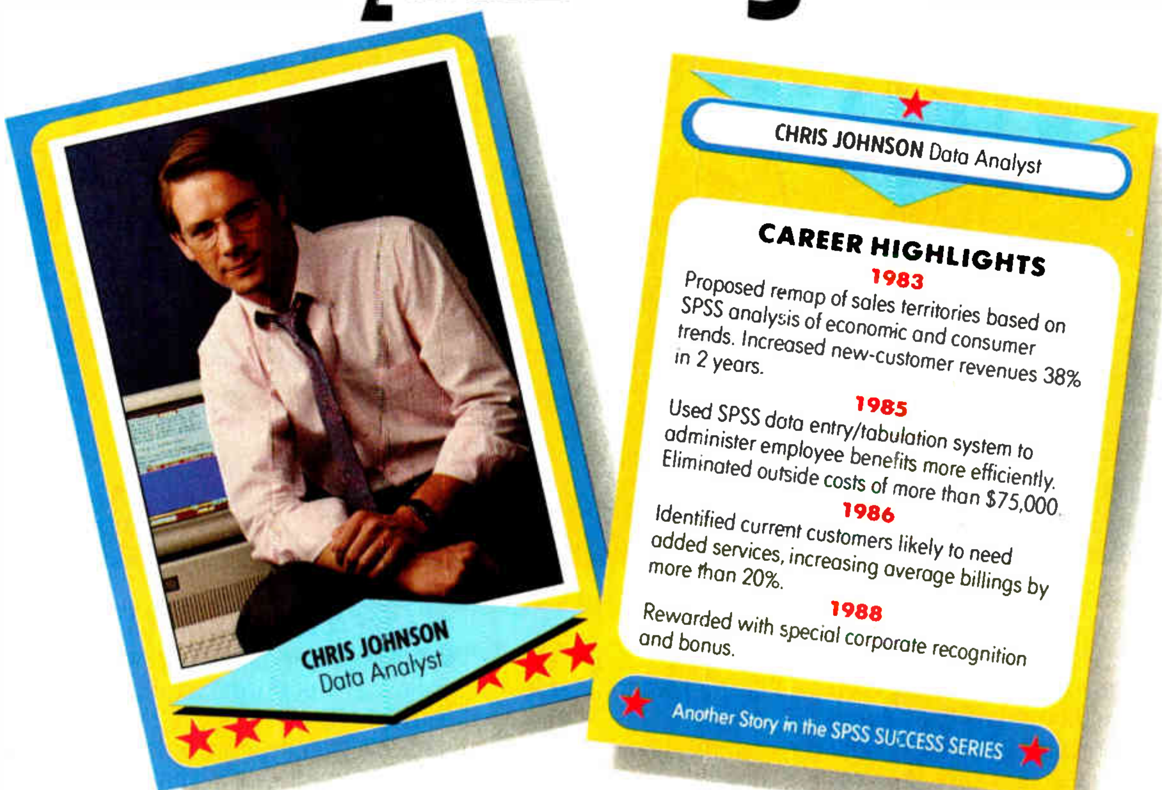

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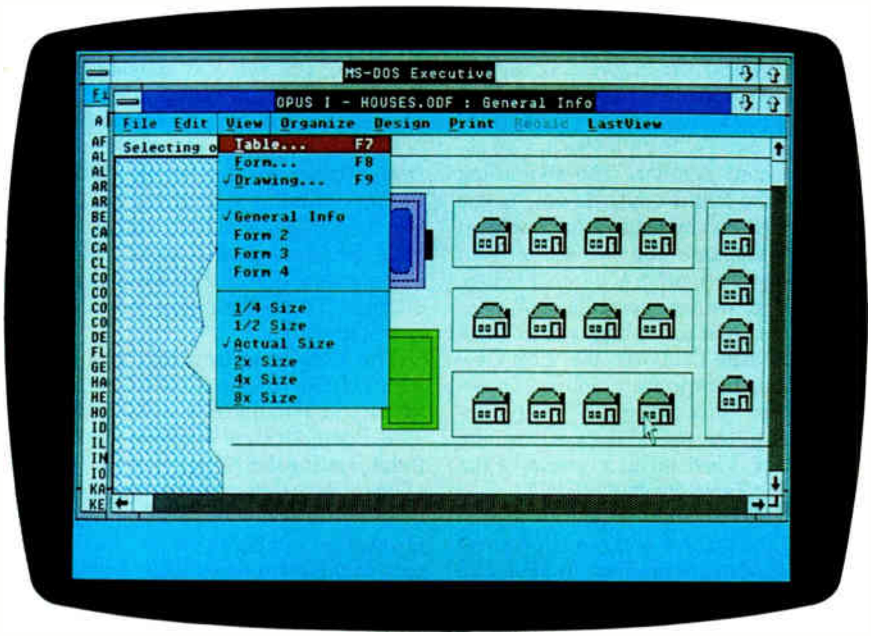
Opus I



A duet for graphics and data

Phillip Robinson

In the database world, dBASE and its typed text commands still rule. But more databases on the Mac and PC are offering to store graphics information along with more conventional dates, dollars, and text strings.

Opus I is a graphics-oriented database management program that runs under Microsoft Windows. This $395 "hyper-drawing" program, as Roykore Software describes it, lets you create and manipulate a database using a graphical display. Although Roykore does not position Opus I as a DOS version of HyperCard, the similarities are immediately apparent. The differences soon show when you dig into the program and its accompanying manual.

To gain some insight into what Opus I does on the PC, you have to look at HyperCard on the Mac. HyperCard isn't really a complete database program, but it offers a graphics-based front end and a scripting language for anyone who wants to link graphical pictures, buttons, and icons to stored information. Opus I is an alloy of graphics and database features that bears a certain similarity to HyperCard. The brass tacks of information are still stored in records and fields, but that same information is linked to, and available from, a graphical display.

A Window on Installation

Opus I requires an IBM PC, PS/2, or compatible; at least 512K bytes of RAM (the main program file is just 256K bytes long); EGA, Hercules, or compatible graphics; a color or monochrome monitor; and DOS 3.x.

Installing Opus I is a breeze, particularly if you already have Windows on your hard disk. Just copy the files from a single 1.2-megabyte floppy disk, and you're ready to run. If you need a 360K-byte or 720K-byte 3½-inch floppy disk, Roykore offers a toll-free number to call for quick delivery.

If you don't already own Windows, Opus comes prepared with its own run-time version of the graphical environment. With that, you'll be able to run Opus under Windows but won't be able to run any other Windows applications. I used Windows/386 running on a PC's Limited 386. Through Windows 2.0 or Windows/386, incidentally, Opus I can take advantage of the Lotus/Intel/Microsoft Expanded Memory Specification (LIM/EMS) 4.0. SYS files for the Intel, AST, and IBM expanded-memory boards are included.

Using Windows without a mouse can be slow and inefficient. I used a Mouse Systems optical mouse for this review. However, a mouse is not essential. The Opus I documentation has descriptions for using all commands with either the mouse or the keyboard.

This review covers version 2.04 of Opus I; version 1.0 was released back in May 1987. Version 2.0 was redesigned with Windows/386 and the Presentation Manager in mind and offers more com-

continued

Opus I version 2.04

Type
Hyperdrawing program combining simple database with drawing program, allowing direct links between graphical displays and stored data

Company
Roykore Software, Inc.
749 Brunswick St.
San Francisco, CA 94112
(415) 333-7833

Format
Three 1.2-megabyte 5¼-inch floppy disks

Language
Microsoft C

Hardware Needed
Requires IBM PC, PS/2, or compatible with at least 512K bytes of RAM; one floppy disk drive and one hard disk drive; EGA, Hercules, or compatible graphics; a monochrome or color monitor; and DOS 3.0 or higher

Software Needed
Runs under Windows 2.0 or Windows/386 (comes with run-time version of Windows 2.0)

Documentation
80-page tutorial; 190-page user and reference guide; 65-page guide to Windows

Price
$395; $40 upgrade from version 1.0

Inquiry 1199.

mands for linking drawings and files together.

Tutorials and Examples

There are two tutorials to choose from in the manual. First is a mouse-based lesson, and that's the one I suggest you use if you can. The second tutorial covers exactly the same ground but from the point of view of a keyboard-only user. Both illustrate the groundwork of Opus by postulating a simple real estate database containing information on houses, owners, prices, sales status, and the like.

The sample database and graphics files for this tutorial are on the Opus disk, along with some other example files. In each example, the first view you see upon opening the file is a graphical drawing with some typical Windows menus across the top. The drawing can be viewed at anything from ¼ to 8 times the actual size; you choose the size (in inches or centimeters) on a View menu.

Opus I can create drawings of up to 42 by 42 cm. If you experiment with the drawing by pointing the mouse cursor at graphical elements and then clicking the left mouse button, you'll see that some (but not necessarily all) of the objects are "assigned to a record." That note is written just under the Windows menus. Along with it is the number of the assigned record.

In the case of the housing development example, you'll see unpretentious pictures of 17 separate houses, a tennis court, and a swimming pool, all laid out on a set of streets. Each house has an assigned record number. The swimming pool and the tennis court do not. If you double-click on any house, the graphical display disappears and you see a form containing information about that house: ID number, owner, cost, date of sale, sold status, market value, and interest rate. You can then use the LastView menu to pop back to the graphical Drawing Display (this command always returns you to the previous view), or you can use the View menu to move to the Drawing or Table displays.

The Table contains all the information about all the records laid out in columns and rows. With Form Display, you can also inspect the previous or next form (arranged by ID number), edit the information on the form, print the form, and save any changes you make.

The other examples that come with Opus I, by the way, display information about house sites within California, states within the U.S., and the various levels of a company's accounts payable procedures chart.

Seeing, Importing, and Exporting Data

The Table Display is also ripe for any modifications you want to make in the data within a file. You can put Windows' Cut, Copy, and Paste functions to work or use a Delete Record command from Opus itself. There's also an Undo command to correct any mistakes you might make.

Besides the typical Save and Save As commands, Opus I also boasts a Return To command (for switching back to the previous file), a Lock command (to use your own chosen password to protect a file from any changes), and a pair of Import/Export commands. The Import/Export options let you read or write DIF or delimited files and even offer the flexibility of excluding calculated fields from the export. I was able to move files back and forth from PC Excel to Opus I using these commands.

You can read data into an existing file or create a new file. The Design menu offers separate avenues to creating a Drawing, a Form, a Report, a Mailing Label, or a Field.

For Fields, Opus I presents a dialog box where you choose a Field label and type either text, number, date, or picture. There are three format options for a date field; six format options for a number field (general, currency, business, scientific, percent, and integer); center, left, or right alignment for any field; and cropping or scaling for a picture field.

Calculated fields are easily cobbled from a dialog box that has an editing line for the formula, a scrolling window to select from current field names as formula elements, and a set of arithmetic commands and numerals for making operators. These formulas may contain parentheses.

The Labels option lets you select which field information to enter into which standard line of a mailing address. The Form design consists of taking fields, setting their length (or the number of characters they can hold), and placing them where you want them on the Form Display or tucking them into the hidden part of the form where they won't show during regular processing.

All these design tools are easy to use without much reference to the manual. Opus I also comes with indexed but non-context-sensitive on-line help for all its commands. This help includes references to the pages in the manual if you need further help.

Creating a form and then entering data, either by typing it in or by importing it from some other file, results in a database that can then be searched, sorted, and reported on. Opus I can hold a maximum of 10,000 records per drawing file, 100 fields per drawing file, 1023 characters per text field, 15 decimal places per number field, and 40 characters per field label.

I was disappointed that the error checking on data entry was not very sophisticated. Mistakes such as 4/35/89 are barred, but entering 2/29/89 in a date field prompts no worry at all from Opus.

Designing Reports and Graphics

Designing reports consists of selecting a title, the fields to be printed, statistical

continued

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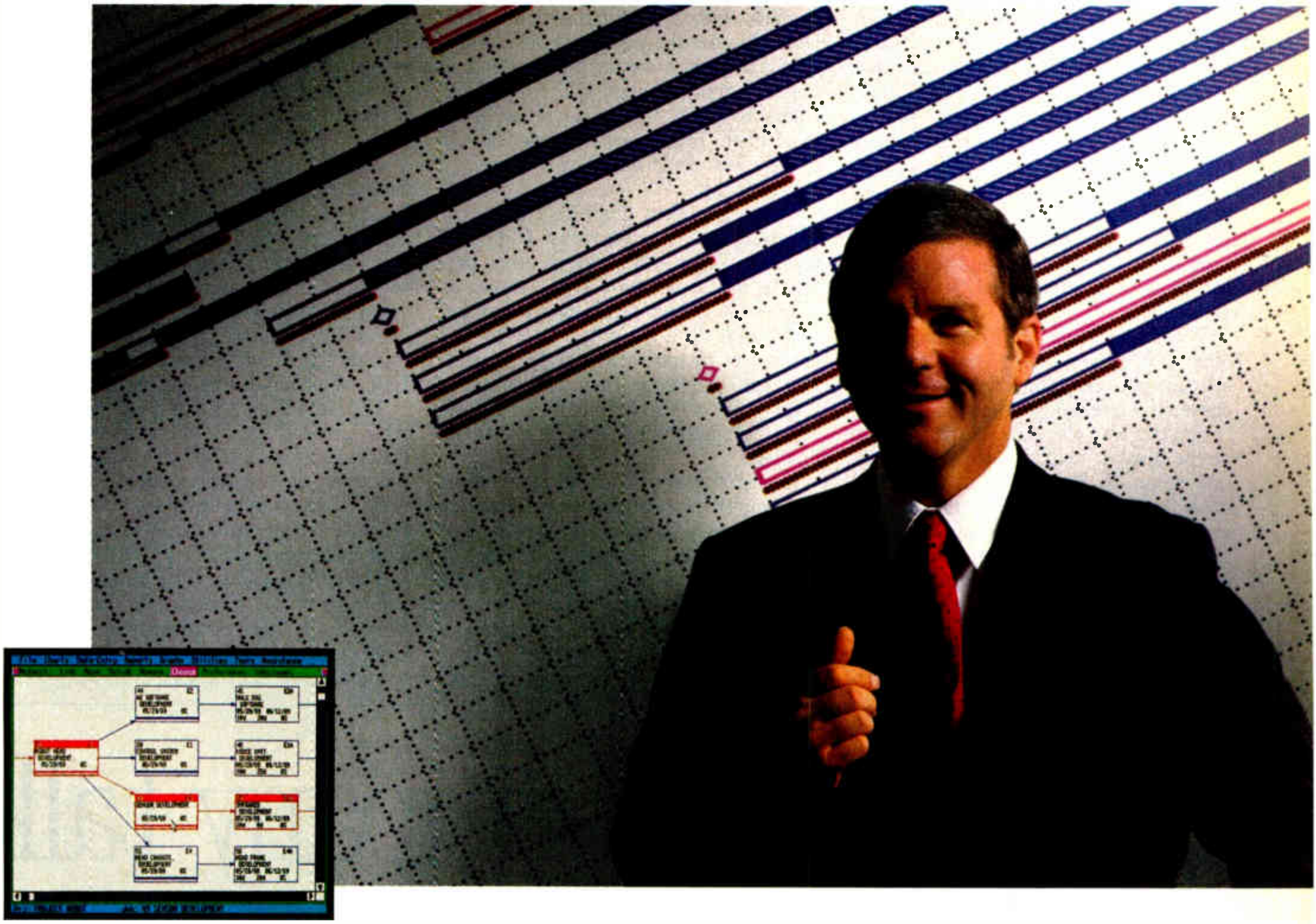

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values to calculate and print (total, average, minimum, and maximum), headings, and a single line each for a header and a footer. Reports can be saved to disk for reuse.

Designing a drawing takes you to an entirely new set of menus, really a second program that is tightly linked to the file manager of Opus I. You can use the drawing program to change a variety of foreground and background colors, text sizes (from 6 to 72 points), styles (seven, including bold, underlined, and so on), and fonts.

There is a menu of fill patterns, another of line styles, and a Tool menu with ellipse, pie, polygon, rectangle, line, curve, and freehand commands.

You can also choose to plant a symbol on the display, selecting it from a separate menu of 12 symbol names (e.g., main, airplane, start, PC, car, desk, and arrow) and then positioning it on the screen. Symbols can be renamed or replaced. If you replace a symbol in the symbol set, all the instances of that symbol on the screen will also change.

Once an object is on the display, you can select, move, cut and paste, or reshape it (for some types of objects). You can also rotate it, group it with other objects, dissolve the groups, or position the object in front of or behind overlapping objects. You can draw with a grid and rulers for alignment and can snap objects to a grid. From the Drawing Design display, you can print, save, or start on a new drawing.

You can import graphics from other programs via the Windows Clipboard and send Opus I graphics to other programs the same way. Opus stores its graphics as objects, limiting the number of objects in a drawing only by the amount of memory in your PC system. You can use more than one graphics display for a single database file and store these graphics in more than one file on disk.

Connecting the database information and graphics is relatively easy. Just click on an object in the Drawing Design display and choose Assign Objects. A small window pops up that lists all the objects and their numbers in the current drawing. You can assign and unassign records to any object on the screen. Then, when you save these assignments and return to the standard database Drawing display (not the Drawing Design display), clicking on the object brings up the information from the assigned record. Even if that object is moved to another point on the display, it will still have the same assignment.

Searches and Sorts

Once you have your database all designed and set to go, you'll probably want to browse through it and do some searching or sorting. In any of the main views—Form, Table, or Drawing—you can find a record (by its ID), select records (by entering search values in the fields of a blank form), or sort records.

The selection process can include AND and OR logical operators between fields, and within fields it can use operators such as "match exactly," "begin with," "less than or equal to," "within a range," and so on. It can also use wildcard characters.

The sorting can be done on any field; you click on the fields in the order you want to sort them. Repeated clicks on a field switches between ascending and descending order for the sort.

You can highlight or hide either the results of a selection or the unselected members. This is one of the strongest reasons to have a graphical database display, where you can immediately see which members have been ferreted out. In the houses example that comes with the tutorial, for instance, the houses already sold or priced above a certain level can be quickly shown graphically onscreen, or printed for immediate reference by someone who isn't entirely comfortable with tables of data displayed on a computer.

Sophisticated Edge of Opus

The most sophisticated feature in Opus I is the Programmed Links you can create. These give the program more of a taste of "hypermedia," though they are limited in scope compared to the much richer set of commands you'll find in HyperCard.

By holding down the Control button in the Drawing Design display and clicking twice on some drawn object, you bring up a Program Object window. Here, you can tell Opus I to react to a single mouse-click or a double-click on that object (this is called programming a button).

The action Opus takes when it perceives the clicking is up to you. You could tell Opus to bring up another form, to go to another drawing file, or even to start another Windows application program. The Program Object window lets you specify the action—you'll see a scrollable list of 26 commands—and the path names for any files you call up. The command list includes Print Reports, Sort Records, LastView, Highlight, and Find Record.

Unlike HyperCard, Opus has no script language to let you create more commands than these. However, since Excel is another Windows application and has its own macros, including AUTOEXEC macros that run when an Excel window is opened, Opus I can perform some tricky maneuvers using Excel as an agent. With version 2.04 of Opus, you can open multiple Excel spreadsheets without restarting the main Excel program each time, thus saving RAM space.

Drawn Conclusions

Opus isn't HyperCard, mainly because it doesn't have a HyperTalk language to extend its features. Nor does it offer some of the subtle data-manipulation strengths you'd find in competing and similarly priced database managers or file managers, such as Q&A or Reflex Plus. This is especially true for calculating fields and error trapping, linking data files together, and creating custom data types. Opus doesn't have the features to replace my main database management software or even to transport some of HyperCard's abilities to PCs.

But the ability to link an underlying database directly to a graphical display, along with the built-in drawing tools to create and modify such a display, makes Opus I an important program to consider. That's especially so if you're creating an application for someone who isn't already an experienced database user. You can customize the on-line help files and lock drawings to prevent changes. Opus I can be a great tool for creating simple file management applications in a wide variety of fields. ■

Phillip Robinson is an editor at Virtual Information *and lives in Berkeley, California. He can be reached on BIX as "robinson."*

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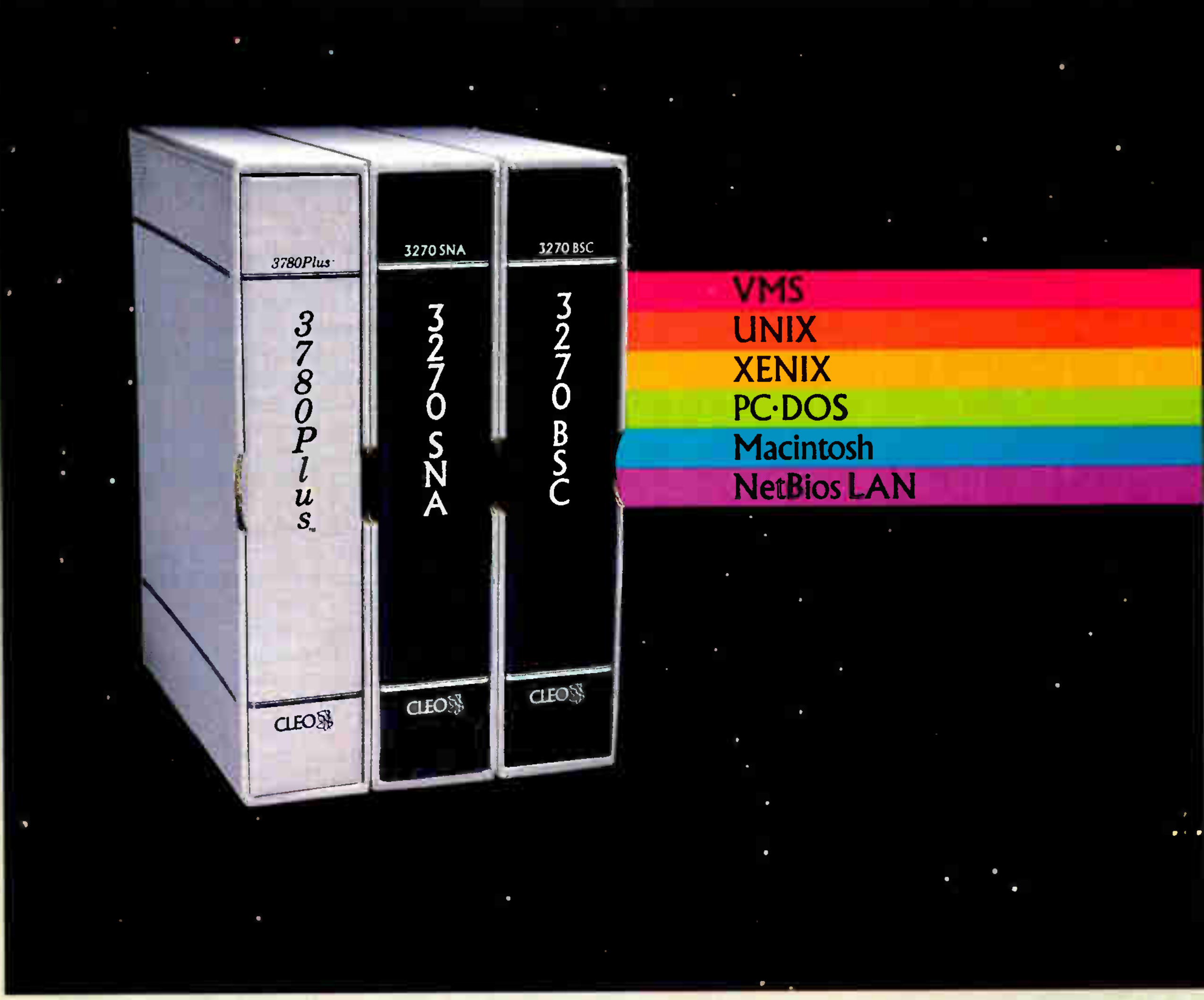

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Symbolic Math on the Mac

Mathematica provides powerful problem solving and graphics

Peter Wayner

When I was in high school, my calculus teacher told us we could use computers to do our homework if we chose, but he was sure they wouldn't be much help with the integration and differentiation. That was not very long ago, but he must be more careful with those claims now.

Software that manipulates equations as easily as numbers is not new anymore, and a remarkable new version of the genre, Mathematica 1.0 ($795), is now available for several different computers, including the Macintosh, Sun386i, Silicon Graphics Iris, NeXT computer (bundled), and IBM RT PC. Its symbolic capabilities are strong, and its user interface is very easy to use.

Most simply, Mathematica tries to be everything to anyone who needs to use mathematics more complex than addition and subtraction. It computes numbers with a precision limited only by the memory of the computer and the patience of the user. Typing `100!` will return an answer of more than 150 digits. You can also specify any arbitrary precision to save time or screen space.

The program manipulates equations symbolically, solves them for zeros, differentiates them, and integrates them if it can find a way. When you type `Expand [(x+y)^2]`, the program returns `x^2+ 2xy+y^2`. Differentiation is as easy, and integration will work for almost any function that can be integrated. If the integration won't work symbolically, the program performs it numerically. The algebra package arranges the answer in whatever form you desire, and the results can be either completely factored into irreducible polynomials or left expanded.

Another simple command lets you easily turn the data and the equations from these computations into two- or three-dimensional graphs. Axiometric plots and contour graphs of both rectangular and spherical coordinates are easy. You can control the shading with another function or leave it up to the program. The program allows you to place point sources of multicolored light anywhere to illuminate the graph in the best possible way.

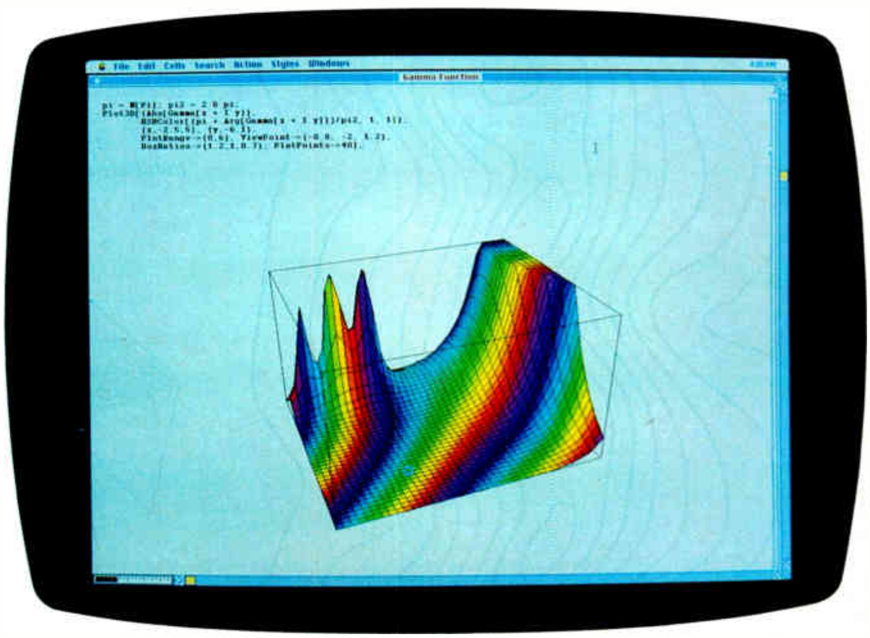
When any of the built-in mathematical operations are not enough, you can program Mathematica to do new tricks. The language is an interesting blend of Lisp, Pascal, APL, and Prolog. You can write functions as Pascal-like procedures, Lisp-like functional programs, or Prolog-like rules. The system comes with many files of programs for handling math like differential equations and Laplace transforms.

Getting to the Core

The program has two parts: the kernel, which does all the mathematical work, and the user interface, which moves the information back and forth. These two parts don't need to run on the same machine, though, and it is possible to run the kernel on a fast machine like the Cray while running the user interface on a Macintosh. The terminal software for handling this remotely is built into the program.

The kernel is written in C and should run exactly the same on all machines. The kernel's main section performs basic numerical computations and algebra of symbolic expressions. The code for more complex operations, like integration, is stored in modules that you load separately. This conserves memory,

continued



Mathematica 1.0

Type
Mathematics system

Company
Wolfram Research, Inc.
P.O. Box 6059
Champaign, IL 61821
(217) 398-0700

Format
Five 800K-byte disks

Language
C

Computer
Macintosh SE or II with at least 2.5 megabytes of RAM; versions also available for the Sun386i, Silicon Graphics Iris, NeXT computer (bundled), IBM RT PC, and 80386 machines

Documentation
750-page *Mathematica*
125-page book on the Macintosh interface

Price
Mac II version: $795
Mac SE version: $495

Inquiry 855.

a scarce commodity with such a large program. The code also frees memory as soon as possible, so you don't have to interrupt computation for garbage collection.

The basic syntax is similar to that of other symbolic mathematical packages, such as Macsyma or Maple. The input must be an expression of numbers, variables, and functions of other expressions. It's just like typing an equation into a standard computer program. Mathematica parses the expression, places it into its own internal format, and evaluates all the functions until the simplest form possible is uncovered.

The number of different functions is amazing. Hundreds of relatively obscure functions, such as the zeta, the beta, and the gamma (including variants like the incomplete gamma function, the digamma, and the polygamma), are implemented in addition to the old familiar ones like sine, logarithm, and absolute values. The package includes almost every continuous function used for physical modeling that I can think of.

Mathematica can expand a rational function into terms or factor it into the smallest expressions on command. Differentiation is easy to do because its rules are so well defined. Integration is much more difficult, however, since answers are not always known to exist, but Mathematica can usually do as well as any table of integrals that you'll find in a book.

I found a small bug in Mathematica's approach to integrating the difficult Gaussian distribution $e^{(-x^2)}$. No closed-form solution exists, but since the integral is so common in statistics, the solution is written as `sqrt(pi)/2*Erf(x)`, where `Erf` is the error function circularly defined to be the integral of $e^{(-x^2)}$. If I asked for the closed-form answer, Mathematica responded correctly, but if I asked for the definite integral from negative infinity to infinity, it answered `0` instead of the correct answer, 1.

If symbolic integration is not possible, you can switch to numerical integration by substituting `NIntegrate` for `Integrate` in your command. The basic command will not always work if there are singularities in the function, but the manual explains many of the potential traps in numerical integration and possible solutions. This is not a bug in the system. Numerical integration can be tricky and inaccurate if not used carefully.

The syntax can also be a trap for the naive user. When I typed `Integrate [Sin(x),x]`, Mathematica responded `1/2 Sin (x^2)`. When I typed `Integrate[Sin[x],x]`, the right answer was returned. The difference between the square brackets and the parentheses caused the mistake: In the first case, Mathematica thought `Sin` was acting as a simple variable, not as a reserved function. Mathematica's lax policy for parsing multiplication symbols compounds the problem: The asterisk is optional, and Mathematica assumes multiplication when no operator is present.

Tailored User Interface

The user interface is different for each computer. All versions display the graphics in some form, but they do not share all the same features. I used a Mac II version that could take advantage of a color monitor. I also ran a version for the Sun386i running Unix.

The most important feature distinguishing the Macintosh version is a very fancy editor called the Notebook. The

(a)

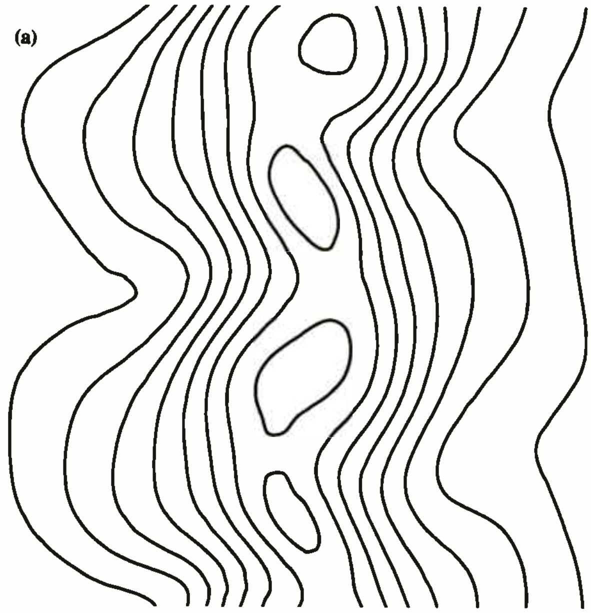
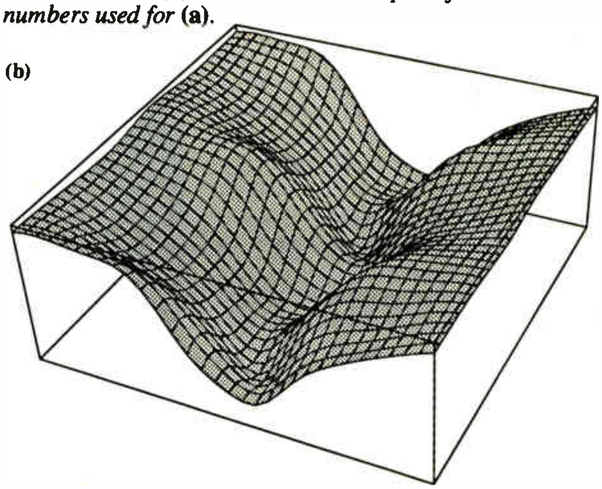


Figure 1: (a) *Contour graphics of a simulation of the electrical field in an aurora. The 32 by 32 array of numbers was produced by a FORTRAN program and imported with one command.* **(b)** *Three-dimensional plot of the same numbers used for* **(a)**.

(b)



basic component of the Notebook is a cell that can be simple text, a line of input to Mathematica, the resulting output, or a PostScript graphic. The formatting of all the cells can be easily controlled and switched on and off. The usual Macintosh font commands and styles are all available, as is a large complement of predefined formats for titles, footnotes, and so forth.

You can have the graphics cells displayed in either pictorial form or raw PostScript. You can edit the cell visually with a few commands to change line widths and remove the grid from a function, for example, or you can rewrite the raw PostScript code. Naturally, these graphics look quite nice on the Apple LaserWriters.

The cells can be grouped into various layers like an outline. The right side of the window is dedicated to bracket-like handles for selecting, cutting, pasting, and grouping cells. If you don't want to see the entire cell on the screen, a few clicks reduce it to a small cell displaying only the top line. A few more clicks return the complete cell to the screen. A Notebook with many different levels is easy to maintain.

If the cell is an input cell for the kernel, you can edit it and then have it recalculated. This is a handy feature if you make mistakes while typing in a long expression. The standard Macintosh cut-and-paste operations make this feature easier. If several cells grouped together are steps in a long calculation, you can link them together so a change or recalculation of one would force the recalculation of all of them.

This is probably one of the best implementations I've seen of a hierarchical editor. The brackets marking the ends of cells and groups of cells are easy to understand and manipulate. They are ideal for scientific papers, which usually have a rigidly defined format and a tree-like structure.

However, Mathematica makes several small changes in the Macintosh interface that might confuse a few people. One potential detraction is the use of the preferences file. Apple suggests that every application should create a preferences file if it can't find one. Mathematica doesn't want to do this. It just asked me to look for it on the disk. This problem arose because I set up the preferences file to load the integration functions. Unfortunately, I did this on a 2-megabyte machine without enough memory to hold it all, and the program crashed whenever it tried to follow the preferences file. I threw away the preferences file and then discovered that I needed to dig out the master disks to get everything moving again.

On the plus side, the help system is more sophisticated and includes a new menu selection, "Why the beep," which explains the last error.

The Sun version is much less friendly. The window is essentially a standard terminal. The kernel formats the equations so the output looks exactly like the Macintosh's, but there is no cell structure. The graphics are just as good because there is a PostScript interpreter. The lack of a Notebook doesn't affect the essential function of Mathematica, but you will miss it if you like working on a Mac.

But the Sun version has other advantages, since it is a Unix machine with virtual memory. It has a built-in interface to the Unix pipes that lets it communicate easily with other processes on the machine; another program collecting data can ship it over to Mathematica for processing automatically. The virtual memory uses the disk as additional memory; with it, a Sun machine with 4 megabytes of memory can handle problems many times larger than a Macintosh with 8 megabytes can handle. This makes the machine much more attractive to users who need to compute large programs. I suppose the best compromise would be running the Macintosh front end with a kernel running on a Sun machine, although that could be a rather expensive proposition.

Powerful Graphics

Mathematica's built-in graphics capabilities are its strongest asset. They make it easy to pause for a moment and get a picture of a function without running another software package. Most other mathematical packages don't offer built-in graphics.

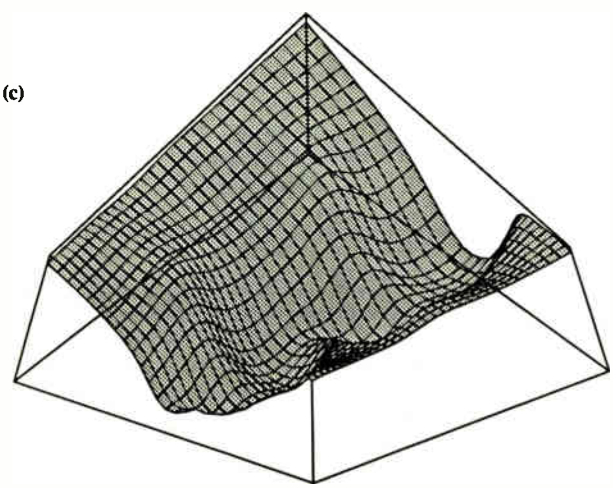
While some people might consider it a luxury, there's no question in my mind that the feature is desirable. I like to see functions, even though I know that the picture rarely yields much tangible insight. Simple pen-and-paper mathematics showed me long ago that $y=\log(x)$ grows slower than any polynomial, but I still think of the picture of the curve to convince myself of this.

The kernel handles the plotting and can produce a variety of different graphs.

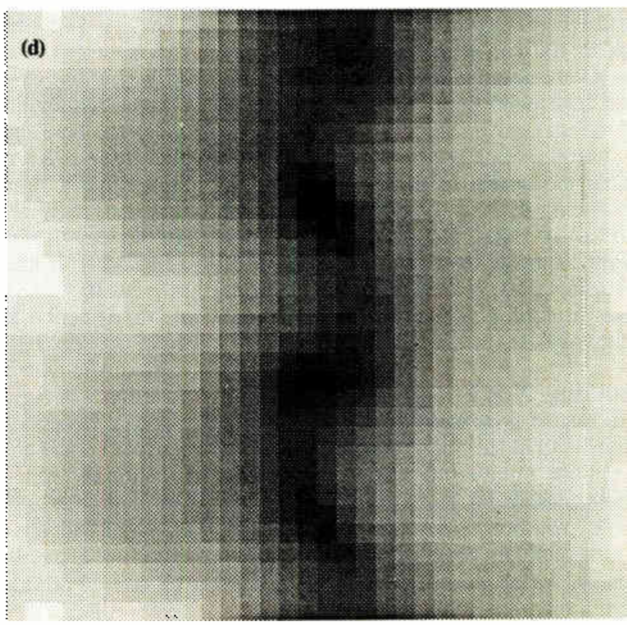
continued

(c) *A different viewpoint of the plot in* **(b)**.
(d) *A density plot that assigns each point a shade of gray based on its value.*

(c)



(d)



The software can plot both one- and two-variable functions or lists of data in a table with one or two dimensions, with very little help from the user. The computer chooses the scales of the axes, determines a good selection of points, and produces a decent graph with just the function and the endpoints. If there are singularities, Mathematica clips the graph quite well. If the result isn't perfect, you can change the number of points used, plot range, labels, aspect ratio, color, shading, viewpoint, and lighting. (The viewpoint and lighting are only for three-dimensional plots.)

You can choose to plot two variable functions in a three-dimensional perspective, a contour plot, or a density plot. I took an old file filled with a 32 by 32 array of data points in standard FORTRAN form. Mathematica accepted it without any problems. I then made four different plots (shown in figure 1) in about 5 minutes. It's almost impossible for it to be any easier.

The three-dimensional plotting routines are impressive. The graph can be a simple wire-mesh outline, a shaded surface, or some combination. You can specify the shading with another function or leave the shading up to Mathematica. It will use an ambient light or any list of colored point sources around the graph.

Mathematica's graphics are based on PostScript. Each version of the software comes with its own PostScript interpreter for displaying the images on the screen. You can also save the PostScript commands separately into a file, and you can later edit and print them out on a PostScript printer. Using PostScript as an intermediate language is a wise choice because you can customize your graphics on a very detailed level if you want. You can also print them out on a variety of different laser printers.

Mathematica's graphics commands make the system an ideal tool for writing mathematical textbooks and creating slides for talks. Most people just don't want to go to the time and expense of creating plots, but Mathematica destroys that excuse. Graphs come easily from functions.

Building New Functions

No matter how many functions Mathematica included, there would always be a need for more—and that is one of the main reasons for having the package on-hand. You can program new functions in Mathematica's own programming language, which is a mélange of many different features from other languages.

The main structure is Lisp-like. Expressions are just nested layers of functions that are manipulated by other functions. These expressions can be joined in lists, and functions will operate on lists of expressions with ease. The matrix operations borrow their syntax from APL, a language that handles matrices with nimble grace.

You can define functions in a variety of ways. The basic format is a rule-based system similar to Prolog or other logic programming languages. You specify

Some programmers may have problems remembering the syntax.

the function and the pattern of the input variables as a rule. When Mathematica encounters the function again, it tests the parameters against the pattern, and if they match, it executes the function. It always tests the most specific rules first.

A simple example of this method is the program for computing Fibonacci numbers, taken from the manual:

```
fibonacci[n_Integer] :=
    fibonacci[n-1]+fibonacci[n-2]
fibonacci[0] = fibonacci[1] = 1
```

The first two lines state that whenever `fibonacci` is called with an integer, the answer is the sum of the two preceding Fibonacci numbers. The third line establishes the base values for 0 and 1. This puts three rules into the system. When Mathematica encounters the Fibonacci function, it checks the input against the list of rules. If the parameter is 0 or 1, it returns 1. If it is an integer, it recursively calls itself. Otherwise, it does not evaluate the function and returns the expression `fibonacci[...]`.

This rule-matching algorithm lets you "overload" a function and teach Mathematica a variety of ways to handle an operation. I could easily have the Fibonacci function detect if the input was an equation and then do something completely different with the equation. The pattern-matching algorithm would then execute that code. For example, `Plus[2 2] = 5` is a valid line, and whenever Mathematica needed the sum of 2 and 2, it would evaluate it as 5. In all other cases, it would use the internal routine for addition.

Naturally, these rules don't apply only to numbers. One rule for integration looks something like `Integrate[y_+z_, x_] := Integrate[y_, x_] + Integrate[z_, x_]`. Whenever Mathematica finds `Integrate` called on the sum of two expressions, it moves the addition outside the integral and computes `Integrate` of the two subexpressions. In reality, when Mathematica integrates, it is just searching through a table and repeatedly applying the rules until nothing more can be done.

The internal code for each function is up to the programmer. You can implement IF statements and WHILE loops, and this leaves you several decisions. A function can be implemented with all the special cases filtered by a network of conditionals, or it can be implemented with the special cases as rules. Each might be more efficient for different tasks.

One problem many programmers will find with Mathematica is remembering the syntax. The average user will have very little trouble using the software, because Mathematica's built-in functions have fairly straightforward definitions. You use the complete words "Integrate" or "Expand," for example, although you can create an alias with abbreviations.

The programmer, though, must deal with much more sophisticated problems. There are so many features that each requires its own set of symbols, and there aren't enough keys on the keyboard. There are more than a handful of different assignment operators doing different things. The underscore character, for example, can be used in six different ways to specify the pattern for a rule.

The ">" symbol means "greater than," the ">>" means "save to a file," and ">>>" means "append to a file." The exclamation point after an expression means "factorial"; if it comes before a command, it tells Mathematica to execute the command on the external operating system, but only on some systems; and if there are two exclamation points before a word, it means "display the contents of a file."

These aren't bad features, but they illustrate how complex Mathematica can get below the surface. A beginning and even an intermediate user could use Mathematica without realizing all the underlying depth. Programming it on an advanced level, though, requires a deep understanding of what is going on and an

continued

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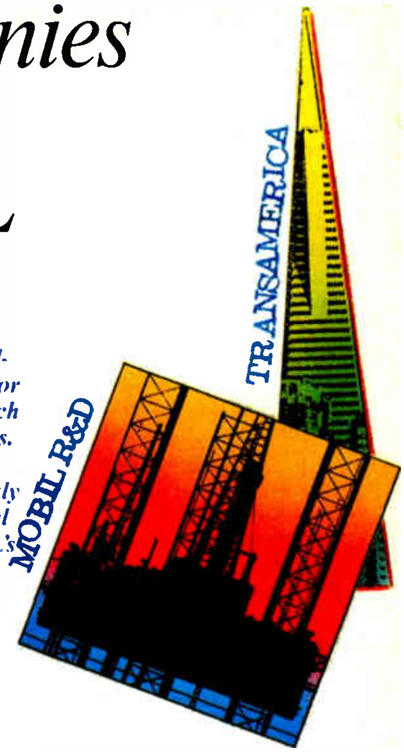

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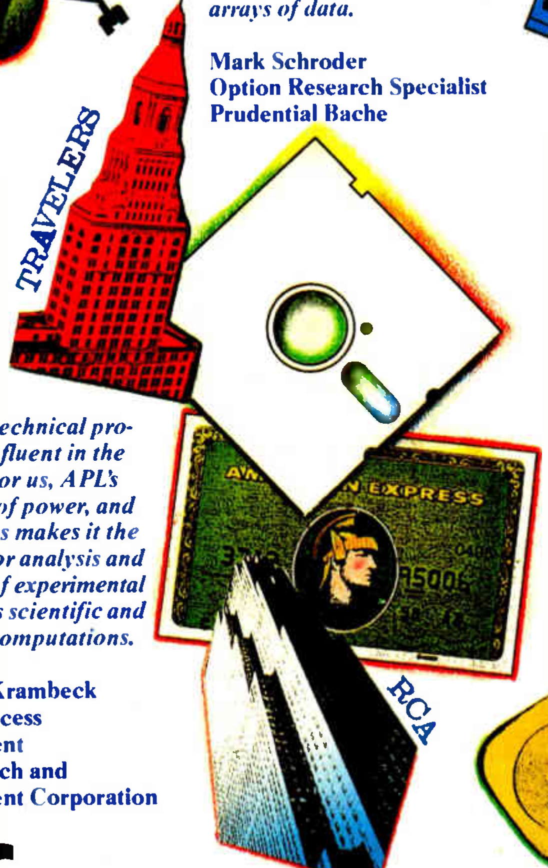

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encyclopedic knowledge of many different combinations of symbols. C programmers will feel comfortable, but Pascal programmers like me might be put off by the semantic confusion.

Well-Documented

There are two different types of documentation for Mathematica. The information about the version for your specific computer comes in a separate manual. The manuals for the Macintosh cover the relevant features in such a well-illustrated and excruciatingly detailed way that the package includes a second, thin *Summary for Macintosh Experts.*

The details about the kernel can be found in Stephen Wolfram's 750-page book, *Mathematica* (Addison-Wesley, 1988), which comes with the program. The writing is clear, and the organization is good. The first pages provide a simple overview of all the capabilities. A user interested in just the basic commands need only read the first full chapter. The small details about the structure of the system and about programming it can be found in the other chapters.

At times, I found myself wanting to know more details about the algorithms Mathematica was using inside; there are many times when it uses automatic settings to get results that can be wrong if used naively. For example, the section on numerical integration sketches possible problems nicely, but it doesn't give very good details about what is going on when it attacks singularities. The entire software system is so complex that 750 pages is only enough for a cursory sketch of many of the less prominent functions.

And the Answer Is...

The user interface on the Macintosh is a big asset and a pleasure to work with after running old symbolic packages on mainframes, though the programming language can be difficult to use. If you want to really use all the capabilities, be prepared to be confronted with many different options. Mathematica has almost too many ways to do things.

There are a few negatives. The program is the largest memory hog since HyperCard. It can run on a Macintosh with 2 megabytes of memory, but not very well. Integration needs at least 2.5 megabytes. I used a 5-megabyte machine and lived comfortably. If you use the Sun computer, its virtual memory takes care of this problem.

I found several bugs in my early version of the software. The graphics software crashed when I moved the viewpoint of the graph to the origin. Some of the sample Notebooks didn't do everything they said they would. Given the size and the complexity of the program, the bugs were not surprising, nor were they more common than expected. Wolfram Research says it will provide fixes to these bugs in version 1.1, which will be a free upgrade for users.

If you plan to do mathematics—real mathematics, with symbols, not just numbers—then Mathematica might be the one main software package for you. It can do pretty much anything mathematically that you might want a computer to do. Its symbolic powers are strong, and excellent graphics functions are built directly into the software. ■

Peter Wayner is working toward a Ph.D. in computer science at Cornell University. He can be reached on BIX c/o "editors."

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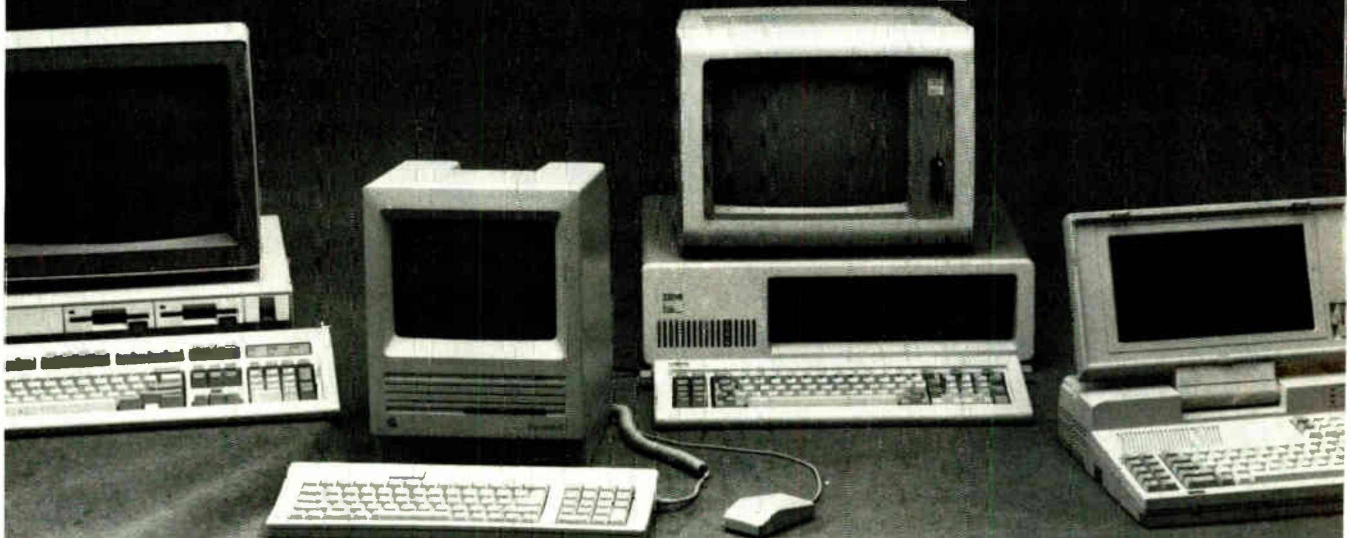

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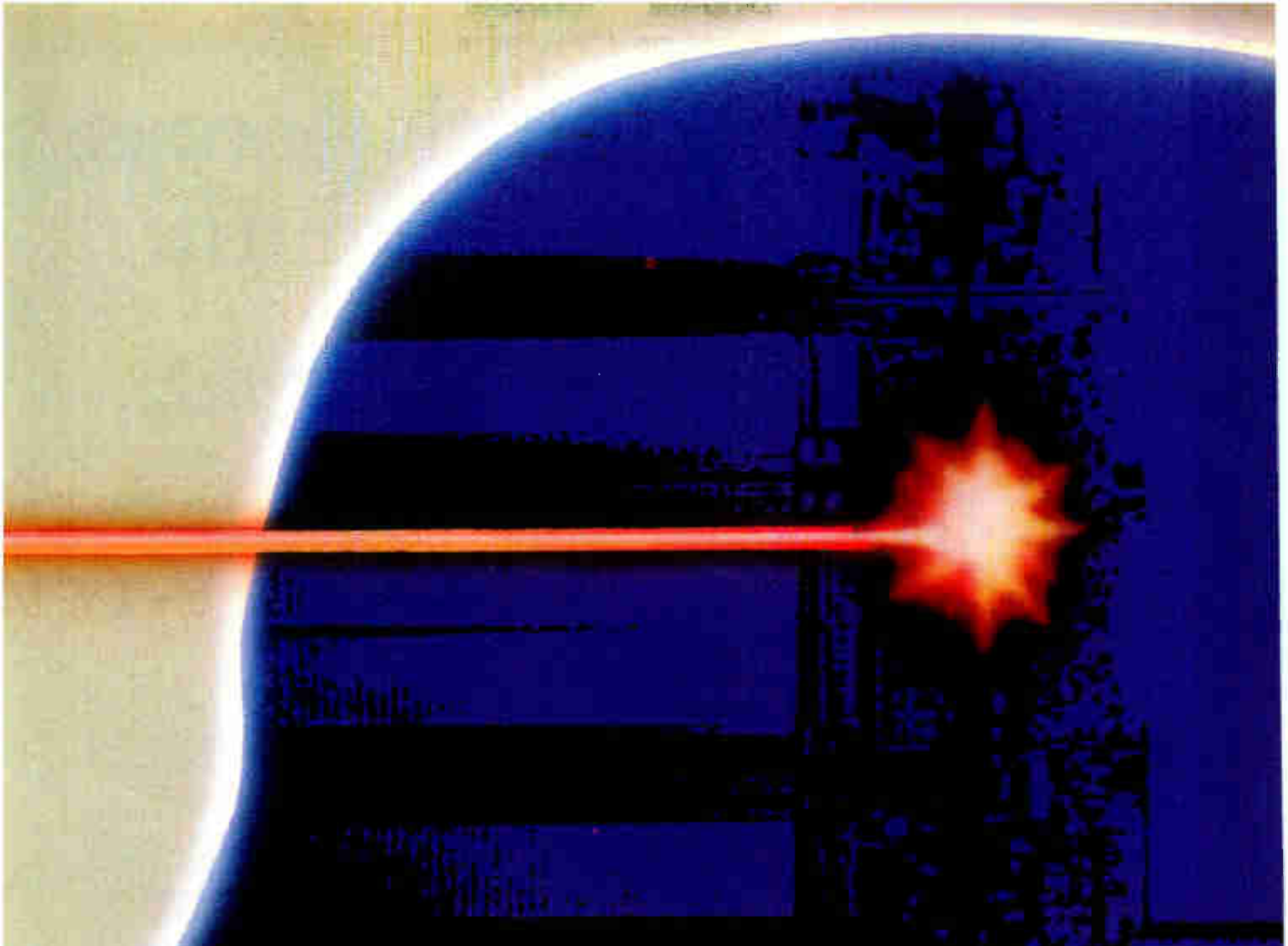

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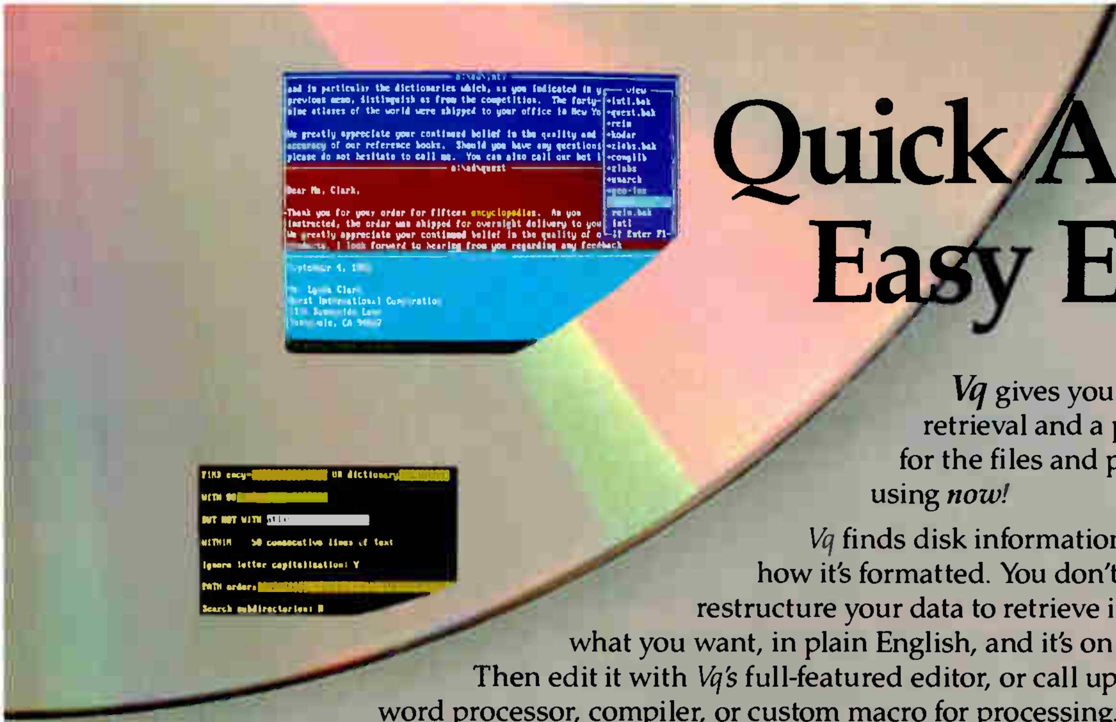

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PC Communications

PC Communications

The word "communications" means different things to different people. Depending on context, it can imply talking face-to-face, writing letters, conversing on the phone—even using body language. In any context, it involves the sending and receiving of information.

BYTE's first expanded In Depth section is devoted to the field of PC communications. It explores various aspects of LAN technology, from cable choices to protocols, from operating systems to programming, and from management to security. It also brings you up-to-date on the current status of dial-up communications software and modem technology.

In our first article, "Fiber vs. Metal," James Y. Bryce examines the cabling choices currently available, including fiber-optic, twisted-pair, and coaxial. He explains the pluses and minuses of each and describes fiber-optic technology in detail.

In "Looking for Trouble," Harry Saal gives us guidelines for managing and troubleshooting a LAN. He writes about the logical tools we need to locate a LAN problem and provides a list of some of the physical tools available that can help in "Troubleshooters," the resource listing. In a similar vein, "The Data Bandits" by William M. Adney and Douglas E. Kavanagh discusses possible security threats to a LAN, including viruses, data theft, and accidental data destruction, and provides direction for how to make your LAN more secure.

While LANs are a major source of excitement—at least in the BYTE office—most of us also still dial up various services and bulletin boards through our modems. In "Dialing Up 1990," Brock N. Meeks describes the current state of dial-up packages and provides a list of many of the current offerings in the resource listing "Communications Programs." And in "Whither the Modem?" John H. Humphrey and Gary S. Smock provide an update on modem technology and on the rising speeds and falling prices of modems.

In "OS/2 Hits the Networks," Ken Thurber discusses the role of OS/2 in various network situations and how it interacts with the offerings of the major network companies. He also writes about OS/2 as a distributed-systems platform. You don't always, however, have a univendor situation. In "When One LAN Is Not Enough," William Stallings discusses internetwork protocols—how you can establish connections between similar and dissimilar networks to extend your communications ability.

Few of us yet understand the inner workings of NetBIOS, but Brett Glass opens up that complex world and lays it at our fingertips in "Understanding NetBIOS." Another puzzle lies within the acronyms APPC and LU 6.2. Ralph Davis leads us through this one in "A Logical Choice" and provides the details of the communications protocol used by IBM's SNA and its connection to distributed processing.

Finally, Ed Tittel shows us how to connect and communicate between PCs, Macs, and VAXes on a single network in "Making the Connection." He also provides a resource listing of connectivity products.

Altogether, we hope you'll find this section on PC communications enlightening. We have all learned to use modems and even to become dependent on them by now. And if market trends are any indication, we will all become very familiar with LANs as well in the near future.

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth

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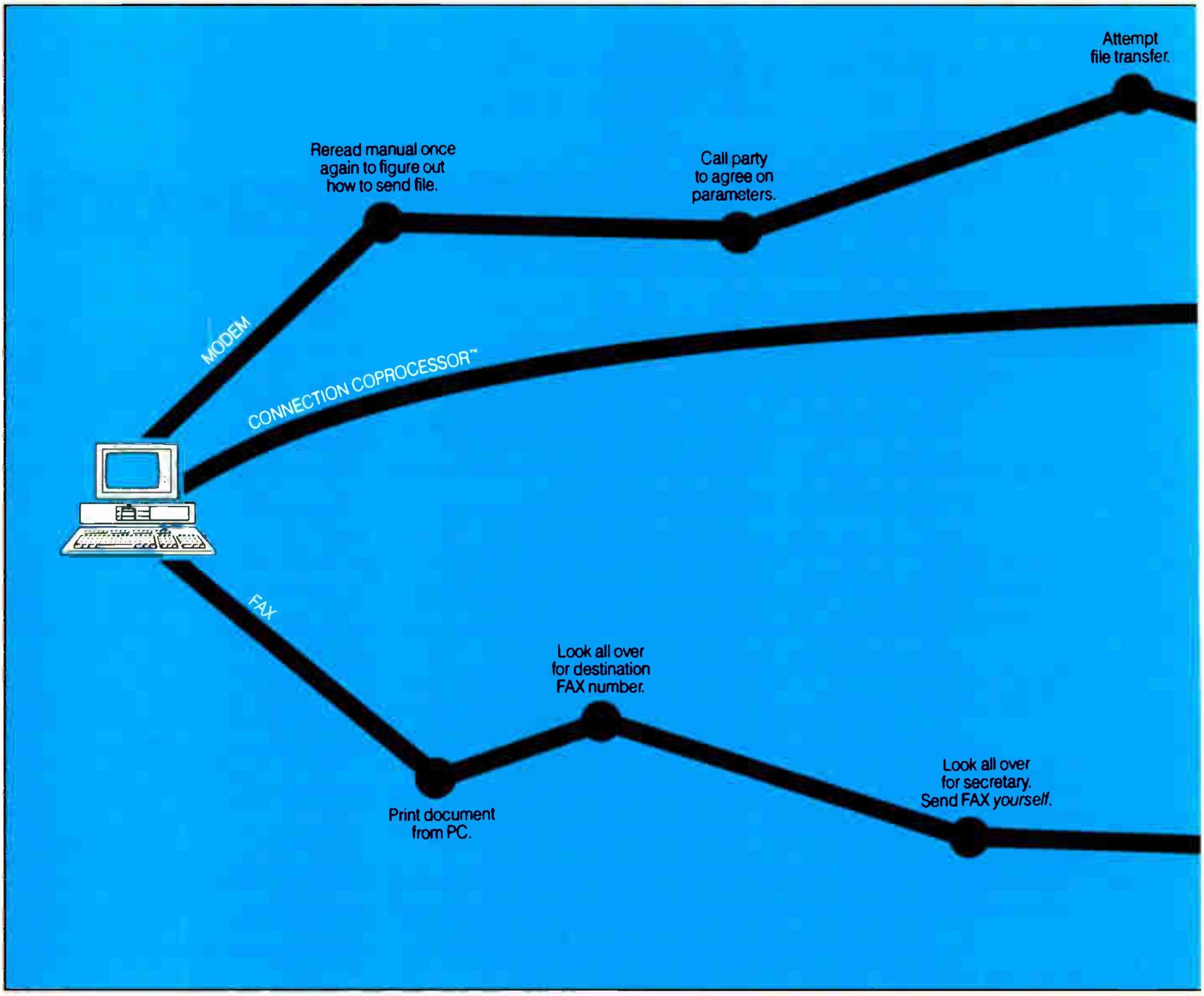

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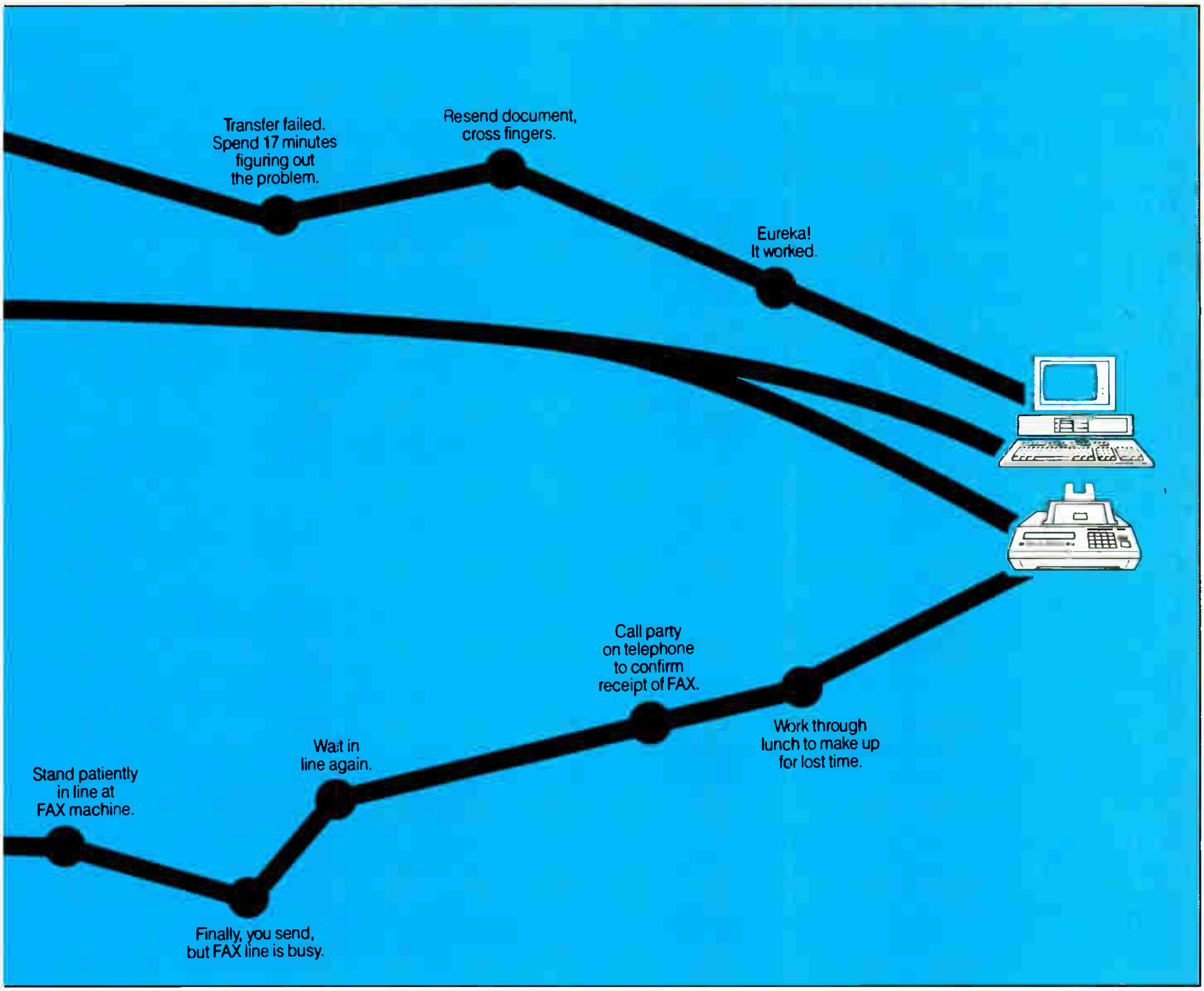

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Fiber vs. Metal

Mix, match, and choose between fiber-optic and metallic cables

James Y. Bryce

The wait is over. Fiber optics has been considered an exotic animal, a technology that might offer great potential but is too complicated and expensive for routine use. But no more.

Despite repeated bursts of television advertising praising fiber optics in long-distance telephone networks, the computer community still hasn't accepted it for local-area networks (LANs). But careful consideration of fiber optics' costs and performance and that all-important cost-to-benefit ratio often demonstrate it to be the best choice, if not for an entire network, then for significant portions of one.

What Is Fiber Optics?

An optical fiber is manufactured by drawing a large cylinder of glass, called a *preform*, out over a long distance until it is one long piece of pure glass whose diameter is measured in millionths of a meter, or microns. The fiber, just like the preform from which it was made, has two fundamental components that extend along its entire length: the core and the cladding (see figure 1).

The core is the smaller, interior portion of the fiber. It can be anywhere from 5 to 100 microns in diameter. In LAN fibers, the diameters usually range from 50 to 100 microns (very small cores of 5 to 10 microns are reserved for long-distance telephone fibers). Light signals travel through the core.

The cladding also is composed of glass, but it was designed in the preform stage to have a different index of refraction than the core. Although the resulting fiber is drawn from the same preform, the two components transmit light at slightly different velocities; thus, light is bent, refracted, as it enters the transition between the core and the cladding. You observe the same physical phenomenon when looking through water and trying to spear a fish; the light bends when it passes from air to water. This bending is designed into the fiber and keeps the signaling light within the core.

Various materials are used to encase the fiber. The initial materials are chemical coatings that protect the glass. These are followed with strengthening and protective plastics and even metal sheaths that "harden" the fiber, or more likely the collection of fibers, against environmental damage. Fiber optics is considered so reliable and so secure that military organizations such as the U.S. Army now use fiber for almost all communications—even under battlefield conditions.

Launching the Optical Signal

Two electronic devices are generally used to "launch" the optical signal into a

continued

fiber. Long-distance telephone circuits use lasers because they need power and coherent light for transmission over distances of several tens of kilometers. Computer LANs use LEDs of considerably weaker output powers and incoherent light to transmit signals over distances of only 1 or 2 kilometers.

The end of the fiber is carefully cut, or "cleaved," at a 90-degree angle to its length; this produces a flat face that is carefully aligned with the LED or laser through connectors. The LED or laser then is pulsed with the electrical signal, and light is transferred to the fiber. In "single-mode" fiber, like that used in long-distance telephony, this light can enter at only one angle and therefore travels through the core in one mode, without significant refractions at the cladding.

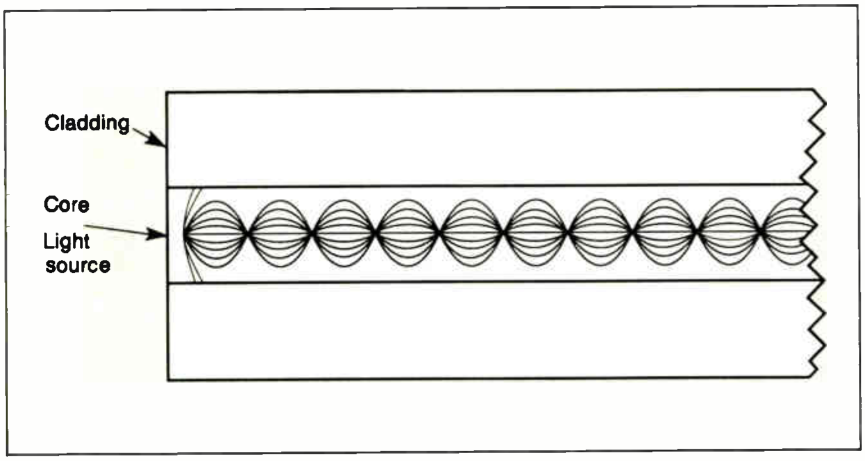

Figure 1: *With graded-index multimode fiber cable, light is constantly refocused as it travels through the core.*

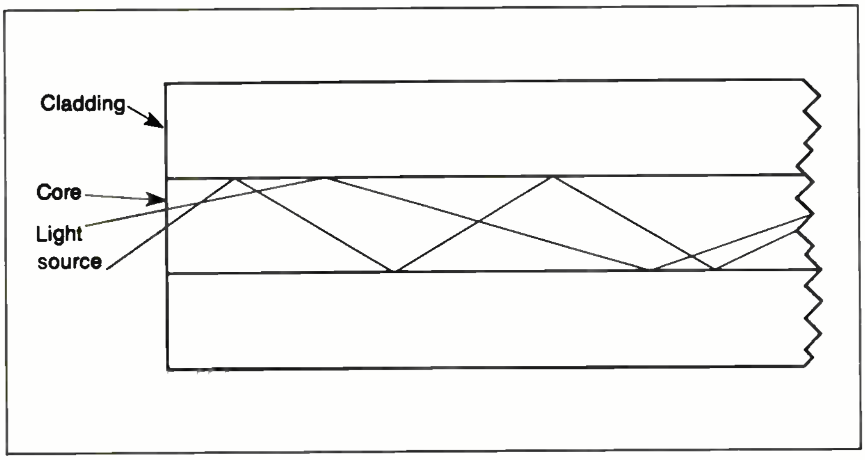

Figure 2: *In step-index multimode fiber, light travels through the fiber, being refracted back and forth from the core's boundary with the cladding.*

Table 1: *Fiber-optic performance as compared with twisted-pair and coaxial.*

	Twisted-pair	Coaxial	Fiber
Data rate per kilometer	16 megabits	500 megabits	1000+ megabits
Accessibility to being tapped	Easy	Easy	Difficult
Signal radiation	Yes	Yes	No
Potential for explosion	Yes	Yes	No
Bit error rate	1 in 10^6	1 in 10^6	1 in 10^9+
Static problems	Yes	Yes	No
Grounding problems	Yes	Yes	No
Size and weight by data rate	Large	Large	Small

In the "multimode" fiber used for LANs, the light can enter at a number of different angles, creating different paths, or "modes," of travel through the fiber. Each mode travels through the fiber, being refracted back and forth from the core's boundary with the cladding or being constantly refocused. Light entering the fiber at a shallow angle is refracted fewer times than that entering at a steep angle. (See figures 1 and 2.)

The different paths resulting have different lengths. These differing lengths ultimately result in data-rate limitations, as the different modes arrive at slightly different times. At extremely high data rates, these different modes cause adjacent optical pulses to merge into one another at the point where the practical data-rate limit for a given length of fiber is reached.

Although data rate is more limited with multimode fiber than with single-mode fiber over LAN distances of usually less than a kilometer, the multimode material can carry data rates substantially greater than 1000 megabits per second. Also, multimode fiber is easier to handle, installing connectors is simpler, and LEDs are far cheaper than the lasers used for single-mode fibers.

Comparing Cables

Fiber optics wins on almost every point when you contrast it with metallic cables (see table 1). The two types of metallic cables most widely used are twisted-pair and coaxial. Twisted-pair cables have been in use the longest and are the most misunderstood. Currently, there is a significant interest in making almost any twisted-pair found in a building carry LAN signals, because twisted-pair cable, especially that already in place, is considerably cheaper than other cable technologies.

The pressure of this idea has been so great that IBM declared an unshielded twisted-pair designated "type 3" as part of the IBM Cabling System. A number of companies have installed the cheaper cable only to discover in mid-1988 that IBM's extension of the Token Ring data rate from 4 megabits per second, which worked over reasonable distances on type

3, to 16 megabits per second meant that it would no longer work. This dilemma is generally true of metallic cables: As the data rate increases, signals degrade more and more over unit lengths of cable.

The problem results from the cable's susceptibility to interference (in metallic cables, this is at least partially protected by shielding) and attenuation of signal levels in a fashion more detrimental to high-frequency than to low-frequency components. The typical digital signal begins as a square wave. A square wave is a collection, at least theoretically, of an infinite number of sine waves of different frequencies. Cables attenuate the low frequencies the least, the high ones the most. So as the square wave travels down the cable, it begins to decrease in strength and spread out, or round off. Adjacent square waves do the same, and pretty soon the different pulses are running into one another (see figure 3).

The signal must be regenerated in a device that can tell the difference between the now distorted wave shapes and reconstruct them as new digital ones and zeros—clean square waves. This device is usually called a repeater. In considering any cable, you must consider how much it distorts a signal over a unit distance. For easy comparison, the unit distance usually chosen is 1 kilometer.

In this article, I have considered only cables of high-quality construction and

continued

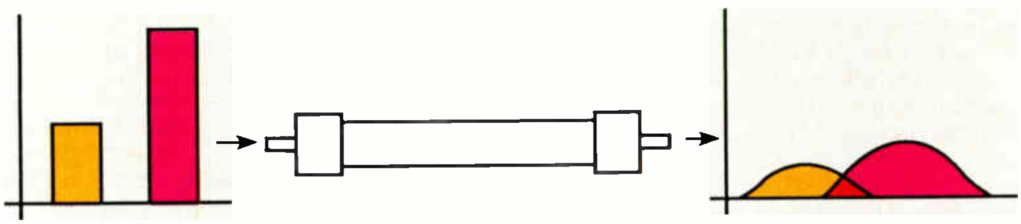

Figure 3: *The change in signal levels over metallic cable. Beginning as a square wave, the typical digital signal will weaken and round off as it travels down the cable. As adjacent square waves do the same, the different pulses run into one another.*

The Future Is Plastics

Traditional twisted-pair and coaxial cables have a few characteristics and tricks left that bear mention, especially in getting from the wiring closet to the machines on the floor. And just around the corner lurks plastic fiber, ready to bring economic light to that last link.

Twisted-pair is so widely installed that a major effort has been under way to use it for ever higher data rates. There are real limits to twisted-pair for the future. Current work to make most reasonably good twisted-pair carry IEEE 802.3 (ISO 8802/3) signals over useful distances at 10 megabits has met with success. Usually, this is called Ethernet on twisted-pair, although the Xerox-developed Ethernet, strictly speaking, is slightly different from 802.3 in details such as preamble, address technique, logical link control, type and length fields, and maximum frame size.

Previous efforts at 802.3 protocol over twisted-pair were limited to 1-megabit data rates and standardized as 802.3 1Base5. Since the newer technologies offer 10 megabits, you should expect such lower data-rate systems to fade into obscurity very quickly. Products of two manufacturers represent somewhat divergent 10-megabit twisted-pair techniques; other companies are also entering the field.

Synoptics Communications of Mountain View, California, offers LattisNet. This system uses two twisted-pairs for a maximum distance of 110 meters, depending on the quality of the wire. Cabling goes back to a concentrator. The product also provides modules for fiber-optic connections among concentrators and to individual devices. Current work by the IEEE 802.3 committee (802.3 10BaseT) is expected to standardize on a scheme very similar to this.

3Com Corp. of Santa Clara, California, has introduced a method that is considered an extension covered by the current standard usually applied to "thin Ethernet" (802.3 10Base2). In this system, devices called PairTamers are attached to thin Ethernet coaxial cable (RG 58 A/U or C/U) on one side and to a single twisted-pair on the other. With good-quality twisted-pair, distances of up to 76 meters can be realized. This is often more than adequate for ordinary building installations.

A single run uses a PairTamer at each end of the twisted-pair. The device simply converts from coaxial cable on one side to twisted-pair on the other, so no other special electronic equipment is needed. Once the conversion to coaxial cable is made, the standard thin-Ethernet methods of daisy chaining from one machine to the next and so on may be adopted. 3Com provides information for calculating the distance limitations of the combination of twisted-pair and coaxial cables; the company also provides cable-system test equipment and multiport repeaters as aids in constructing systems.

Thin Ethernet still has some tricks left also. Its standard installation requires that a loop of cable be pulled to each device; there, a tee connector passes the signal by a transceiver tap usually built into the network card inserted into a microcomputer. Multiport devices such as the DEMPR from Digital Equipment Corp. allow eight runs of thin-Ethernet coaxial cable to daisy chains of machines, converting the usual bus topology into a star.

As Dustin Hoffman learned in *The Graduate*, there is one word that defines the future—*plastics*. Plastic fiber-optic cable is here and has been for quite a while. The primary difficulty with the material has been its narrow bandwidth and high attenuation when compared to glass. Now research is leading to practical and cheap plastic fiber. Hoechst-Celanese of Somerville, New Jersey, and Codenoll of Yonkers, New York, are working together to provide such fibers for local-area networks.

Plastic fibers are 200 to 500 microns in diameter, can be cut with simple and inexpensive tools, and are installed with minimal training using connectors designed to make the job easy. Why is all this so simple and applicable to the wiring-center-to-machine connection? The distances involved are short, 100 meters or less, and many systems contemplate regeneration of the signal, either at the wiring center, the machine, or both; thus, signal-loss budgets of 20 dB usually available in an optic system allow otherwise sloppy, high-loss connections characteristic of the rough techniques developed for plastic fibers.

Watch for plastic fiber over the next year; it will probably be your cable of choice for workstation hookup. It may be offered so cheaply that you will choose to pull it in along with twisted-pair or coaxial cable waiting to install connectors and actually use it when electrical-to-optical conversion costs drop.

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standard type; hence, my estimates are at the high end of performance. For twisted-pair in particular, the types found strung throughout buildings after being abandoned by telephone companies are at best only vaguely known and thus not adequately standard to provide a basis for comparison. IBM's full-specification cables, such as "type 2," provide a more predictable base.

How Do They Perform?

Data rate: Twisted-pair is by far the poorest performer in terms of data rate per unit distance. The better grades, such as those that meet IBM's type 2 specification, are good for perhaps 16 megabits per second over a kilometer. Coaxial cable is far better, having a capacity of 300 to 500 megabits per second. But fiber optics is the hands-down winner, being able to carry more than a gigabit (1000 megabits) per second over that same kilometer. We don't make use of those data rates now, but the future holds that prospect.

The most exciting prospect for high data-rate communications is called the fiber distributed-data interface. It's currently in the final stages of specification as a fiber-optic token-passing ring that operates at 100 megabits per second. That rate has a variation to 200 megabits per second, and increases beyond that are anticipated. The FDDI specification will initially furnish the backbone connecting slower LANs, but, as our machines improve in power, we'll need to directly connect such high-speed fiber-optic networks to our mainframes, minicomputers, and even microcomputers.

Security: Security of the cable system has become a major concern of many LAN installations. At the extreme, complex specifications, such as the Tempest rating promulgated by the Department of Defense, are required of electronic cables and gear; a great deal of the Tempest specification deals with shielding. Installations that are even more secure require a fuller complement of cable protection, including encasing cables within thick conduits and blocking all wall penetrations; the Strategic Compartmentalized Information Facility requirements furnish an example.

You can tap metallic cables with rather simple devices; the amount of signal energy removed by such taps is usually too small to be detected by all but the most sensitive instruments located elsewhere on the cable. Fiber-optic cables, however, are very difficult to tap. And if a successful tap is made, the signal drawn from the cable is on the order of a decibel or more, an amount easily detected by standard optical-measuring equipment.

Metallic cables carry signals that are basically radio waves. The cables act like antennas radiating their signals freely. Good-quality shielding greatly limits this radiation, yet shielding is not perfect. A poor connector may have a great deal of leakage. Fiber-optic cables do not radiate at all.

Explosion potential: Consider a fuel depot, an oil refinery, a chemical plant, an operating room where explosive anesthetics may be used, or a gunpowder plant (I actually designed a fiber-optic system for a gunpowder plant). In each instance, using metallic cables that carry electricity adds to the danger of creating a spark and a subsequent explosion. Fiber-optic cables have no such dangers.

Bit error rate: Tests performed by various laboratories have shown that about one error in every 1,000,000 bits can be attributed to metallic cables. Similar tests on fiber-optic cables show 1000 times fewer errors, or one error in every 1,000,000,000 bits, or better.

Static: The most important instance of static is lightning. A lightning strike within 100 or so meters of a metallic-cable system can induce a very strong voltage flow in the cable, destroying equipment and, perhaps, endangering people. Since fiber-optic cables need no metal components, lightning can't induce a voltage.

Grounding problems: We've all heard the 60-Hz hum that results when an audio plug is being inserted in an amplifier. That hum occurs when the center pin goes in and the shield is not firmly connected. It reminds us that the earth is the return for all currents, and we are surrounded by a 60-Hz power system inducing current flow in all metal.

If a communications line is slightly less than perfectly grounded, such a "hum loop" may result, with the potential for interfering with signals. Different points within the same building, and certainly between buildings, have different grounding potentials. Equalizing these potentials is often very difficult. At worst, the differences found could be dangerous to people coming into contact with cables connecting two points. Fiber-optic cables have no possibility of this kind of current flow.

Size and weight: A quick glance at representative cables and their respective data-rate capacities shows that fiber-optic cables are far smaller and lighter than their metallic counterparts. This leads to ease of installation, since less equipment and less labor are required to pull in major cable runs.

But How Much Does It Cost?

OK. You're convinced—fiber optics is the best way to go for performance and for the future. But isn't it prohibitively expensive? See table 2.

Cable cost: Almost everyone thinks that fiber-optic cable is very expensive when compared with twisted-pair and coaxial. However, for quality cable that you would use in a well-designed LAN for a moderate-to-large setup, the basic cable costs are the same: $0.50 to $1.00 per foot. Plenum cable for use in areas where air is moving, above the ceiling grid in most recently built buildings, costs about two to three times as much. The cost of the cable itself is a constant.

Installation: Twisted-pair and coaxial

continued

Table 2: *Fiber-optic costs versus those for twisted-pair and coaxial cables.*

	Twisted-pair	Coaxial	Fiber
Cable cost per foot	\$.50–1.00	\$.50–1.00	\$.50–1.00
Installation	1*n*	1*n*	2*n*
Design	1*n*	1*n*	2*n*
Testing	1*n*	1*n*	1.5*n*
Electrical to optical	None	None	+50% to +100%

require about the same amount of labor to install. Fiber-optic cable installation costs about twice as much, due in part to the higher skill level required, but more to the law of supply and demand. Few qualified installers are currently available; thus, they can charge a higher price.

Design: Systems of any size must have qualified designers. You don't just drop a cable system for a particular LAN into a group of multistory buildings; extensive design work must precede installation. Twisted-pair and coaxial designs cost about the same. Fiber-optic design will cost about twice as much, again due mostly to supply and demand.

Testing: Testing twisted-pair and coaxial cables involves well-known techniques and generally available instruments. Since fiber is not so well known and its test instruments are more costly, testing fiber-optic cables costs about half again as much as testing metallic cables.

Electrical to optical: Neither twisted-pair nor coaxial needs any special conversion devices to connect to a computer. Fiber-optic systems require circuits at each device that convert electrical signals to optical signals and vice versa. These circuits can add 50 percent to 100 percent to the price of the network interface. Manufacturers, such as Codenoll of Yonkers, New York, and Siecor of Research Triangle, North Carolina, have been reducing the prices of these conversion devices over the past 2 years.

Where Do You Start?

So, you're convinced. You want to get into fiber and beat the crowd that will finally acknowledge the inevitable 3 to 5 years from now. Where do you start? You start by trying to figure out what the standard fiber is, how to connect it, and where to use it.

Over the past several years, LANs have used a confusing selection of core and cladding sizes. Cores of 50, 62.5, 85, and 100 microns have all found favor at various times. All but the 100-micron core have cladding diameters of 125 microns; the 100-micron core has a 140-micron cladding. IBM has specified the 100/140 core/cladding cable as "type 5" for its Cabling System. Yet, when connecting to cluster controllers, IBM uses the 62.5/125 cable developed by Western Electric. Most forecasters believe that this will be the dominant fiber size in LANs. Although there are other contenders, the SMA 906 connector is usually the one found on LAN equipment.

Where do you use fiber first? Due to the grounding problems, potential for interference, and ease of installation, connection between buildings is the place to start. Most LAN designs contemplate this (e.g., the use of the fiber-optic "remote repeater" in IEEE 802.3 networks). Next, use fiber optics for the riser cable among floors in multistory buildings. Again, ease of installation and limited numbers of necessary optical-to-electrical conversions make this an appropriate selection.

The last question becomes when to install fiber directly to each workstation on the network. Fiber-optic interfaces are available for this now, but they add to the cost. Installing all the drops to all the workstations could add up to a considerable expense. (For a less-expensive alternative, see the text box "The Future Is Plastics" on page 256.) This step also involves some specialized equipment, such as "star couplers," that replace the usual bus topology if your LAN is based on the IEEE 802.3 contention model. If you use the IEEE 802.5 Token Ring, various manufacturers, such as Proteon of Boston, Massachusetts, already offer appropriate fiber-optic interfaces.

For many installations, adding the workstations may be too expensive or complex at the present time, but within the next few years, fiber will go all the way to the end user's workstation—a workstation that will have a huge appetite for the amount of information that only fiber optics can satisfy. ■

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Looking for Trouble

If your LAN's performance falters, software may be the culprit

Harry Saal

Sooner or later, every local-area-network manager senses it or starts to hear it from the users: Operations that once seemed fast now take longer. Sometimes a lot longer.

Unfortunately, while a network is fantastic when it works well, it's depressingly complex when you have to decide what needs fixing. It's assembled from many components: workstations, servers, their respective operating systems, cables, cards, LAN management software, standard applications, the users' own applications, plus everybody's batch files and handy utilities.

When something goes wrong, how do you find the problem? Is it the hardware? The cabling? The users? Is it time for an upgrade? (See the text box "Tricks of the Trade" on page 260.) Well, actually, many network problems are software problems—either its design, use, or installation.

Although software snags are often the cheapest and simplest problems to fix, they are often ignored as people search for hardware trouble. In fact, LAN design and management courses often reinforce this hardware bias and give first priority to the system's physical aspects. Many courses discuss troubleshooting via sessions on how to use a time-domain reflectometer to locate cable breaks or impedance mismatches, or how to locate a card that's jabbering (transmitting nonstop and jamming the network), but none on how to spot a defective routing table or a mistaken bit in a server's access authorization.

Spotting the Problem

Automatic recovery from an error is fundamental to the design of many LAN components. Every time a workstation launches a packet (or frame—the terms are equivalent) onto the network, it has to assume that the packet may not arrive. On a bus system, there may be a collision as two workstations try to transmit at once. On a ring system, there may be a break as another workstation inserts into the ring or drops out. On any of them, the receiver may be busy, or its buffers may overflow. And of course there may be noise or interference so that the packet arrives damaged.

For all these and dozens of other reasons, LAN protocols have a number of provisions for retry and recovery. In the end, the message gets through. Network speeds are high enough to allow many retries; most of the time you won't even notice.

This built-in recovery complicates the task of testing and troubleshooting. When a link is cleanly severed so nothing gets through, you can locate the break relatively quickly. But when there's a partial failure, the system's own recov-

continued

Tricks of the Trade

Having a problems with your LAN? One of these options may help:

• Upgrade your network server's operating system. You may find that features such as backup, shared-file interlocks, and manager maintenance may be more important than gross speed. Probable costs: $500 to $5000, times the number of file servers.
• Upgrade the version of DOS for the workstations. DOS is still what directs each workstation's work and redirects requests for network files to the network. Versions differ both in the resources they support and in the way they do it—and in the amount of space they consume. Probable costs: $50 to $100, times the number of workstations.
• Switch to different software on your current network hardware. This is a major change. Probable benefits: unclear. Probable costs: Thousands of dollars per file server, bridge, or gateway, plus the costs of the organizational impact of a whole new set of network commands and conventions.
• Upgrade to a faster network technology. This is a big one. There's a factor of 10 difference in the transmission speeds of different cabling systems. But is that where the problem is? To take advantage of a different network technology, you almost have to start over, with a new design for cable layout, new network boards at each workstation and server, and perhaps different servers. Probable costs: Incalculable.
• Split the network into subnets with gateways or routers. Each subnet you create will be freed from other subnet traffic. Each packet that has to traverse the bridge must go through additional processing and transmission time. Probable cost for the installation of a bridge: $5000 to $10,000.
• Add another file server. Distributed file servers may ease access, give you redundancy in case of a failure at one of them, and reduce traffic to each. Adding an extra file server may also introduce new problems of dividing storage between them, assigning users to servers, and finding where anything is. Probable costs: $3000 to $9000 for each file server, depending on speed and capacity, plus software and licensing.
• Upgrade your server's CPU speed. There's a range of 5 to 1 in CPU speeds of machines that might be servers. Switching to a faster server CPU might help, or it might do nothing if that's not where the bottleneck is. Probable cost: $500 (for a turbo board) to $10,000 (for a suitably equipped top-of-the-line 30-megabyte 25-MHz 80386).
• Upgrade your server's disk speed. There is a range of at least 3 to 1 in the access time of the disk. If requests don't get through to the disk, it may be idle. But if the server is being swamped with needless requests, speeding it up may not help. Probable costs: $1000 to $4000, times the number of servers.
• Upgrade server cache memory. If the server doesn't have the memory to stack incoming requests, it may have to discard them, forcing the workstations to retransmit. If it doesn't have the memory to save data that's ready to send, it may have to retrieve it again, requiring new disk accesses. Probable costs: may be zero if you can reallocate cache from

Table A: *The 19 adjustable parameters in IBM's PC LAN.*

Parameter	Explanation	Default	Min.	Max.
SHR	Number of available network directories	5	1	150
RDR	Number of user workstations served	10	1	29
REQ	Number of network request buffers	2	1	3
RQB	Size of each network request buffer (REQ × RQB may not exceed 48K bytes)	8K bytes	5K bytes	32K bytes
TSI	Time-slice ratio of net and local processing	5-4	0-0	9-9
PRB	Size of print-spooling buffer	5K bytes	5K bytes	16K bytes
PRP	Printing priority vs. other local processing	3	1	3
SHB	Size of buffer for regulating shared R/W	2K bytes	5K bytes	60K bytes
SHL	Number of locked ranges in shared files	20	20	1000
USN	Number of message aliases	1	0	12
MBI	Size of incoming message buffer	1750 bytes	5K bytes	60K bytes
CMD	Number of concurrent NetBIOS commands	8	*	32
SES	Number of concurrent NetBIOS sessions	16	*	*
SRV	Number of servers used	2	1	31
ASG	Number of network devices open	5	1	32
NBC	Number of network buffers	3	1	64
NBS	Size of each network buffer (NBC × NBS must not exceed 32K bytes)	.5K bytes	.5K bytes	32K bytes
PB1...3	Size of buffer for each network printer (Sum of PB1...PB3 may not exceed 16K bytes)	1K bytes	80 bytes	16K bytes

* Depends on server configuration and values of USN and REQ.

ery procedures often overcome the fault and thereby mask a chronic problem.

It's not unusual for a network's speed and resilience to mask a program bug that in any other context would be obvious. Imagine, for example, that someone puts together an electronic mail system in which (because of a programming error) each workstation routinely sends every message 15 times. (Don't laugh; a test with AND where it should say OR produced this.) Further imagine that each receiving workstation, when it finds it has multiple copies of the same logical message, discards earlier versions and keeps only the last. When the system is tested on a lightly loaded network, each message sent from A to B arrives properly. Network speeds are so high, and there are so many other variables at each end, that no one notices the 15 repetitions. So the system is installed.

Knowing the length of the average message, the number of workstations, and the number of messages each workstation sends, LAN managers can easily estimate the system's capacity. But as the load grows, those 15 repetitions begin to take their toll. Users begin to complain. Has something broken? Not really. The existing memory; $500 to $2000 per server if expansion memory is required.

- Upgrade workstation speeds. In most environments, the real work is still done at the local workstations. When users complain that response is slow, it's always possible the problem has nothing to do with the network but is entirely within the local workstation. Probable costs: $500 (for a turbo card on an existing machine) to $8000, times the number of workstations you upgrade.
- Upgrade workstation cache memory. The approach here is not to speed up transmission through the network, but to reduce the need for network requests. If you have less than 640K bytes of RAM, by all means bring each workstation up to that point. There are numerous ways to use additional RAM beyond that. Probable costs: $500 to $1000 per workstation upgraded.
- Upgrade width of data path on network-interface cards. There's variation in the method (and hence the speed) with which cards transfer data from the workstation's main memory and return it. A major consideration is whether the card uses an 8-bit or a 16-bit bus. Probable costs: $500 to $800, times the number of workstations upgraded.
- Upgrade the "smarts" of your network-interface cards. A "smart" network card can do much of the network processing (e.g., decoding various levels of network protocols) on the card, while the workstation CPU does something else. A "dumb" card may have to steal processing from the workstation CPU—and that may or may not make a difference in what the user sees. Probable costs: $500 to $800.
- Adjust network parameters, an easy and cheap change. Making sense out of which to change is not so easy. Cost: little or nothing in dollars, but lots of time experimenting and figuring them out. As an example, table A lists the adjustable parameters in IBM's PC LAN.

bug was there from the beginning; they just didn't notice it at first. A lightly loaded network usually has so much excess capacity that even gross errors aren't noticed until later when load builds up.

A Troubleshooter's Tools

Simple LAN evaluation devices concentrate on physical measurement, such as bits-per-second transmitted, or bits-per-destination accumulated over a sampling interval, perhaps sorting these by the workstation to which they're addressed. These summary tabulations accurately quantify the total flow, but they do little to identify specific software problems.

If you manage a LAN, you must move beyond being able to spot a problem; you must be able to analyze the cause of the problem. Overall statistics let you say, "Yes, indeed, there's a problem," or even "The problem has something to do with workstation X and server Y." But such measurements still give you no idea what they're transmitting or why they're transmitting it.

To look in detail at transmissions, you have to be able to eavesdrop on the network. To understand what you're hearing, it's essential to decode the protocols. You have to be able to work back through the various layers to look at what's being said. This is no simple matter because there are so many layers to decode; a typical packet may contain many levels. The lowest level, data-link control (DLC), specifies the workstation address of the source and destination, the gross length of the packet, and the type of message it contains. That message in turn contains a header and an indicator as to the type of message it contains, and so on for as many levels as the situation requires.

For example, on a token ring running Novell NetWare, an acknowledgment from the file server that a file has been opened typically contains four nested messages (see figure 1). They range from a generic token-ring message at the DLC level, through an indication of the logical destination and protocol (Xerox Network System transport protocol, or XNS), to, finally, the actual message—in this case, in the encoding adopted by Novell.

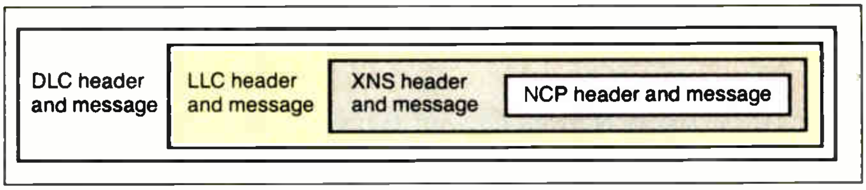

Figure 1: *On a token-ring LAN running Novell NetWare, an acknowledgment from the file server that a file has been opened typically contains four nested messages. They range from a generic token-ring message at the DLC level, through an indication of the logical destination and protocol, and finally the actual message—in this case, in the encoding adopted by Novell.*

There are altogether 91 bytes at the DLC level. Of those, 77 are the LLC (logical link control) message, 74 of which are the XNS message. Of those 74, 40 bytes are the Novell NCP (NetWare Core Protocol) message, 12 of which are devoted to the file's name and 6 to its handle. At each level, the length and type of the message is arbitrary, so decoding must thread back from the lowest level to the highest before even establishing the boundaries of the various messages.

Message interpretation is not self-contained. For example, figure 3 is a reply to an earlier request; interpreting it depends in part on knowing what the request was. All this can be done, but it's far more work than just converting hexadecimal bytes to operation codes or letters of the alphabet.

Once you can read what the machines are saying to each other, many problems become ridiculously simple—and very easy to fix. While the effort or cost of decoding is substantial, the rewards are enormous. That is, if you consider the large potential costs of possible system upgrades, the investment has very high leverage.

A Potent Illustration

The following example illustrates the problems revealed by protocol decoding. Imagine you are a user at a workstation and you want to open a word processor called WP, stored in a public directory of a network file server. When WP was first installed (when network usage was light), you just typed WP and up came the word processor. Now there's a small but irritating delay. Counting frames by destination reveals a surprisingly large burst of packets sent back and forth between the time you ask for WP and the time it's delivered. What's going on?

Putting a protocol analyzer on the case reveals that each successful use of WP is preceded by a string of "file not found" messages. Looking at the details of those messages, you find that whenever the workstation requests the file, it runs through a series of requests in which the file's name is stated with an incorrect path. When it finally asks for the file correctly, the workstation gets it at once.

continued

Troubleshooters

If you are thinking of buying LAN-monitoring devices, the following list may be helpful.

• Software installed to supplement existing hardware. You can install these programs, probably the least expensive and easiest to install of the options, on an existing network workstation.

EtherProbe Network Analyzer $995
For workstations using 3Com's EtherLink Plus network-interface card. Monitors and displays Ethernet XNS and SMB packets.
3Com
3165 Kifer Rd.
Santa Clara, CA 95052
(800) 638-3266
(408) 562-6400
Inquiry 976.

LANWatch $1200
Works with a variety of Ethernet cards. Useful for studying network traffic.
FTP Software
P.O. Box 150
Kendall Square Branch
Boston, MA 02142
(617) 868-4878
Inquiry 977.

• Special network card and software kit, for installation on an existing PC. Here you can install a vendor- or protocol-specific system instead of a standard network-interface card, permitting a workstation to act as a conventional workstation or as a network analyzer.

LANalyzer EX5300 .... $9975
For Ethernet and StarLAN. Install in an AT compatible. Collects and records incoming packets through 16 independently programmable filter channels. During playback, packets can be displayed in hexadecimal or ASCII, with decoding of DLC and LLC packets and identification of codes in TCP/IP, DECnet, XNS, AppleTalk, MS-NET, ISO, and NetBIOS.
Excelan, Inc.
2180 Fortune Dr.
San Jose, CA 95131
(800) 392-3526
(408) 434-2300
Inquiry 978.

LAN DETECTOR ..... From $10,995
For Ethernet, 10-megabit twisted-pair Ethernet, or StarLAN. Install in an AT compatible. Can be connected on thick, thin, or unshielded twisted-pair cabling. Implements the protocol-interpretation capability designed into The Sniffer.
Interlan, Inc.
155 Swanson Rd.
Boxboro, MA 01719
(800) 526-8255
Inquiry 979.

• Self-contained specialized collector and analyzer. A specialized workstation, including built-in hardware and software for tabulation of summary statistics and filtering of packets to be analyzed.

ISOLAN 1140 .... $7950
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Westborough, MA 01581
(508) 898-2422
Inquiry 980.

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Inquiry 981.

Excelan EX5500 .... $15,750
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(415) 965-1800
Inquiry 982.

Why does the workstation go through this sequence of invalid requests each time? Because the network has inappropriately carried something over from the single-machine environment: reliance on the DOS `path` command to let DOS search directories in which a file might be found. Although the `path` command still works, it can place a needless load on the network.

Each workstation has access to disk drives of its own and directories on one or more network file servers. The usual way to refer to the network directories is to assign them letters so they look like virtual drives. A workstation with drives A and C of its own might then configure virtual drives with names somewhere between D and Z as names for network directories.

A Bird's-Eye View

Each workstation starts up with an AUTOEXEC.BAT, which sets various parameters, starts the network software, and assigns names to network directories. It also sets the `path` command. This gives DOS a list of drives or directories in which to look for an executable file (i.e., one whose extension is .BAT, .COM, or .EXE).

When you simply type the name of a file (e.g., WP to access your word processing program), DOS always looks first in your current working directory. If there's no executable file of that name there, it checks a reserved area of memory called the DOS environment for a `path` statement. The `path` consists of a list of drives or directories separated by semicolons. DOS searches each of those directories in the order in which they're listed. As soon as it finds an executable file whose name matches, it stops searching and reads and executes the file.

Trying to make things simple and consistent for everyone, LAN managers usually define `path` so that, on each machine, DOS first looks in the root directory of the workstation's own hard disk, then in a network virtual disk assigned as a private area for the user, then in turn in each of several network directories devoted to different kinds of applications. Each cluster of network directories is assigned to a virtual drive. In IBM's PC LAN, it might look something like this:

```
NET USE F:\\FileServer\NET\
  PRIVATE\UserID
NET USE P:\\FileServer\NET\
  PUBLIC
```

Each application has a directory of its own. An application package's instructions typically suggest creating an exclusive subdirectory. The manager of the LAN then creates on the server a separate directory for each application. So that each workstation can find any network application, in whatever network directory it may reside, the manager sets each user's `path` in a way that guarantees that DOS will find the application. The path is something like this:

```
path=\;C:\;F:\;P:BAT;P:\SPREAD;
  P:\ACCTS;P:\MAIL;P:\WORDPROC;\
```

After everyone has installed this setup, a few quick tests demonstrate that it works and is easy to use. But what really happens? Every time you execute WP, the workstation's DOS looks for WP in the current directory and then in the local hard disk. Not finding it in either of those, DOS asks the network file server to look in one of the directories identified in the workstation's `path`. When the server can't find the file there, the workstation asks for it in the next directory.

Since (in this example) the correct path is the sixth of the network directories, the workstation asks the file server to look in five wrong directories before it hits the right one. Each of those wrong requests generates a directory search at the server and a pair of network messages.

continued

Some Simple Remedies

Several simple remedies will solve problems like the one just mentioned. They all involve less reliance on the path command for finding files.

• *Using synonyms*. Some DOS shells provide a synonym facility in the workstation. When you type a command, the shell looks in a table of synonyms, so that (for example) when you type WP, the shell immediately substitutes

```
\\FileServer\Net\Public\Word-
Proc\WP
```

in the command that it passes to DOS.

Using synonyms means that each workstation needs a table that pairs the local name for an application with the full network path to it. With the synonym table downloaded to each machine (e.g., at start-up), there is no searching of directories, and the machine can directly transmit a request for the needed file.

• *Centralizing executable files*. Network managers can decrease searching by not creating separate subdirectories for each application and by putting all the applications in one directory, called, for example, APPS or BIN. Then there's only one network directory on everybody's search path.

• *Establishing and enforcing standardized batch files*. Retain separate network directories, but put a common network directory of batch files on everybody's search path. Make sure these batch files don't rely on the path command to locate directories, but instead contain explicit paths. The batch file WP.BAT has to say the following:

```
Z:\WORDPROC\WP.EXE %1 %2
```

If the batch file stipulates the letter for a virtual drive, all users must adopt a common convention for assigning drive names to network directories.

The Importance of Caching

Each personal computer has a CONFIG.SYS file that tells DOS how to set up the machine each time it boots. One of these parameters sets the number of buffers in main memory for reading from the machine's own disks. The disk-read buffers amount to a cache: easily accessible temporary storage for items you're likely to want again.

Caching is based on statistics: When you ask to read part of a file, chances are that in a few milliseconds you will ask for more of the same file. So DOS gambles. When you ask to read just a little, often it reads not only what you asked for but the following bytes as well. It keeps what it just retrieved in a buffer. Experience shows that's what you're likely to ask for next. When you do ask, it has what you need right there in memory, without requiring another disk access.

When your personal computer serves as a network workstation, it sets up another set of similar buffers, but for caching data received from a network server. Caching at the workstation is important, not so much because it saves transmission time—depending on the disks involved, it may or may not—but because it can greatly reduce the number of requests to a network file server.

> *Caching has a price. To the workstation, it means setting aside a part of main memory that might otherwise be used for active programs.*

Caching has a price. To the workstation, it means setting aside a part of main memory that might otherwise be used for resident software or currently active programs. Occasionally, it means sending a long packet when in fact only a small part of it is used. If you set aside too much space for buffers, you starve the programs that the cache is supposed to serve. The payback is its effect on network traffic, especially on the number of packets transmitted.

To collect an example for this article, we set up a protocol analyzer to report traffic between a workstation and a network server on a Novell token-ring system installed at Network General's headquarters. We had intended to measure the flow with normal caching at the workstation, and then measure again after we deliberately disabled the workstation's cache. In running this simple test, we were surprised to find a nice example of a common problem that we didn't realize we had. Despite the fact that each workstation had allocated a cache, in the sample we observed, the workstations were failing to use it.

On this network, every workstation starts out with a standard menu that it downloads from a central server. First, we recorded the workstation's request for the file and the server's response. To our surprise, the trace of "normal" operations showed 13 consecutive reads and acknowledgments just to get one batch file of 263 bytes. Although the workstation had allocated a cache, clearly it wasn't using it. The workstation was asking the server to send almost the same fragment over and over. Why?

Our next step was to look in detail at the workstation's request to open the file and the file server's reply. Decoding the workstation's first request, we saw the contents of figure 2 at frame 53.

The workstation requested "exclusive read-only" use of the file (hexadecimal 11). Figure 3 is the reply it got from the server. The server opened the file, but rejected the request for "exclusive" use and instead provided "shareable" use. It did that because at the server, the file was flagged "shareable, read-only."

Following normal NetWare rules, a workstation does not buffer a file that is opened as "shareable." Here's the reasoning. "Shareable" permits concurrent access by different users. Some of them may have read-write access. If there's a possibility that someone else may be updating the file, it would be dangerous to read ahead. That's because after your machine reads part of the file into its cache but before you refer to your cache, someone else may update the file, making your cached version obsolete.

At the server, this file is flagged "read-only." There's no way another user could be updating it. Although *we* knew that, the workstation had no way of knowing. The workstation knew only that when it asked for "exclusive read-only," what it got was "shareable read-only." It couldn't be sure that the file server hadn't opened the file "shareable read-write" for somebody else. To be prudent, in such a situation the workstation never uses its cache.

Our LAN manager had flagged this file incorrectly. It should have been marked "exclusive read-only." Although you might not guess it from the name, this permission allows any number of people to open a file at the same time, provided they all have read-only access.

How did an experienced person like our LAN manager assign the wrong access code to a network application? Well, by reading the network manual that states: "Files flagged Shareable can be read by more than one user at a time.

This attribute is usually used with the Read-Only attribute." (*SFT NetWare Getting Started: Supervisor's Guide*, pub. 113, rev. 1.00. Novell, November 1987, pp. 5–12.)

Neither of those two sentences is false. But they lead you to believe that "shareable read-only" is just what you want for an application that many people will load from a network server. In fact, such a file should be marked "exclusive read-only." (Remember, as long as it's read-only, "exclusive" does not prevent multiple users from having the file open at the same time.) We asked the LAN manager to make that change. The effect was dramatic. One request and one reply (see figure 4) did it all.

For this simple 263-byte file: Packets transmitted declined from 26 to 2; bytes transmitted declined from 2558 to 387; and elapsed time declined from 0.163 to 0.003 second.

```
      NCP C Open file NG.MNU
NCP:  --- Open File Request ---
NCP:  Request code = 76
NCP:  Dir handle = 07
NCP:  Search attribute flags = 06
NCP:        ...
NCP:  Desired access rights = 11...
NCP:        000..... = Not defined
NCP:        ...1.... = Exclusive (single-user mode)
NCP:        ....0... = Allow others to open for writing
NCP:        .....0.. = Allow others to open for reading
NCP:        ......0. = Open for writing disallowed
NCP:        .......1 = Open for reading
```

Figure 2: *In this example, the workstation requested "exclusive read-only" use of the file (11 hexadecimal), which enabled caching; the request was rejected by the server. This action by the server disabled caching at the workstation level, causing the system to complete 13 reads and acknowledgments to receive one batch file of 263 bytes.*

```
      NCP R F=10F7 OK Opened
NCP:  --- Open File Reply ---
NCP:  Request code = 76 (reply to frame 53)
NCP:  Completion code = 00 (OK)
NCP:  File handle = 00A3 5616 4642
NCP:  File name = "NG.MNU"
NCP:  File attribute flags = 81...
NCP:        1....... = File is shareable
NCP:        .0...... = Not defined
NCP:        ..0..... = Not changed since last archive
NCP:        ...0.... = Not defined
NCP:        ....0... = Not execute-only file
NCP:        .....0.. = Not a system file
NCP:        ......0. = Not a hidden file
NCP:        .......1 = Read-only
NCP:  File execute type = 00
NCP:  File length = 263
NCP:  Creation date           = 15-Jul-88
NCP:  Last access date        = 26-Aug-88
NCP:  Last update date/time   = 8-Jul-88 18:53:02
```

Figure 3: *Here is the reply the workstation received from the server after requesting "exclusive read-only" access to the 263-byte batch file. Although the server opened the file, it rejected the "exclusive" use request and instead provided "shareable" use, because the file was flagged "shareable read-only" at the server. The workstation wasn't using its caching, because under NetWare rules, a workstation doesn't buffer a file that is opened as "shareable."*

Rel. Time	Cum Bytes	From Workstation	From File Server
0.000	67	NCP C F=31F7 Read 512 at 0	
0.003	387		NCP R OK 263 bytes read

Figure 4: *By changing a file marker from "shareable read-only" to "exclusive read-only," the packets transmitted for this 263-byte file declined from 26 to 2. Bytes transmitted declined from 2558 to 387, and the elapsed time declined from 0.163 to 0.003 second.*

Tweaking in the Dark

Many network parameters are easy to set but difficult to evaluate. For example, you can set both the size and number of network buffers. Larger buffers can diminish segmentation of file transfers. But larger buffers at the server don't help unless they're matched by the size of buffers at the workstations that use them. If making buffers larger permits fewer of them, that increases the probability that there will be no buffer free to receive a packet, so the packet must be discarded. A discarded packet must be resent.

The sender of a discarded packet decides when to resend it on the basis of a time-out parameter. If the specified time-out is too large, the sender waits idly before replacing a lost packet. If the time-out is too small, the sender worsens the contention for buffers by resending a packet that has been queued rather than lost. How can you balance these conflicting adjustments?

Making the adjustments when all you have to go on is whether or not the network grinds to a halt is so close to flying blind that it's very hard to make a rational recommendation. Listening with a protocol analyzer and making specific observations gives you a basis for noting when you've made things worse and when you've managed to improve them.

Knowing the Problem

Keep in mind three things when you run into network problems. First, you need to identify the problem. Networks are plagued with software errors, many of them trivial to fix but impossible to diagnose by guesswork. Second, you need to acknowledge the painful fact that you—the way you run your network—may be part of the problem. And third, you need to realize that you may be able to fix the problem very simply—but first you have to be able to see what's happening. ■

Harry Saal is president of Network General Corp. in Mountain View, California. He can be reached on BIX c/o "editors."

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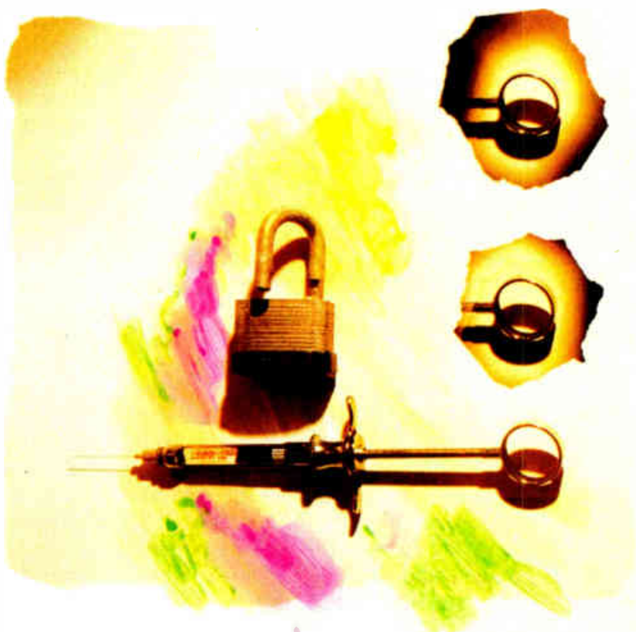
The Data Bandits

Viruses, theft, and accidental destruction are all dangerous foes when it comes to network data

William M. Adney and Douglas E. Kavanagh



Now that your personal computer is part of a local-area network, should you be concerned about the integrity of your data? Well, if you store data on the file server, yes. In fact, you may want to take additional precautions to secure your data.

In many offices that use LANs, a network administrator sets up and maintains data-security policies and procedures. But to rely solely on that person to ensure that your data is secure is neither realistic nor wise. You should do your part as well. After all, it's your information—your spreadsheet, your documents, your time and effort—that must be protected.

Protected from what? There are many potential threats to your network data in today's computing environment, but three are most common: virus programs, accidental destruction, and theft. We'll look at these threats and the countermeasures you can take to reduce or eliminate them.

Computer Viruses

Viruses present a very real problem for computer users, particularly for network users. Many viruses attach themselves to a file used by the operating system, such as the BIOS (i.e., IBMBIO.COM), the system kernel (IBMDOS.COM), or the command interpreter (COMMAND.COM). The most insidious attach themselves to COMMAND.COM and are passed on to other disks and directories by the DIR command. Unfortunately, the virus is only the latest in a series of destructive programs that began with the Trojan Horse and the Time Bomb.

The Trojan Horse program looks like it does one thing, but it actually does something else—like destroy a disk directory or scramble a disk's file allocation tables. The significant point about the Trojan Horse is that it always does its vandalism every time it runs. Like the Trojan Horse of ancient Greek lore, the program masquerades as some type of innocuous application; it can be any kind of .COM or .EXE file that purports to display graphics, list a directory, "unerase" files, or just about anything else. The disguise usually doesn't last long.

Trojan Horses can be very destructive. They can do everything from erasing files on a disk to invoking the system's FORMAT program. If the files are only erased, they can generally be recovered by an unerase utility.

If a Trojan Horse invokes FORMAT, your chance of recovery depends on your system. In general, you can't recover files from a reformatted floppy disk because most FORMAT versions actually overwrite everything. On a hard disk—

continued

including the network's file server—the network administrator may be able to recover most files (except for the root directory) with an "unformat" utility. The Mace Utilities package, for example, includes both unerase and hard disk unformat utilities you can use to recover data.

The Time Bomb is even more insidious. It can perform the same kinds of vandalism that a Trojan Horse can, but it usually does so by checking the system date and executing its destructive code on or after a programmed date. As you might guess, the Time Bomb is more difficult to detect and identify because your computer may work correctly for a long period of time—at least until the system date reaches the "bomb date." Unfortunately, you may not know you have a Time Bomb until it is too late and your data has been destroyed or corrupted.

A virus program may contain destructive code like the Trojan Horse or the Time Bomb, but it has one added feature: It is capable of reproducing itself and usually does so by "attaching" program code to one or more files in the computer system. As a result, it is extremely difficult to "kill" a virus once it is in your system, since this usually requires a detailed examination of all files to be sure that they have not been infected.

It may not be enough to delete a suspected file, because other files may be infected. Many of today's virus programs seem to like to pick the system files, such as the BIOS or the command interpreter, for their free ride into your system, and they do so because nearly all of today's popular computer systems have identical filenames. But a virus can also attach itself to just about any file in your system.

Spotting a Virus

Detecting a virus can be relatively straightforward. The first problem you might notice is that an infected system or network won't perform normally. You may have sudden and unexplainable system freezes while using the same software you have always used. Or you may have problems running the software—it doesn't save or print files properly, it doesn't respond to commands normally, or it simply does strange things.

The second way you can spot a problem is through the drive light on a floppy or hard disk drive. Does it light up every few minutes, indicating some kind of disk activity when you are not using your system? This is not a positive indicator, because some software has an autosave feature that records data stored in memory after a certain number of minutes or keystrokes. Check your software manual to see if you have this feature; if you don't, you may have a virus in your system.

Another way to spot a virus-infected program is to keep an eye on the date of .COM and .EXE files displayed by the DIR command. In particular, the date of COMMAND.COM shouldn't change unless one of the users has modified the file. Since that requires technical knowledge, you can check the date of COMMAND.COM on your DOS distribution disk, and it should be the same throughout your system on your working disks. Dates for applications software will usually be the date of installation or last upgrade. If you have a directory-listing program that displays the date of system or hidden files, be aware that some programs may update the BIOS file.

A virus is difficult to "kill" because it can reproduce itself.

One last way you can spot a possible virus is to know which files should be on a disk and which files shouldn't. Unfortunately, it's easy to "hide" files from the DIR command, so you will need some kind of utility program, such as WindowDOS from WindowDOS Associates, that displays all files on your disk. For example, the IBM PC BIOS and system kernel usually have both the System and Hidden attributes set.

In some cases, the files are also read-only. The WindowDOS program displays all filenames—including hidden, system, and read-only files—as well as the size, date, and attributes for each file. You can watch for any unexpected new files or changes in size or date to existing files by periodically running a directory utility program.

In all documented cases, there is only one way to get a virus in your system, and that is to copy an infected file or program. The bad news is that you have much more exposure to a virus, since you may not have any control of the programs and data that are placed on the network. An ounce of prevention is still worth a couple tons of cure. Unfortunately, the prevention approach presents considerable operational problems. The following three rules can help you prevent a virus from infecting your system:

- Copy program files only from original distribution disks that come in a shrink-wrapped package. This is generally safe, although in at least one documented case a distribution disk actually contained virus code. If everyone follows this rule, it will also aid in the fight against software piracy. In any event, be sure to use a known original source that you trust.
- Don't copy program files from bulletin board systems. This may or may not be a viable option because you probably won't have any control over what other network users do. Unfortunately, some viruses spread through BBSes, and conscientious operators are inventing many ways to cope with the problem. Many of us use BBSes regularly, but you should only use those that are known to be reputable.
- Finally, buy software that helps prevent a virus from attaching itself to your files. Shareware and commercial programs are available, such as the Mace Vaccine program, that intercept and warn you of all attempts to update your system files. Mace Vaccine is a memory-resident program that takes about 4K bytes of memory, and Mace recommends that it be placed first in the AUTOEXEC.BAT file. This and other similar programs can help provide some protection against most of today's virus programs.

Preventing viruses isn't easy. But if you're cautious and vigilant, you can protect your network's health and prevent data destruction or corruption.

Accidental Destruction

Accidental destruction is another threat to your network data. In fact, it is probably the most common threat to data on a file server. A head crash on the network's file server or the electronic failure of a hub communications controller can wipe out a tremendous amount of data. So can power failures.

In fact, mistakes of all kinds can cause catastrophic data loss—for example, accidental use of the dreaded DEL *.* command if you are logged on to the wrong drive or subdirectory. You can counter these threats to preserve your data. Many of these countermeasures apply to most systems even if they are not on a network.

One way to get around the DEL *.* command problem is to provide network subdirectories for each user. If all users work out of their own subdirectories, only they will have read, write, and delete privileges for files in those directories. Although other network users may have read privileges in other subdirectories, they cannot write files to, or delete files from, a directory not their own. Even so, you should always keep backups of all files in your subdirectory.

You can always opt to store your data on floppy disks in your computer and use the network only to run application programs. While this might also prevent someone from stealing your information off the network, it has the disadvantage of being slower, since floppy disk drives take longer to write data.

If you elect to store your files on the network, the best way to protect them from a head crash or other file-server problem is simply to periodically back up your critical data to a floppy disk on your own system. When you are involved in a complicated project, you should back up often—for example, every time you take a coffee break.

Theft of Information

Theft or compromise of confidential information is another potential threat to using a network. For example, let's say you are a manager using a word processor to write performance reviews on your staff or using a spreadsheet to develop the annual budget, including salaries, for your department. How do you keep that information confidential?

Sometimes, securing confidential information doesn't require a lot of special software or hardware. Since, in most cases, simple precautions are best, just don't keep that information on the network at all. Record all confidential data on floppy disks and lock them in your desk as you would any other sensitive or restricted information.

Remember that the network administrator usually has "supervisor" privileges that, of necessity, permit access to any network drive or subdirectory—but not to your floppy disks. But if you need to store the information on the network, virtually all of today's network software has a variety of internal security features defined and maintained by the network administrator.

Both public and private subdirectories and drives can be defined, and user rights and privileges can be defined for various subdirectories. You should understand what privileges you have for the server areas you use. For example, some public subdirectories (needed by all users) contain various programs you may use, and normally you can read and execute programs in that subdirectory but not write (or add) programs to it.

Also, typically, at least one public subdirectory or drive includes read/write privileges for all users and is specifically intended to allow transfer and sharing of data among individuals and departments. In addition, each user normally has a private subdirectory with read/write privileges for that single user and with read-only privileges for other users.

Some network software also provides commands that let you define specific privileges for each file. You may decide to declare a file as private, which means that only you can read or write to it. Keep in mind, however, that the network administrator and other users may have supervisor privileges that allow them to access any file on the network. If a file is really confidential, the easiest way to keep it that way is to store it only on a floppy disk.

Most of the best network software also

continued

includes access-control features that require you to enter a unique user identification (i.e., a log-on ID) and a password when logging on. It's important to choose your password carefully and keep it confidential. And you should change your password periodically—at least once every 2 months—just in case someone else has learned or obtained it.

Modem availability can create another security problem. A major point of vulnerability is a network's dial-up capability. If outside users can access your network, you may want to check with your network administrator to understand what kind of security measures have been implemented to prevent unauthorized access or unauthorized use of a networked modem.

Coping with the Security Problem

You can effectively deal with the two most common network-security problems—accidental destruction and theft of information—by using floppy disks in your system to store all data. This prevents theft of confidential data as long as you keep the floppy disks locked up. It also prevents others from accidentally destroying your data; however, you should make a backup of your original data in case you make a mistake.

Keeping a backup copy of your original floppy disk is also a good idea because it can reduce or eliminate loss of your data if a Trojan Horse, Time Bomb, or virus is introduced into the network. You may also want to keep at least two backup copies of critical files and rotate them as needed so you will have a way to recover that data—just in case.

Preventing data destruction resulting from a virus is difficult for an individual user, but you may want to consider one of the "anti-virus" programs for your individual system. Discuss this idea with the network administrator, because there may be various restrictions about running these programs on the network.

Most of these suggestions can be easily implemented on your own system. More important, you can do something to protect your data when your personal computer has been added to the network. And if you follow these suggestions, you will have taken a major step in protecting your data. ■

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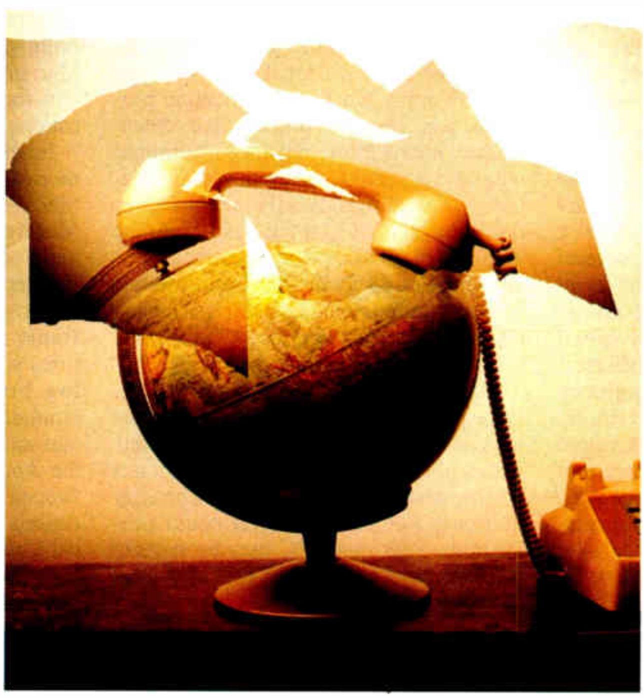

As we approach the 1990s, more people than ever before will be dialing in and logging on. The front-line troops in the current army of communications tools are dial-up communications packages. And the next decade of dial-up software is already upon us.

Software developers are pushing existing technology, anticipating new developments, and improving on tried-and-true techniques. The result is that you have at your fingertips more sophisticated and varied communications options than ever before. Let's look at some of these.

According to Script

Early communications programs had crude scripting capabilities; script files created a few years ago looked more like hieroglyphics than a command file does. And although you had to spend hours creating these nearly incomprehensible scripts, the most advanced applications for them were often no more than automatic log-on and message-retrieval functions. Enter today's command-programming languages.

The programming language found in a top communications package, such as Smartcom III from Hayes Microcomputer Products, lets you take advantage of the multitasking operating system provided for use with script programs. For example, the Simple Communications Programming Environment (SCOPE) in Smartcom III lets you write a program that will poll an on-line database every hour and download pertinent information. Such a program can run in the background while it queries the database. If the on-line session should provide some valuable data, the program can sound an alarm to warn you that something urgent has been downloaded.

You can also create "meta-applications," which involve multitasking and interprocess communications. The script language found in Relay Gold and Relay Silver is an excellent example. Relay's script language is built on an Application Program Interface (API) that allows Relay to send and receive commands and data from programs such as Ashton-Tate's dBASE III Plus. A typical application might proceed as follows:

- Your PC is set to automatically receive data from a mainframe, under the guidance of a script program.
- As your PC downloads information, Relay boots up the dBASE API and then initiates another script that sends keystrokes to dBASE to execute report-writing functions.
- The same script can then upload this report to the mainframe.
- As insurance against line noise or other induced errors, Relay can examine

continued

dBASE responses. If there is an error or the data is nonexistent, the Relay script receives the error message, interprets it based on a set of error-trapping routines coded in API, and takes action accordingly.

Such complex scripts often require the knowledge of an experienced programmer, especially if the script language is unlike the traditional programming languages. Fortunately, many of today's scripting languages resemble popular languages. Crosstalk Mk.4 from Digital Communications Associates is one such example; its language, CASL, resembles Pascal. This similarity makes writing complex scripts an easy task for those familiar with Pascal. In addition, functions built into CASL let you exchange messages between script programs that are running simultaneously.

Many of the more sophisticated scripting languages let you automatically write scripts in a "learn" mode. In this application, you log on and perform a typical on-line session while the communications program "watches" or records all your keystrokes. These keystrokes are saved, and when you issue the final command, the program compiles them into a script file. To repeat the on-line session, all you have to do is execute the script file the program has automatically written.

Some scripting languages, such as the one found in Microphone II for the Macintosh, let you write sophisticated modem controls. You can add several different modem scripts to your script file. These scripts let you take advantage of technically complex high-speed modems, such as the Telebit TrailBlazer, a modem notorious for its complexity (see "High-Speed Modems" by John H. Humphrey and Gary S. Smock, June 1988 BYTE). Using the scripting language found in Microphone II, however, controlling TrailBlazer is simply a matter of picking the modem script you want from a menu and placing it in the script you're writing.

Script languages differ greatly in ability and ease of use. In "Communications According to Script" (August 1988 BYTE), Steve Apiki and Stan Diehl supply a chart that outlines 13 top communications programs and shows how many keystrokes each needs to create a BIX script file. The numbers of keystrokes range from a low of 117 to a high of 479.

A Terminal Issue

Depending on your application, terminal emulation is either of the utmost importance to you, or it's a non-issue. Either you need it, or you don't. There is rarely any middle ground.

Terminal emulation allows a PC to act like a specific terminal attached to a mainframe or minicomputer. It's the method of choice for harnessing the horsepower found in most corporate settings. In an era of connectivity, of using all the computing resources that exist within an organization, terminal emulation is vital. And you are likely to find that you need to access several different types of mainframes or minicomputers, each geographically distributed.

The needs for terminal emulation range from simple data entry to allowing your PC to act with some intelligence. The bottom line for those needing terminal emulation, however, is access to information from a remote host; the hows and whys are unimportant. Since the number and type of hosts may vary, you need a flexible terminal-emulation package—one that can emulate several different brands and models of terminals and cope with various hardware setups, and one that you can upgrade as new protocols are instituted.

The best terminal emulations can download data from a host and then return to the PC's own local intelligence so you can apply whatever application program you need to process the downloaded data. More advanced terminal emulations include data-conversion features that automatically reconfigure downloaded data so it fits easily into the displays of PC-based applications. The file-transfer protocols built into today's dial-up communications packages let you make quick "start-and-stop" mainframe accesses in emulation mode.

Maximum flexibility comes from software packages that let you redesign the keyboard to their preferences or in line with a particular application. Bitcom lets you program in custom-keyboard configurations. For example, you could program the keys that a PC uses for certain commands to have those same meanings under terminal emulation.

Relay Gold has a programmable-keyboard feature that lets you switch among several types of keyboard configurations without having to learn each different one. You have the keys in the positions that are familiar to you, something not possible when switching between standalone terminals.

Screen emulation is also of key importance. The ability to display 132 columns is vital to spreadsheet programs. Using a PC for these applications, however, requires more than software-based terminal emulation. For 132-column displays, you need additional hardware—a plug-in board and a special monitor. Or you could use side-to-side scrolling. This technique displays the standard 80 columns on the screen; to look at the other 52 columns, you scroll right (or left) to bring the "off-screen" characters into view.

Some packages place terminal emulation in the PC's memory so that you can operate it as a terminate-and-stay-resident utility.

Today's dial-up communications products offer a wide variety of terminal emulation. However, of the top-selling communications programs, only three offer IBM 3270-type emulation: Crosstalk Mk.4, Crosstalk XVI, and Procomm Plus. And none of these is a complete emulation in and of itself. The two Crosstalk packages require additional hardware (a plug-in board), and Procomm Plus requires a 7171 protocol converter or its equivalent.

Terminal emulation in the Mac environment is starting to gain some speed, too. As the Mac has moved from a closed system architecture to an open one with the advent of the Mac SE and the Mac II, promising developments have pushed the Mac into view as a viable front-end system for IBM-to-DEC mainframe applications.

Earlier this year, Apple unveiled two promising new development platforms: MacWorkStation and MacAPPC. The MacWorkStation is composed of three main communications modules for sending serial and binary data. High-level programming interfaces allow mainframe applications to exploit Mac features such as menus, windows, and dialog boxes. The result is terminal emulation that melds with the Mac icon-and-mouse user interface. MacAPPC is the Apple implementation of IBM's Advanced Program-to-Program Communications (LU 6.2) protocol (see "A Logical Choice" on page 309).

A Matter of Protocol

File-transfer protocols are the heart and soul of any dial-up communications program. In the beginning, there was XMODEM, and only XMODEM, which was developed in 1977 by hobbyist Ward Christensen to let one of his computers trade files with another. He placed the protocol in the public domain, and the rest, as they say, is history.

Because XMODEM was the only publicly available file transfer, it quickly became the de facto standard. Today, there isn't a dial-up communications package

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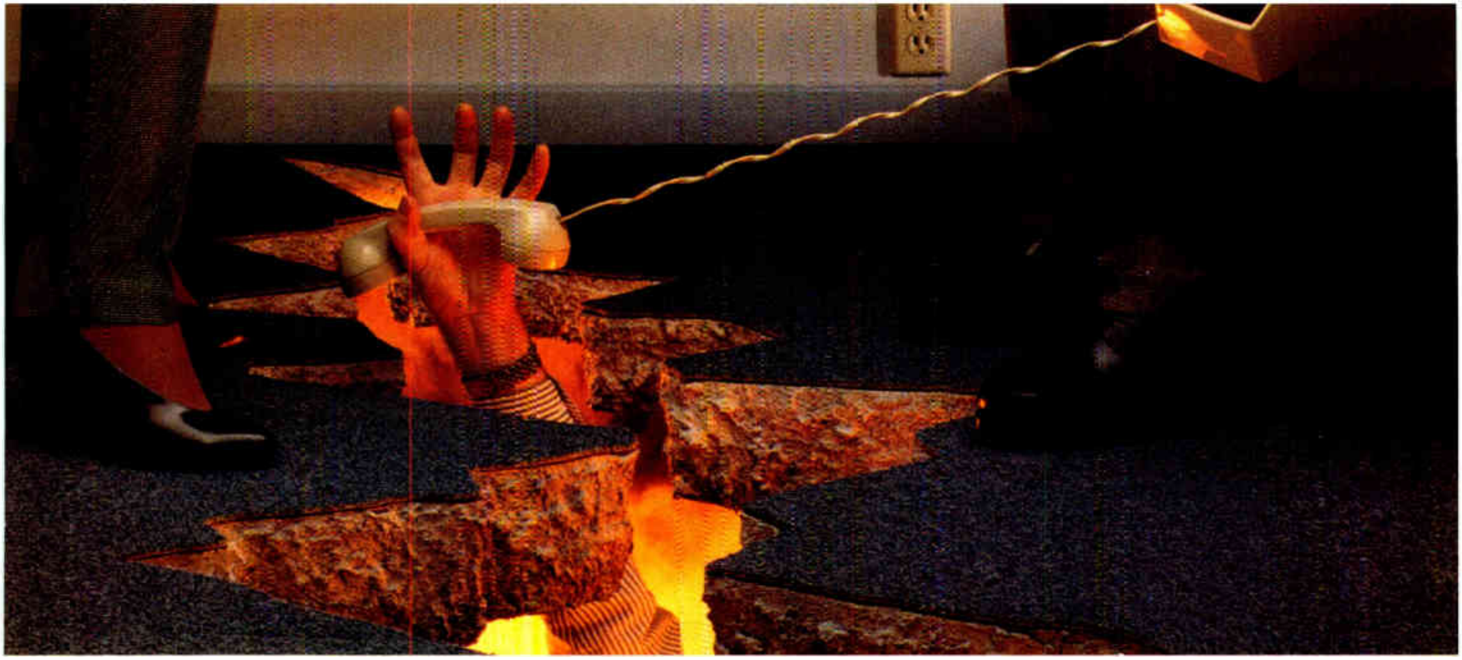

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available that doesn't implement some version of it. I say "some version" because no standards were ever written for implementing XMODEM. As a result, various implementations exist—some good, and some not so good. Now, some 12 years later, there still aren't any standards for file-transfer protocols, a situation that has led to a variety of them, each satisfying a particular need.

Today, there are at least a dozen different file-transfer protocols in the public domain, as well as a handful of proprietary ones. Most of the top-selling communications programs have their own protocols, each designed around what its manufacturer considers to be the best method for sending files across the public telephone network.

The trouble is, these proprietary protocols, regardless of how effective they

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are, can't talk to one another. For example, if you're not running Crosstalk Mk.4's DART protocol end-to-end, you can't use DART to transfer files. Thus, in the spirit of reaching most of the people most of the time, the majority of telecommunicators use some form of public domain file-transfer protocol.

There are two levels of public domain protocols: those like XMODEM and Kermit, ubiquitous among dial-up software packages, and those developed and put into the public domain in hopes that they will become standards, like Tymnet's X.PC, Microcom's Microcom Networking Protocol (MNP), and Hayes's FAST.

Don't expect any standards to emerge, however. The international standard-making bodies, such as CCITT, ANSI, and IEEE, have avoided trying to develop a file-transfer standard. Protocols like Kermit and XMODEM defy definition. They lump together many layers of the Open Systems Interconnection communications reference model, handling both low-level error-correction and high-level file-handling tasks. Such a melding of OSI "stacks" confounds the standards process.

Hayes's FAST, however, addresses only the upper layers of the OSI model. It offers a file-transfer interface, but no error correction. Similarly, MNP addresses the lower layers of the OSI model, offering only error-correction or data-link levels. Because these two protocols adhere, more or less, to the OSI model, their developers have begun to push for standardization. However, the standard-writing process is slow.

Into the next decade, the three predominant protocols are likely to be XMODEM 1K, Kermit, and ZMODEM.

XMODEM 1K is a substantial improvement over Christensen's original, which transferred files in 128K-byte packets. XMODEM was intended for "short-haul" file transfers between computers in the same local region, and over modems with top speeds of 300 bits per second. When bulletin board systems (BBSes) began to proliferate and file transfers started moving hundreds or even thousands of miles, the original XMODEM failed more often than not. XMODEM 1K is a much more robust protocol. It transfers files in 1K-byte blocks and implements an error-correction scheme much better suited to the inherently noisy public telephone network.

Kermit was developed at Columbia University and is the file-transfer protocol of choice for the many research networks, such as Usenet and Bitnet. The user community has since adapted Kermit for use in dial-up communications packages, and it has proven itself a hardy and reliable protocol.

ZMODEM continues to gain popularity due to its "checkpoint restart" feature. This goes into effect if, for example, your modem becomes unplugged from the phone connection, knocking you off-line in the middle of a file transfer. You simply redial, and ZMODEM's checkpoint restart lets you resume your file transfer from the point of interrup-

continued

tion instead of making you resend the entire file from block one.

Other file-transfer protocols, such as YMODEM batch and sliding-windows XMODEM, although sturdy protocols, aren't likely to become the protocol of choice. They were originally intended for downloading several files at once, not individually. But with the advent of "archiving" programs, sometimes called "libraries," the need for these protocols is diminishing. Archiving groups several related files into a single "archive," compressed (or squeezed) to save file space, and downloads them as a single file, eliminating the need for batch-file transfers.

In addition, interest in "attached-file" protocols is growing. These protocols are proprietary in nature, and the communications packages that implement them are of little use for general communications needs. Such programs include Lotus Express, a communications package that automates sending and receiving files on the commercial electronic-mail system, MCI Mail. The advantage of a program like Lotus Express is that it lets you attach a binary file to a standard ASCII text file. When you upload your text message, the binary file is "attached" to the text and uploaded along with it. Another user using the same software can then access the system, read your message, and automatically download the binary file (e.g., a program, spreadsheet, or database command file).

Some commercial on-line systems, such as BIX, have also implemented this feature, but it is a function of the system's software, not of the stand-alone dial-up communications program.

And the Band Plays On

As the communications world strives for faster bandwidth and cleaner, more reliable file transfers, modems operating at speeds of 9600 bps or higher will become common. With the push among the telephone companies to implement new switching equipment and provide cleaner lines, it won't be long before all serious asynchronous communications are moving at 9600 bps or more.

Today's top dial-up communications packages are capable of handling file transfers at speeds up to 115,000 bps. If the future didn't hold the promise of such high-speed file transfers, we wouldn't find this capability in these packages.

The push for faster bandwidth is driven solely by the emergence of high-speed dial-up modems (see "Whither the Modem?" on page 281). Although BBSes are beginning to creep toward handling file transfers of 9600 bps, the real push is from the world of commerce. Electronic funds transfers along leased phone lines can handle data almost as fast as the technology allows. Banks and multinational corporations need to move megabytes of data several times a day, and in this arena particularly, time really *is* money.

For now, 2400-bps capability is sufficient for commercial information services. Most of the on-line sessions are interactive, and you don't need 9600-bps capability to type in your messages. The market for high-speed, dial-up modems isn't standardized. Implementing speeds higher than 2400 bps would mean subscribers to the service would need to have the same hardware that the service uses. While higher speeds would be nice for uploading and downloading, proprietary hardware would lock out the majority of users.

A Bright Future

The future for dial-up communications software is a bright one. For example, when scripting languages become more powerful, they will become easier for nonprogrammers to use, thus sparking more sophisticated and complex telecommunications applications.

Beyond software improvements, however, the move to integrate existing and emerging technologies is likely to provide the most exciting advances. The addition of coprocessor boards to take advantage of multitasking; the implementation of gateway services by the telephone companies to allow access to newer, faster forms of information; a public Integrated Services Digital Network service; faster, cleaner, packet-switched networks; the fiber-optic information highway: All these advances will lead to more communications power literally at your fingertips.

The choices for dial-up communications programs are varied, as are the prices. Remember that paying more doesn't necessarily mean you're getting a better program or a more powerful one.

Another long-held telecommunications edict, "People don't change their communications software," also appears to be crumbling. In this day of custom applications and specialized information needs, staying with a single communications package "in spite of the facts" limits your telecommunications ability.

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Brock N. Meeks is a San Francisco–based freelance writer who specializes in high technology. You can reach him on BIX as "brock."

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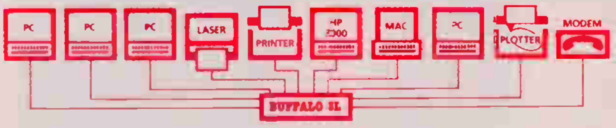

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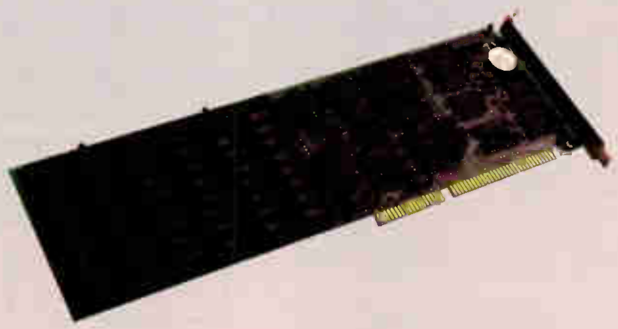

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Whither the Modem?

Speed is up and prices are down—can these trends continue?

John H. Humphrey and Gary S. Smock

Modems are getting faster, and the sheer volume of personal computer users forces their prices down continually. The technology that once produced 1200-bit-per-second modems for several thousand dollars each has advanced so much that today, a 1200-bps modem can be had for less than $100. The future of modem technology holds similar promises.

The Past

In the past, the industry concentrated on standardizing and developing modulation technology (the core "engine" of the modem). From the 1960s to the mid-1970s, the marketplace saw intense competition. AT&T's unique modulation methods led the way with international sanction, following in the form of similar CCITT V-series recommendations.

Early core engines presented technically simple modulation technology that embraced frequency-shift keying (FSK) engines serving dial-link usage in the 300- to 1200-bps range (Bell 103/202 and CCITT V.21/23). Leased-line operation, where the variance of channel conditions is more easily constrained, offered midrange speeds (2400 to 4800 bps) using more sophisticated differential phase-shift keying (DPSK) engines of the Bell 201/208 and CCITT V.26/27 products (see the article "High-Speed Modems" in the June 1988 BYTE).

The late 1970s saw the emergence of more complex modem-engine technology that sported sophisticated quadrature-amplitude modulation (QAM) and dynamic adaptive equalization. Operating speeds climbed to 9600 bps and above for leased-line use. In the early 1980s, the advent of low-cost microprocessors and switched-capacitor filter technology formed a marriage. This union allowed communications engineers to bring DPSK and QAM technology into low-cost forms that gave dial-network users both a speed boost and an operating-performance surge. These improvements came in the form of Bell 212 and CCITT V.22bis products providing 1200- and 2400-bps data transfer rates.

At the same time, digital-communications technology began to thrive for corporate users with the advent of DDS, T1, and, more recently, Integrated Services Digital Network (ISDN) link technology. These nonanalog special-network technologies introduced 56,000 bps, 1.544 megabits per second, and discretely quantized 64,000-bps multiple-packet data transmission potential. It looked like digital transmission technology would quickly surface as the long-term winner for all data exchange. However, the dial network is surprisingly resilient.

continued

Dial links are already installed (our parents and grandparents paid the amortized cost of construction). They intermix to effectively connect anywhere in the global village without needing advanced planning and telephone-company installation services. This provides an expedient answer if you want to get up and running without wading through miles of bureaucratic red tape.

The Present

In our ventures into space, we've made use of orbiting satellites to carry communications traffic. Everything from simple dial-link telephony to TV video and sophisticated military communications have become a target for uplink/downlink traffic. This poses new problems, and with them come new solutions.

In conventional terrestrial telephony, impedance mismatches along the routing path serve to generate echoes. At one time or another, you've probably gotten a link where it sounded as if you were in a tunnel. The dial network once solved this nuisance exclusively with echo-suppressor technology. The "tunnel" effect occurs when echo suppressors fail to operate properly.

Echo suppression works on the premise that humans use the telephone lines and that they are half-duplex creatures—one talks while the other listens; both don't talk at once.

Modems are smarter. They talk to each other simultaneously and must do so to maintain the link. To have effective full-duplex modem communication, you must disable the network's echo-suppression feature; this is the purpose of the familiar answer-tone burst you hear from the distant modem when you dial. Answer tone is a signal to the dial network that this is a data call and that it should shut down echo suppression for the duration of the call.

Echo suppressors assume that only one party will talk at a time. The dial-network monitors signal strength in each leg of its four-wire path (me to you and you to me), assuming that the side of the link with the strongest signal is the talker and that the other side can be safely attenuated during talker activity to prevent echoes from flowing back to the talker. When the talker stops, the network releases its attenuation to allow listener response and squelches the opposite path to protect the listener against echoes.

In this manner, the phone lines are actively and selectively silencing one side of the channel in an effort to provide clean, echo-free communications. You can imagine what would happen if the echo suppressors mistakenly "kicked in" during a data call: One modem or the other could lose the carrier due to the sudden drop in signal strength caused by the echo suppressor. Also, think what would happen if the time delay of the echo were to change radically.

The introduction of satellite communications placed a primary echo-reflection point one-tenth of the way to the moon. Now echoes can flow back to the talker long after the echo suppressor has kicked out and appear during the responding flow of the listener's response. If a call is routed by a multiple-satellite hop (from Omaha to New York, then from New York to Paris), the problem is compounded. Simple suppression of one side of the line based on relative signal strength and fixed time delays breaks down as an effective deterrent.

This situation has spurred research into echo-cancellation (EC) technology. If you know the waveform just issued, you can store it and scan the other side of the line looking for a delayed and attenuated copy—an echo. You can subtract an appropriately scaled and delayed copy of a stored waveform from the inbound path to cancel the echo.

This is how EC technology was born, and today's newest generation of dial-link modems (V.32) make use of EC to achieve full-duplex, 9600-bps communications. Both ends of the link transmit on identical carrier frequencies simultaneously. However, each modem knows the waveforms that it has sent. It uses this information to add an inverted and appropriately scaled and delayed copy of its transmitted data directly into its received signal path, canceling out the effects of transmitter echo. Thus, only the distant modem's inbound signal remains to be processed.

In the early 1980s, work began on what is now the V.32 EC modem engine. By 1984, the CCITT had ratified V.32, and modem manufacturers began the grueling task of designing functional EC modems. To solve the problem, applied mathematicians were put to work in modem development. With them came applied statistics and encryption technologies.

Mathmagic

The industry has learned to use encoding to produce performance gains. *Trellis encoding* is used in today's 9600-bps and higher speed-rated CCITT engines to produce more reliable operation. At first blush, trellis-coded modulation (TCM) looks like pure and simple magic.

First, you add analog horsepower to complicate the core transmission pattern. Instead of using a simple 16-point constellation, for example, you force the modem to a higher-density 32-point constellation. The 32-point constellation offers higher encoding density with its "quintbits" ($2^5=32$), as opposed to the 16-point constellation with its "quadbit" structure ($2^4=16$).

With a given, fixed baud rate (e.g., 2400 baud), the 16-point constellation can deliver data exchange rates of 9600 bps (2400 baud × 4 bits per baud). The more complicated 32-point constellation offers an intrinsically higher data rate capacity of 12,000 bps (2400 baud × 5 bits per baud). It's also more susceptible to channel noise because you have pushed the individual decision points closer together, and any minor noise perturbation is more likely to cause the distant receiver to make a decoding error.

However, instead of using the higher density of the 32-point constellation for speed purposes, suppose you use its added complexity for noise immunity purposes to derive a performance boost. TCM does just that.

Instead of operating at 12,000 bps, V.32 TCM transmission remains at 9600 bps with twice as many constellation points as it needs. The extra constellation points produce a redundant bit. This fifth bit is used as an embedded "checksum" to produce intelligent transmission. Decision rules are used in both the transmitter and the receiver to produce an orderly transmission that is designed to maximize noise immunity.

The redundant bit serves an error-detection function similar to the familiar ninth bit used for parity in 8-bit microcomputer memory systems. The memory-parity bit doesn't prevent errors from occurring; however, it flags them and prevents them from propagating.

With TCM, the fifth bit acts to help the remote receiver make a high-probability choice among possible alternatives when channel noise has distorted the incoming signal. It doesn't absolutely guarantee error-free communication, but it does help by reducing the probability of errors.

The use of redundant encoding techniques like TCM has given rise to faster operating speeds with little, if any, performance penalty. Today's modern leased-line 19,200-bps half-duplex machines churn along rather reliably producing similar noise-immunity characteristics to those of the V.29 9600-bps modems used in the late 1970s.

Along with redundant encoding technology, mathematicians brought encryption technology to the modem world. The best example is today's 2-to-1 to 4-to-1 built-in data compression. If we can compress the data before feeding it to the modem and expand it once it's received, we can achieve a throughput gain without cost to analog engine complexity.

This is an exciting area of technology, and the CCITT has been working feverishly in recent years to construct a platform for standardizing error-detection, error-correction, and data-compression functions in modems known as V.42. These features exist today on a manufacturer-specific basis. X.PC, MNP, and a myriad of alternatives (e.g., Kermit, XMODEM, and YMODEM) exist to reliably transport data and, depending on protocol, provide a speed boost via data compression.

The V.42 standard sought plenary approval from the CCITT, which met last November. Current V.42 specifications seek to form a standardized platform for the development of these non-engine-related modem attributes. Experts expect quick ratification of the V.42 recommendation that embraces early MNP compatibility (up to level 4) as well as a more advanced form of error correction known as LAPM (link access protocol for modems).

V.42 is expected to serve as a platform on which to build for the future with sophisticated add-on features, such as integral data compression being brought along via incorporation into the flexible LAPM protocol. Since the industry has seen impressive speed boosts of up to four times from today's data-compressing modems (see the Telcor Accelerator 2496MA performance in the article "High-Speed Modems" in the June 1988 BYTE), we can expect a larger selection of standardized, interoperable modem products to emerge in the future thanks to V.42.

The Future

Unfortunately, today's concentration on the fruits of mathematics has taken the focus off core-engine development. In the early 1980s, the industry focused on engine development, and the CCITT promoted EC V.32 in 1984, well ahead of then-current technical practice. This served as a challenge to modem designers. Where is the next advanced-engine specification to challenge us into the mid-1990s? Sadly, the answer is nowhere. Many people expected that the world would suddenly go digital and that ISDN would surface quickly to provide a global communications vehicle that was fast, clean, and omnipotent. This simply hasn't happened.

Leased-line technology exists based on second-generation, multidimensional TCM that yields solid 19,200-bps core communications speeds. Unfortunately, these machines are large, expensive, and dedicated to corporate leased-line links. What about higher speeds at the personal computer level for dial use?

Even though standards organizations have not promulgated the next-generation engine technology, entrepreneurial design work is alive and well. The 19,200-bps leased-line machines (for which there are no adopted CCITT standards) have improved to the point that core-engine technology now approaches performance levels robust enough to deliver 19,200-bps dial service. In fact, some of the leaders in this area are experimenting by adding dial backup capability to these leased-line products.

The 19,200-bps modems are currently half-duplex in nature, and no error-correction or data-compression protocols have been added as a front-end to the modem's core engine. If you can use echo cancellation at 9600 bps to yield full-duplex, overlapping-carrier operation, why can't you use the same technology at 19,200 bps to produce a full-duplex dial engine that's twice as fast as V.32? The answer is simple: You can.

Already, derivatives of V.32 using integral data compression have been developed that achieve 38,400-bps operation (four times compression on a core 9600-bps engine). By using echo cancellation and data compression, we can envision an 80,000-bps full-duplex, dial-link product made from today's 19,200-bps engines using a four-times data compressor. Such a machine would rival conventional DDS yet have the flexibility of the dial network's extensive existing routing paths. This technology is at hand.

You can use EC to successfully separate transmitted data from received data under spectral-overlapping conditions. Couldn't you also use several echo cancellers in a given modem design to separate multiple overlapped transmitters sharing the same forward channel to create bit-parallel transmission paths? By blending multiple-carrier technology with EC and then introducing the advantages of integral error control and data compression, exotic modems of the future might be able to break the 100,000-bps speed barrier—an exciting prospect.

Certainly, the bandwidth of analog telephony is not infinite, and there are distinct limits as to how fast you can push data through the pipeline. In the late 1940s, Claude Shannon gave us a formula for computing channel capacity that is based simply on the bandwidth and signal-to-noise ratio characteristics of the channel at hand. Using this formula, we computed an upper limit of 30,000 bps for 3-kHz phone lines that typically exhibit signal-to-noise ratios in the 30-dB range. Shannon's law applies to the base data rate of the modem's core engine, and all bets are off if we precompress the data stream before handing it to the modem engine for transmission. If we could develop the perfect Shannon engine—today's 19,200-bps machines are homing in—and add a 4-to-1 data compressor to it, 120,000-bps communication should result.

Some people think "anti-Shannon" engines may be feasible—modems that are capable of detecting and canceling noise sources in the phone lines. Such a belief arises from looking at background channel noise as the sum of multiple sources and the idea that some key-noise sources aren't entirely random.

If modems could be made intelligent enough to recognize the discrete contributions of these nonrandom noise sources and act to cancel their effects, significant increases in operating SNR and engine performance would result. Anti-Shannon machines offer the hope of link-performance boosts that are independent of a telephone system's age or quality. Combine such thinking with the continual improvement of the links themselves (use of fiber-optic trunk lines for terrestrial links and the addition of satellite and microwave channels to the mix of channel-routing alternatives), and the belief in continued higher operating speeds continues to brighten.

Dial-link machines aren't expected to rival the 1.544-megabit-per-second rates offered by T1 carrier operation; however, there's some distance to go before modem technology is saturated. By the 1990s, we may realize an order-of-magnitude boost above today's 9600-bps operating speeds.

Price and cost follow the degree of circuit integration and are responsive to sheer volume demand. If enough of us want to transmit the contents of a 10-megabyte hard disk across the country—or across the globe—in less than 2 minutes, it will probably happen. ■

John H. Humphrey and Gary S. Smock are general partners of TeleQuality Associates in Golden, Colorado, where they provide engineering consultation and telecommunications design and product testing. They can be reached on BIX c/o "editors."

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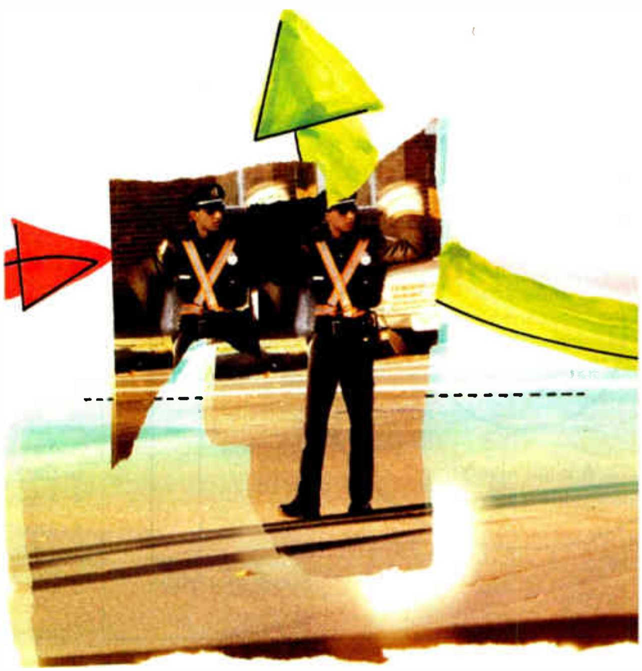
OS/2 Hits the Networks

Expect to see the development of more distributed applications

Ken Thurber



If you operate a local-area network (LAN) and want to run OS/2, you'll face three different concerns. You'll need to provide OS/2 on user PCs; you'll need to understand distributed applications with OS/2; and you'll need to know how OS/2 operates as a server platform.

The first step you need to take to supply network support to an OS/2-based user PC is to extend the OS/2 environment. Applications running on the PC should be able to access files, printers, and devices located on and shared by servers on the network.

Next, you need to provide OS/2 support for network-wide user and system-administration features for the PC. The third step is to provide a networking system with enhanced communications capabilities so that the OS/2-based PC can access other networking and computer environments.

Distributing the Load

OS/2's support of multitasking and the networking of OS/2 PCs is bound to encourage distributed-applications development. These applications will be designed with a user/server architecture, where the user portion is oriented toward the user interface and presentation, and the server portion is oriented toward shared-resource management.

Four basic components provide the underlying platform for distributed applications: the operating system on the user PC; the operating system on the server (see the text box "Pieces of the Puzzle" on page 286); the networking protocol software that enables the PCs and the server to communicate; and the interprocess/intertask communications (IPC) mechanism. (The IPC is implemented on top of the other three components. It handles service requests and replies between the users and the server, respectively.)

OS/2 defines IPC mechanisms for communications between tasks running on the same PC. A particular architecture could extend these mechanisms so that the tasks running on both the user system and the server can communicate.

Besides basic components, a distributed-applications platform needs to provide a distributed naming system that can be used to connect a user to a server transparently. (A naming system can also provide a common view to the user and the system administrator of distributed applications and network resources.) The platform should also supply an environment that lets you manage the server portion of the application from anywhere in the network.

Since OS/2 is a multitasking operating system, it is one choice for a network-server operating system. It's not your

continued

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Pieces of the Puzzle

One of the key software components in a PC local-area network is the network operating system. And what is its primary purpose? To provide multiuser capabilities to a collection of single-user workstations.

In fact, LAN operating systems solve multiuser transparency problems, not applications problems. They provide a common syntax as well as error recovery to increase local and remote operation consistency. They also increase the portability of applications across different LANs and promote hardware independence. A LAN operating system's goal, then, is to:

- Transform a collection of hardware and software resources, namely the LAN and its PCs, into a coherent set of abstract objects or resources.
- Support naming, access, sharing, protection, synchronization, intercommunication, and error recovery.
- Multiplex and allocate these resources among many computations (PCs).

Unfortunately, however, LAN operating systems are not without their problems. For example, none of them addresses the issues of data translation and representation. In other words, most of them support only one type of PC and operating system.

It's also difficult to map a resource such as a file into this network of distributed service and resource structures, and error recovery in an operating system can be complex. Another problem you might notice in distributed systems is that multiple copies of the same software seem to propagate. This is one of the reasons why distributed administrative control in a LAN environment can be a problem.

In addition, if your local network operating system isn't efficient, it may become a bottleneck in the system. If the operating system can use only a small portion of the network bandwidth, it may not matter if the LAN is a 1-megabit-per-second or a 10-mbps system.

Figure A is a logical model of a LAN operating system. In most PC LANs, there is actually a communications kernel distributed across all the PCs, regardless of whether the PC is a server, a workstation, or a nondedicated workstation/server.

This model represents a common mechanism of how you, as a LAN user, can communicate with the server. First, you send out a request from a PC or workstation. It goes through a communications kernel on your PC over the network and through the kernel on the server, where it performs a function or an operation. You then receive the server's reply, which travels through the same mechanism. Thus, there's at least one small piece of software, the kernel, that's common to all the machines in the LAN system.

Another common element is the user interface. The ideal user interface in a PC LAN operating system should at the minimum include all the following features:

- A choice between a menu-driven or a command-mode system; you may prefer a menu-driven system if you're a beginner, or a command-mode system if you have more experience.
- The ability to set the default boot environment; in other words, a server should be able to download default software every time you log onto a network.
- The ability to execute server commands within turnkey applications; this shields you from mundane network details.
- On-line help not only for an application but for the network, too.
- An elegant way to recover from errors in the LAN.
- A locator service that tells you where a resource, such as a specific file, is located in the LAN.
- The ability to handle diskless PCs.

Using such an interface will make communicating and working on a LAN a much more pleasant proposition.

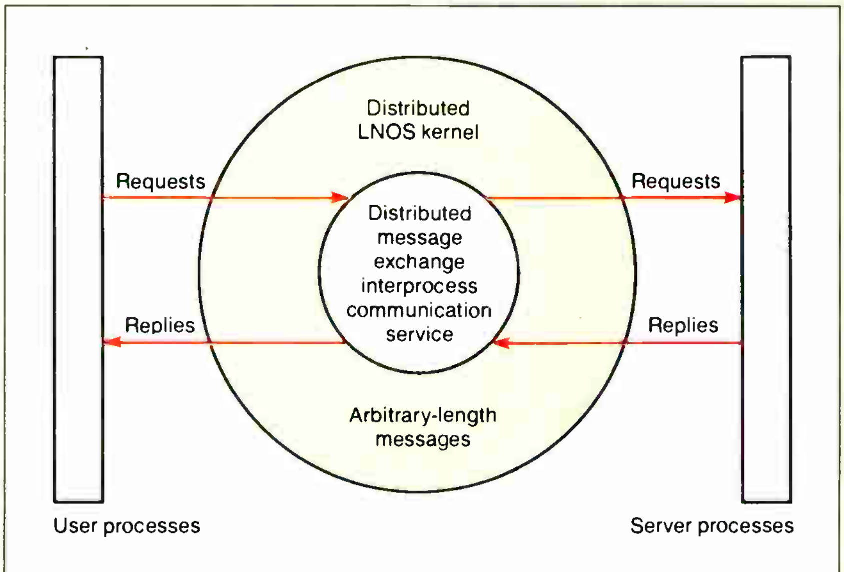

Figure A: *A LAN operating-system model.*

only choice, however. For instance, you could use Unix to provide these same services for OS/2-based PCs. You can also use OS/2 to implement the server portion of a distributed application, but there are other choices as well.

A networking system that includes a solution for OS/2-based servers needs to provide support for an OS/2-based application server and coexistence with OS/2-based file and print servers.

The discussion that follows compares IBM's OS/2 LAN Server to 3Com's 3+Open operating system and also examines how Novell's NetWare fits into the picture.

Comparing Capabilities

Figure 1 illustrates the architectures of the OS/2 LAN Server, the 3+Open network server (which is based on the Microsoft OS/2 LAN Manager), and NetWare. They all support OS/2 network workstations. And, although it doesn't

continued

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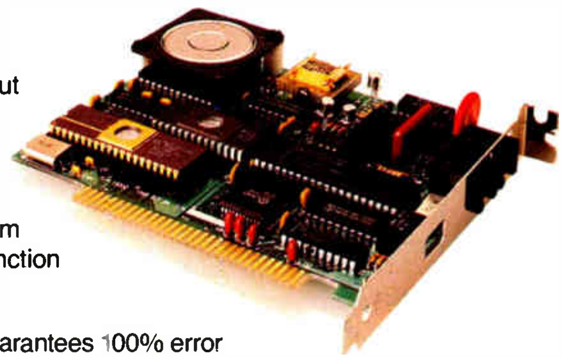

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show in the figure, they are also all compatible with an IBM PC LAN workstation running DOS. In addition, 3+Open can have 3+Open network workstations running DOS.

The figure also shows the Open Systems Interconnection model. If you compare the OS/2 networking architectures to the OSI model, you'll notice the key compatibilities: An OS/2 server is used as the kernel to the network server and the Microsoft Redirector, and thus the server-message-block (SMB) file-system protocol is used.

In addition, IBM and 3Com support the NetBIOS and the data-link-control interfaces. IBM's Advanced Program-to-Program Communication protocol will be supported by the 3+Open server and will use the DLC interface to the physical network connection. Novell's NetWare also supports APPC. In fact, Netware, along with the 3Com and IBM servers, will be compatible with applications developed by IBM and third-party developers and will adhere to the OS/2 program interfaces.

IBM has already announced several applications as part of its OS/2 Extended Edition. Independent third-party applications developers have announced products with similar functions that will be generally available for OS/2-based network systems.

3Com is expected to offer advanced network-service products, including such office-productivity applications as electronic mail and network management. IBM has not yet announced an intention to provide advanced network services for its OS/2 LAN Server, and Novell seems oriented toward third-party suppliers for development of service products.

Sharing the Work

Today's business applications tend to use the basic file-/print-sharing capabilities of network systems. In these applications, all computing is done at the network workstation. The shared disk of the network server stores data processed at the workstation and sends it to a shared printer for hard copy.

Under OS/2, many applications will be distributed. A distributed application shares computing power among network workstations and network servers. Rather than simply sharing disks and printers, the network server also shares computing power.

For example, in a nondistributed environment, you can sort the data in a database that contains names and addresses and render several different printed reports, depending on your requirements. With a distributed application, one or

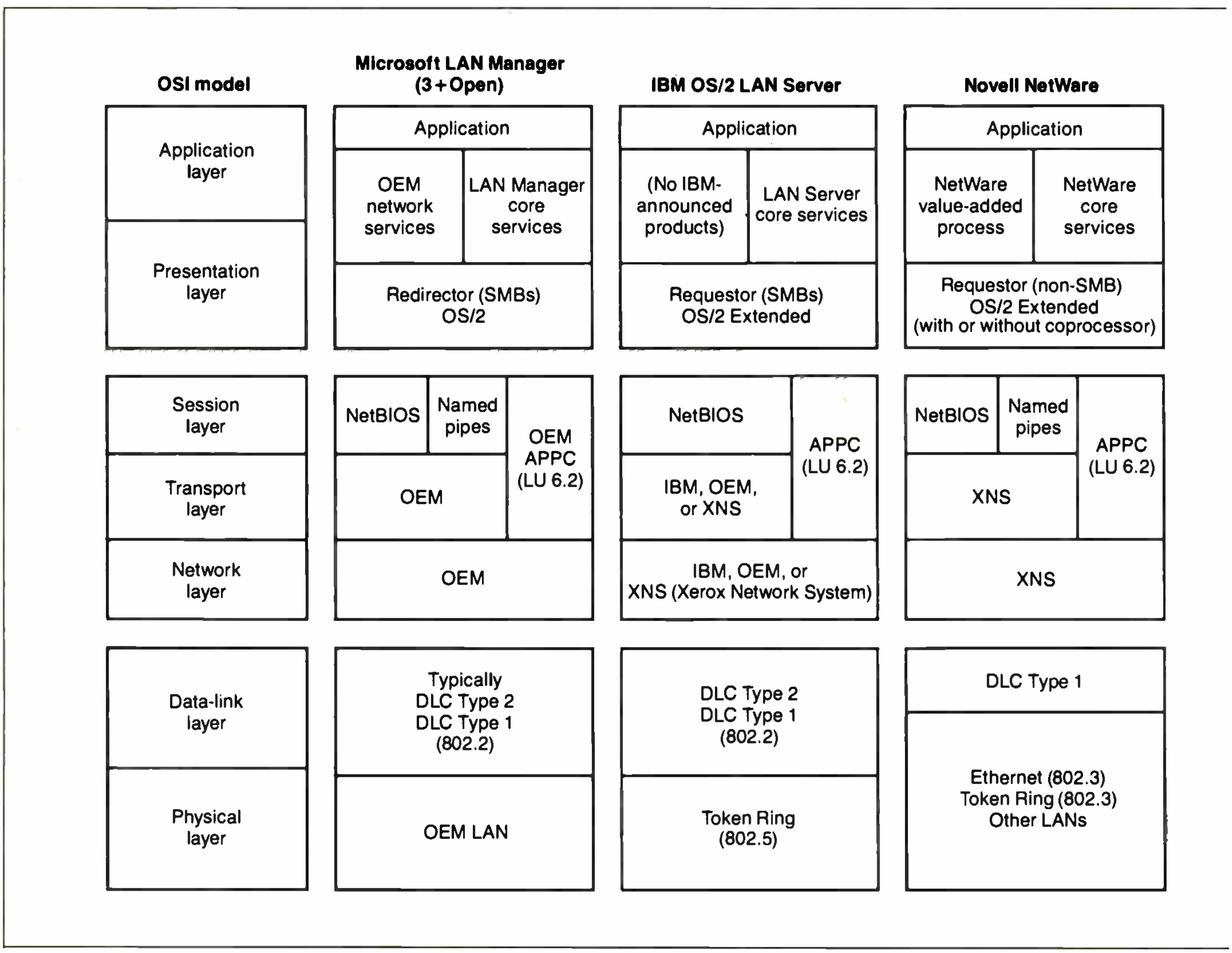

Figure 1: *An Open Systems Interconnection and OS/2 architecture summary.*

more of the tasks (such as sorting or reporting) would be sent to another computer on the network for processing. Depending on their design, distributed applications may offer many advantages, including efficiency, data security, and a better price/performance ratio for network computing resources.

IBM's OS/2 LAN Server clears the way to create distributed applications that have the potential to improve network workgroup efficiency (see the text box "The OS/2 LAN Server" on page 290). However, implementing the concepts involved will be difficult.

For distributed applications to work, network software must support OS/2 on both the network workstation and the network server. NetWare, 3+Open, and the OS/2 LAN Server all do this. Optionally, with NetWare, the network workstation can communicate to a proprietary file server that passes OS/2 requests to a coprocessor board that is internal to the server.

VINES and OS/2

Banyan Systems currently supports both DOS-based and Unix-based servers in VINES. In addition, the company is committed to supporting all aspects of OS/2. By supporting OS/2, VINES can extend the services it now offers to include multitasking features for network-based PCs.

Four major categories of services will be available to an OS/2 workstation connected to a VINES network: NetBIOS, OS/2 connectivity, communications, and data management.

VINES will support OS/2 workstations through a Requestor module for file, print, and device sharing. The appropriate module will be invoked when OS/2 determines that a file, print, or device I/O request is directed toward resources located on the network.

The Requestor module will formulate the request into a protocol packet and communicate with the VINES "socket" interface. VINES will also support the NetBIOS. Figure 2 shows VINES and OS/2 workstation integration.

VINES currently supports a platform for building distributed applications. All services and applications in the VINES product were implemented using this platform. The platform supports DOS clients that can use network-wide IPC mechanisms to communicate with Unix servers. A network compiler technology hides the details of this mechanism.

Banyan plans to extend its distributed-applications platform and will provide full support for IBM OS/2 and OS/2 Ex-

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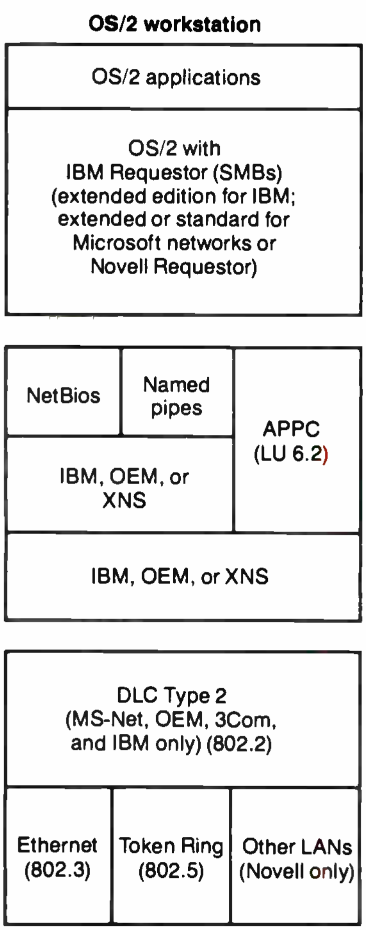

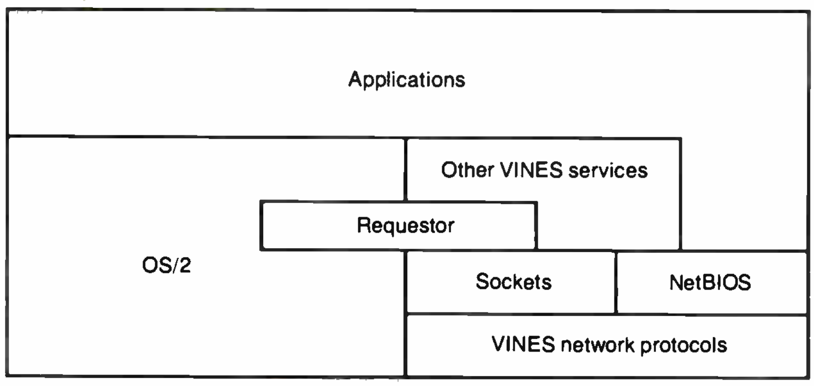

Figure 2: *The Banyan VINES and OS/2 workstation architectures.*

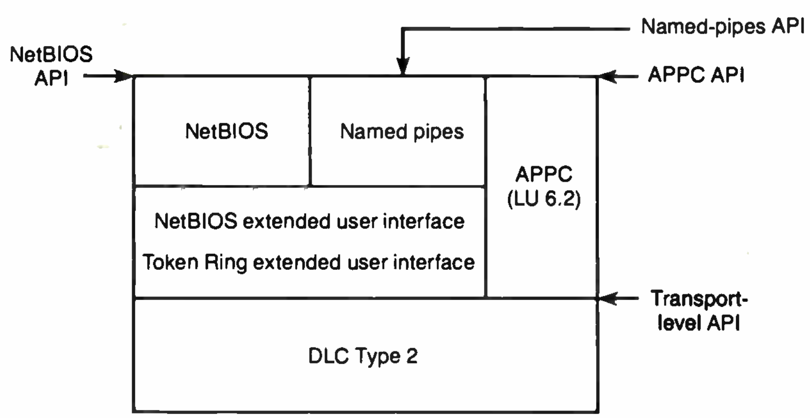

Figure 3: *The APPC, NetBIOS, and transport-level APIs.*

The OS/2 LAN Server

One good point about IBM's OS/2 announcement was that it helped bury speculation concerning the technologies and architectures to be endorsed for the company's OS/2 network product, OS/2 LAN Server. Based on the announcement, OS/2 LAN Server apparently incorporates key technologies derived from the 3Com and Microsoft joint development of the OS/2 LAN Manager.

Specifically, IBM's announcement reaffirmed that software developers should write to the open programmatic interfaces of OS/2 rather than to proprietary systems. It also made clear that IBM endorses OS/2 network servers as a key component of an open-system applications platform for distributed network applications, meaning that OS/2 support on both network workstations and servers is important.

And last, but not least, IBM reaffirmed Advanced Program-to-Program Communication use in the IBM PC LAN Program that uses the Microsoft Redirector, server-message-block protocol, and NetBIOS. These are the same protocols and standards incorporated in the OS/2 LAN Manager.

OS/2 addresses three major needs. It provides protected-mode operation to fully utilize the 16-bit processing and increased memory-addressing capabilities of the newer PCs. It supports multitasking and the necessary intertask communications facilities. And it supports the new generation of hardware system architectures, such as the PS/2s.

When, in the past, MS-DOS dominated the IBM PC and PC-compatible operating systems, the major network operating systems all adopted a DOS-like appearance. With the advent of OS/2, however, this may change.

tended PCs connected to a VINES network. Support for the NetBIOS and APPC interfaces will be provided for both DOS and OS/2. VINES will support all applications interfaces for network and distributed applications as defined by IBM OS/2, OS/2 Extended, and the LAN Server Program.

Microsoft's LAN Manager defines four applications interfaces: OS/2 file, print, and device sharing; the NetBIOS interface; networking extensions to the OS/2 IPC mechanisms; and user workstation and administration interfaces.

VINES will be compatible with the first two interfaces. The third interface is an alternative network IPC mechanism. Support will be included if there is a strong need. The fourth interface is specific to the LAN Manager's implementation of file, print, and device sharing on an OS/2 server and in Banyan's view is not necessary for OS/2 connectivity or IBM compatibility.

All About Named Pipes

Named pipes are an IPC mechanism supported mainly by the Microsoft LAN Manager and Unix. Named pipes provide an interface that extends the IPC of OS/2 transparently across the network. They offer a higher-level interface to APPC, NetBIOS, or the network-transport layer, so it's easier to create an application that uses remote procedure calls across the network.

Many developers believe that named pipes, a complement to the interprocess pipes used throughout OS/2, enhance productivity and workgroup applications, while APPC is best-suited for program-to-program communications among homogeneous IBM PCs, minicomputers, and mainframes.

Named pipes let an applications developer access a computing resource (which may be located elsewhere on the network) as if it were local. They do this by simplifying the effort of building network-intrinsic applications.

Named-pipe availability, however, doesn't exclude you from developing applications that directly use the APPC, NetBIOS, or transport-level APIs (see figure 3).

Developers of network-intrinsic applications believe this interface is most appropriate for office-productivity applications that don't require access to larger homogeneous IBM systems as their primary function. However, the applications won't function in an IBM OS/2 LAN Server environment.

Keeping a Secret

What no one likes to talk about is why 3Com's and Novell's past approaches have outperformed the IBM PC LAN Program.

The answer is simple: The PC LAN Server uses DOS as its native operating system, while 3Com and Novell designed special high-performance proprietary server operating systems.

But if 3Com and Novell include OS/2 as the server-based operating system, what will happen to their performance? Note that 3Com continually stresses the idea of its "core"; that means either that 3Com will run OS/2 and be saddled with performance comparable to IBM's or that it must enhance the operating system and end up with some level of incompatibility. ■

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When One LAN Is Not Enough

Bridges, routers, and gateways can "network the networks"

William Stallings

The growth of personal computers in the office environment has triggered two dramatic developments in rapid succession. The first was the introduction of personal computer local-area networks. The second was the interconnection of these LANs to each other and to other types of LANs.

A single LAN hardly solves all of a business's interconnection problems. Like it or not, the wide-ranging mix of computers found in typical corporations often requires more than one LAN for service. The word processors in one department, the personal computers in another, and the mainframes in the back room all need their own types of LANs. As a result, LANs of many sorts, using everything from simple twisted-pair cabling to hyperfast optical fiber, have found their way into offices and labs. Internetworking protocols, therefore, are now a necessity.

In fact, the "networking of networks" takes place within single buildings and across continents as corporations attempt to provide company-wide access to electronic files, services, and resources. Electronic-mail systems, for example, gain value geometrically as new users are brought on-line, a procedure that often requires differing LANs to be linked efficiently and transparently.

Bridges, Routers, and Gateways

Internetworking technology has yielded three types of products: bridges, routers, and gateways (see figure 1 and the text box "Making the Right Decision" on page 295). In essence, a bridge operates at layer 2 of the Open Systems Interconnection (OSI) seven-layer architecture and acts as a relay of frames between like networks.

A router operates at layer 3 of the OSI architecture and routes packets between dissimilar networks. Both the bridge and the router assume that the same upper-layer protocols are in use. The gateway operates at layer 7 and provides a link between dissimilar architectures (e.g., OSI and Standard Network Architecture) on either the same network or different networks. I'll first look briefly at bridges and then at the functions and standards for routers.

How Bridges Operate

To understand the action of a bridge, consider first how communication takes place among devices attached to a single LAN. For example, on a bus-topology LAN, similar to ring topologies, data on the bus is transmitted in packets. So, if host computer X wishes to transmit a message to host computer Y, X breaks its message into small pieces that are sent, one at a time, in packets.

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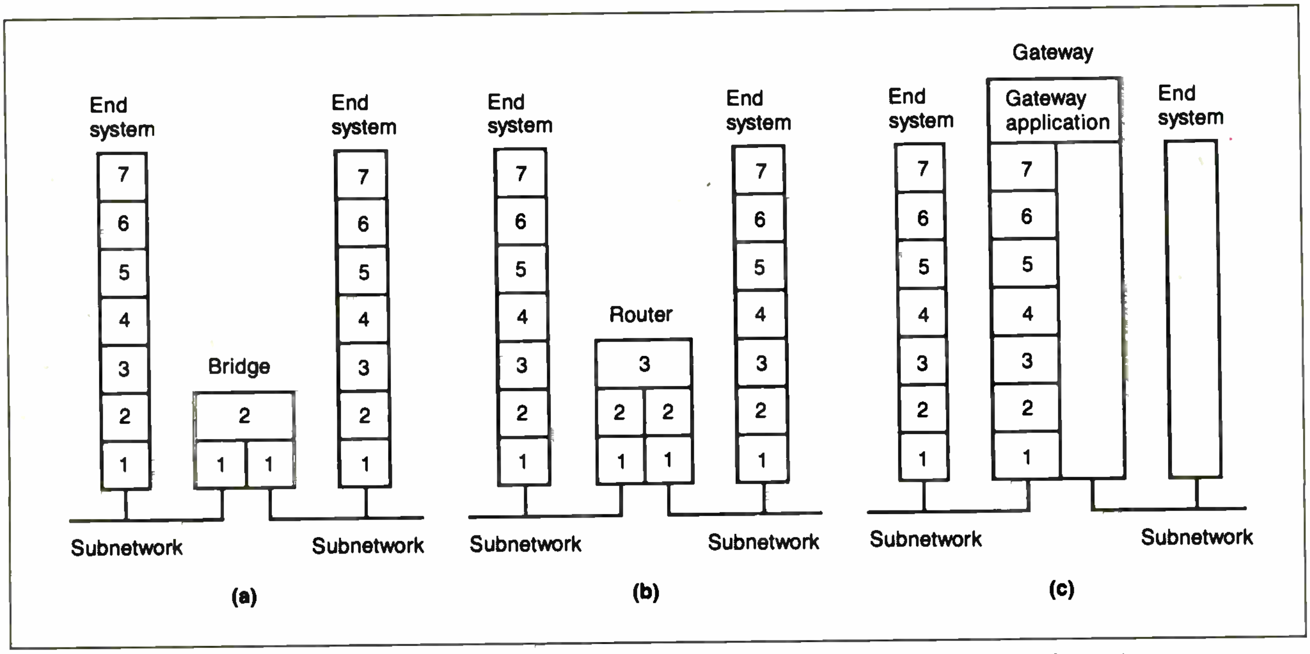

Figure 1: *Internetwork devices:* (a) *bridge,* (b) *router, and* (c) *gateway. (The numbers refer to the OSI layers.)*

Each packet header includes, among other items of control information, the address of Y. Based on some medium-access control technique (e.g., CSMA/CD or token bus), X inserts each packet onto the bus. The packet propagates the length of the bus in both directions, reaching all other hosts. When Y recognizes its address on a packet, it copies the packet and processes it.

Now suppose you want to link two LANs, A and B, using the same protocols. You can do this using a bridge attached to both LANs (frequently, the bridge function is performed by two "half-bridges," one on each network). The functions of the bridge are few and simple:

- Read all packets transmitted on A and accept those addressed to any host on B.
- Using the medium-access control protocol for B, retransmit each packet on B.
- Do the same for B-to-A traffic.

The bridge doesn't modify the content or format of the packets it receives, nor does it encapsulate them with an additional header. Each packet to be transferred is simply copied from one LAN and repeated with exactly the same bit pattern on the other LAN.

Since the two LANs use the same LAN protocols, it's permissible to do this. The bridge must contain addressing and routing intelligence. At a minimum, the bridge must know which addresses are on each network to know which packets to pass. Further, there may be more than two LANs interconnected by a number of bridges. In that case, a packet may have to be routed through several bridges in its journey from source to destination.

The bridge provides a transparent extension to the LAN. It appears to all hosts on the two (or more) LANs that there is a single LAN on which each host has a unique address. The host uses that unique address and need not explicitly discriminate between hosts on the same LAN and hosts on other LANs; the bridge takes care of that.

All about Routers

Router operation, as figure 1b indicates, depends on a protocol at OSI layer 3 (network layer), sometimes known as an *internet protocol*. Figure 2 depicts a typical example. Let's say you have a number of PC LANs in your organization; perhaps each supports a separate department. In addition, there's a backbone LAN that links all the PC LANs to each other and also supports minicomputer and mainframe resources that are accessible company-wide.

Figure 2 shows the operation of the internet protocol for data exchange between host A on PC LAN 1 and host B on PC LAN 3 through a backbone LAN. These hosts and the routers must share a common internet protocol, such as the International Standards Organization (ISO) standard protocol for connectionless network service or the Department of Defense (DoD) standard internet protocol (see the text box "Raising the Standard" on page 297); in either case, this is referred to as IP.

In addition, to communicate successfully, the two hosts must share the same protocols above IP. For example, the two hosts must both have the same transport protocol, such as the ISO standard transport protocol (TP) or the DoD standard transmission-control protocol (TCP).

The IP at A receives blocks of data to be sent to B from the higher layers of software in A. IP attaches a header specifying, among other things, the global internet address of B. That address is in two parts: network identifier and host identifier. I'll refer to this block as the IP datagram. Next, IP recognizes that the destination, B, is on another network. So the first step is to send the data to a router, in this case router α. To do this, IP hands the datagram down to the LAN protocol, which appends a header that includes the address of router α, forming a packet.

Next, the packet travels through LAN 1 to router α. The router strips off the packet header and analyzes the IP header to determine the ultimate destination of the data, in this case B. The router must now make a routing decision. There are two possibilities:

- The destination host B is connected directly to one of the subnetworks to which the router is attached;

continued

Making the Right Decision

The simplest of the internetworking devices is the bridge. This device is designed for use between local-area networks (LANs) that use identical protocols for the physical and link layers. Because the devices all use the same protocols, the amount of processing required at the bridge is minimal.

Since the bridge is used when all the LANs have the same characteristics, why not simply have one large LAN? Depending on the circumstances, there are several reasons for using multiple LANs connected by bridges:

- *Reliability*. The danger in connecting all data-processing devices in an organization to one network is that a fault on the network may disable communication for all devices. By using bridges, the network can be partitioned into self-contained units.
- *Performance*. In general, performance on a LAN declines with an increase in the number of devices or the length of the wire. A number of smaller LANs will often give improved performance if devices can be clustered so that *intra*network traffic significantly exceeds *inter*network traffic.
- *Security*. The establishment of multiple LANs may improve security of communications. It's desirable to keep different types of traffic (e.g., accounting, personnel, strategic planning) that have different security needs on physically separate media. At the same time, different users with different levels of security need to communicate through controlled mechanisms.
- *Geography*. Clearly, two separate LANs are needed to support devices clustered in two geographically distant locations. Even in the case of two buildings separated by a highway, it may be far easier to use a microwave bridge link than to attempt to string coaxial cable between the two buildings.

Routers

You can only use bridges to connect similar LANs. Of course, in many cases, you might need access to devices on several types of networks.

A general-purpose device that can be used to connect dissimilar networks and that operates at layer 3 of the Open Systems Interconnection (OSI) model is known as a router. The router must be able to cope with a variety of differences among networks, such as the following:

- *Addressing schemes*. The networks may use different schemes for assigning addresses to devices. For example, an IEEE 802 LAN uses either 16-bit or 48-bit binary addresses for each attached device; an X.25 public packet-switching network uses 12-digit decimal addresses (encoded as 4 bits per digit for a 48-bit address). Some form of global network addressing must be provided, as well as a directory service.
- *Maximum packet sizes*. Packets from one network may have to be broken into smaller pieces to be transmitted on another network, a process known as segmentation. For example, Ethernet imposes a maximum packet size of 1500 bytes; a maximum packet size of 1000 bytes is common on X.25 networks. A packet transmitted on an Ethernet system and picked up by a router for retransmission on an X.25 network may have to be segmented by the router into two smaller ones.
- *Interfaces*. The hardware and software interfaces to various networks differ. The concept of a router must be independent of these differences.
- *Reliability*. Various network services may provide anything from a reliable end-to-end virtual circuit to an unreliable service. The operation of the routers should not depend on an assumption of network reliability.

There is a place for both bridges and routers in planning the development of an internet. Bridges are easy to configure and have no effect on the host software. In an environment where all the communicating devices are on similar LANs, this is the appropriate solution. If you have a mixed environment, you need the more complex routers. However, even then, you can use bridges to interconnect some of the LANs.

Gateways

You can use bridges and routers to solve internetwork problems in an environment when all the devices implement compatible protocols from the OSI model. This is the ideal situation. However, there will be times when a proprietary network architecture such as Standard Network Architecture (SNA) has already been installed.

Because of the investment in the proprietary system, it's expensive and disruptive to attempt to replace all the communications software with OSI-based software. On the other hand, you want to use OSI to gain access to products from a variety of vendors.

The gateway provides a way to permit the coexistence of OSI-based and proprietary products and gives you the tool you need to plan and implement a smooth migration to an exclusive OSI strategy. It's a device that connects different network architectures by performing a conversion at the application level. The gateway itself must use all seven layers of the OSI model, plus all layers of the proprietary architecture.

The gateway is used as a staging area for a two-step transfer of data. Consider a file transfer as an example. In the OSI world, the file-transfer standard is file transfer, access, and management (FTAM). Two OSI hosts can exchange files using FTAM. Similarly, two hosts with proprietary architectures can exchange files using the proprietary file-transfer application. If a mixed transfer is attempted from an OSI host to a proprietary-software host, then the sending host automatically (without user intervention) sends the file to a gateway using FTAM. The gateway accepts the file and then transfers it to the intended destination using the proprietary file-transfer protocol. A transfer in the reverse direction proceeds similarly.

Other applications (e.g., electronic mail and document architecture) can also be achieved via gateway. Thus, the gateway must contain both the OSI version and the proprietary version of any application requiring gateway services.

Using a gateway has several key limitations. For instance, the gateway is a potential bottleneck. In an environment where there are large numbers of both types of hosts, there may be considerable traffic through the gateway. To overcome performance limitations, you might need more than one gateway. This complicates the host software, which must now decide which gateway to use for each transfer.

Also, the service provided for a given application is the "least common denominator." For example, FTAM supports the use of priorities. If the proprietary file-transfer protocol does not, then the priority discipline is imposed only between the OSI host and the gateway. From the gateway to the other host, no priority scheme is used.

The market for gateways is projected to grow rapidly. This is because OSI-based products are becoming increasingly prevalent and cost-competitive, while there is and will remain for some time a large installed base of systems based on proprietary communications architectures, especially SNA. While the gateway is not ideal, it provides a way to cope with a mixed environment.

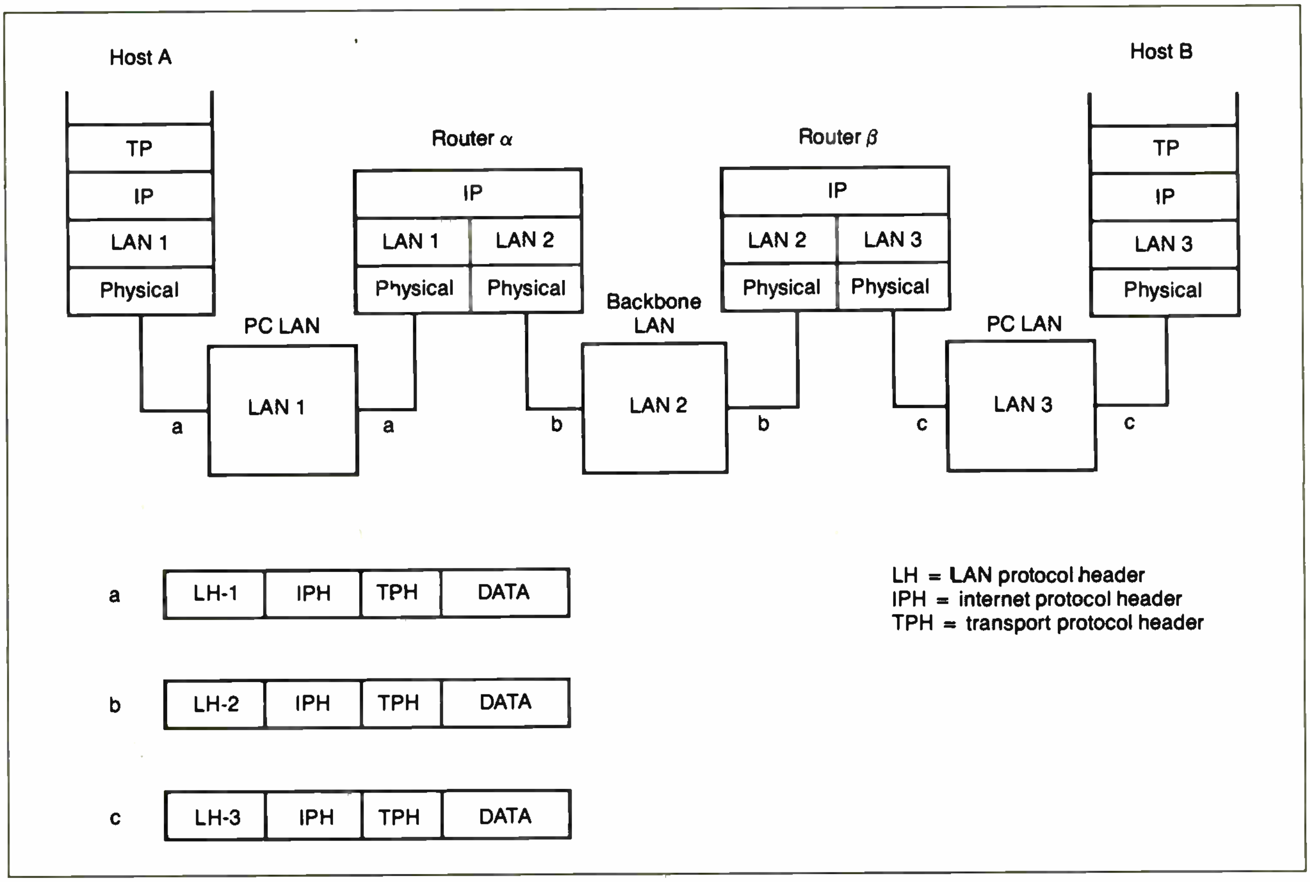

Figure 2: *The host machines and routers share the same internet protocols. The hosts also share the same transport protocols.*

- or, to reach the destination, the packet must traverse one or more additional routers.

In this example, the data must be routed through router β before reaching the destination. So router α constructs a new packet by appending a LAN protocol header to the IP data unit containing the address of router β. When this packet arrives at router β, the packet header is stripped off. The router determines that this IP data unit is destined for B, which is connected directly to a network to which the router is attached. The router therefore creates a packet with a destination address of Y and sends it out onto LAN 3.

At each router, before the data can be forwarded, the router may need to segment the datagram in order to accommodate a smaller maximum packet size on the outgoing network. In such a case, the datagram is split into two or more segments, each of which becomes an independent IP datagram. Each new datagram is wrapped in a lower-layer packet and queued for transmission. The router may also limit the length of its queue for each network to which it attaches to avoid having a slow network penalize a faster one. Once the queue limit is reached, additional datagrams are simply dropped.

This process continues through as many routers as necessary for the datagram to reach its destination. The destination host recovers the IP datagram from its network wrapping the same way the router does. If segmentation has occurred, the IP module in the destination host buffers the incoming data until it can reassemble the entire original data field. This block of data is then passed to a higher layer in the host.

The IP doesn't guarantee that all data will be delivered or that the data that is delivered will arrive in the proper order. It's the responsibility of the next higher layer, the transport layer, to recover from any errors that occur. This approach may not be completely reliable, but it provides for a great deal of flexibility.

The IP approach means that each unit of data is passed from router to router in an attempt to get from source to destination. Since delivery is not guaranteed, there is no particular reliability requirement on any of the subnetworks.

Thus, the protocol will work with any combination of subnetwork types. Since the sequence of delivery is not guaranteed either, successive data units can follow different paths through the internet. This allows the protocol to react to congestion and failure in the internet by changing routes.

But What Is Its Function?

The routing function is typically accomplished by maintaining a routing table in each host and router that gives, for each possible destination network, the next router to which the IP datagram should be sent.

The routing table can be static or dynamic. In the case of a simple configuration, such as a collection of PC LANs and a single backbone LAN, a static table is adequate. For a more complex configuration involving a number of LANs at different locations and perhaps one or more wide-area networks, the static table has several drawbacks. It doesn't allow alternate routing for load leveling, and it doesn't provide for rapid reconfiguration

Raising the Standard

The International Standards Organization (ISO) has issued a standard for an internet protocol, the Protocol for Providing the Connectionless-Mode Network Service (IS 8473), often referred to as ISO-IP.

The protocol is best understood by examining its header format (see figure A). Data to be transmitted is inserted into a datagram with the ISO-IP header with the following fields:

- *Protocol identifier*. When the source and destination hosts are connected to the same network, an internet protocol is not needed. In that case, the internet header is null, except for a special code in this field.
- *Length indicator*. Length of the header in octets.
- *Version*. Included to allow revisions to the standard.
- *PDU lifetime*. This field is used to specify the maximum number of routers a datagram can visit so as to prevent endlessly circulating datagrams. The value is specified in units of 500 milliseconds, but it is generally assumed that each unit represents one "hop."
- *Flags*. The SP flag indicates whether segmentation is permitted. The MS flag is the More flag described in the main text. The ER flag indicates whether an error report is desired by the source host if a datagram is discarded.
- *Segment offset*. Used in the segmentation and reassembly operations.
- *Type*. Indicates whether this datagram contains user data or an error message.
- *Checksum*. Computed on the header at each router for error detection.
- *Options*. Optional parameters include Security, defined by the user; Source Routing, which allows a source host to dictate the routing; Recording of Route, used to trace the route a datagram takes; Priority; and Quality of Service, which specifies reliability and delay values.

The Military Standard

As part of its suite of standards, generally referred to as the TCP/IP protocol suite, the U.S. Department of Defense has issued a standard for an internet protocol. Actually, the DOD-IP predates and is the inspiration for the ISO-IP. Although the formats and details of DOD-IP and ISO-IP differ, they provide essentially the same functionality.

Because DOD-IP and other military standards have been around longer, they are more widely used than the ISO standards. In particular, a number of vendors provide TCP/IP-based products and routers employing DOD-IP.

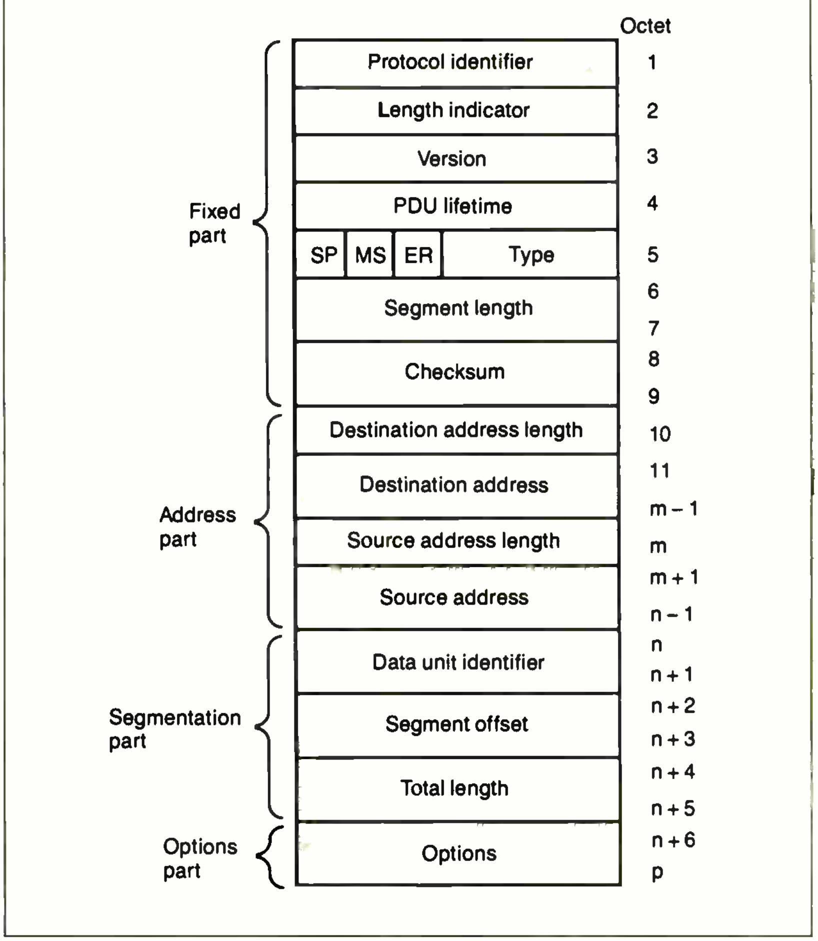

Figure A: *The 15-part header format for the ISO-IP, the ISO's standard for an internet protocol.*

in the event of a router failure.

A dynamic table is more flexible in responding to both error and congestion events. For this technique, there must be a protocol that will allow the routers to exchange information about congestion and the topology of the configuration. This area is still experimental; the required router-to-router protocols are still evolving.

Achieving Segmentation

Both the ISO and DoD IPs specify the same technique for segmentation. The technique requires the following fields in the datagram header: ID, Length, Offset, and More flag. The protocols use the ID to uniquely identify a host-originated datagram. The ID consists of the source and destination host addresses and a sequence number. The Length is the length of the user data field in octets, and the Offset is the position of a segment in the original datagram in octets.

The IP layer in the source host creates a datagram with Length equal to the entire length of the data field, Offset = 0, and the More flag set to false. In order to segment a long datagram, an IP mod-

continued

Table 1: *The segmentation of a datagram.*

Segmentation example

Original datagram	First segment	Second segment
Length=472	Length=240	Length=232
Offset=0	Offset=0	Offset=240
More=false	More=true	More=false

ule in a router performs the following tasks:

- It creates two new datagrams and copies the IP header fields of the incoming datagram into both.
- It divides the data into two approximately equal portions, placing one portion in each new datagram.
- It sets the Length field of the first datagram to the length of the inserted data and the More flag to true. The Offset field remains unchanged.
- It sets the Length field of the second datagram to the length of the inserted data, and it adds the length of the first data portion to the Offset field. The More flag remains the same.

Table 1 gives an example of the segmentation of a datagram. The procedure can be generalized to an *n*-way split.

To reassemble a datagram, there must be sufficient buffer space at the reassembly point. As segments with the same ID arrive, their data fields are inserted into the proper position in the buffer until the entire original datagram is reassembled; this is achieved when a contiguous block of data is buffered, starting with an Offset of 0 and ending with data from a segment with a false More flag.

Typically, reassembly is done at the destination host, to avoid burdening routers with unnecessarily large buffer space and to permit segments to arrive via different routes.

The Future

The use of internetworking is growing rapidly, and all types of devices will play a role in the future. You can use a bridge primarily to link LANs that use the same networking protocols.

Bridges don't provide links to other kinds of LANs or long-haul networks. You can use a gateway as a special-purpose protocol converter. The only truly general-purpose device of the three is the router.

The international standards are gradually gaining wider acceptance and clearly represent the wave of the future. We can expect to see a rapid increase in ISO-IP-based LANs and routers over the next year or two. ■

Editor's note: *This article is based on material in the second edition of the author's* Data and Computer Communications *(New York: Macmillan, 1988).*

William Stallings is president of Comp-Comm Consulting of London, England, and the author of 12 books on data communications topics. He can be reached on BIX c/o "editors."

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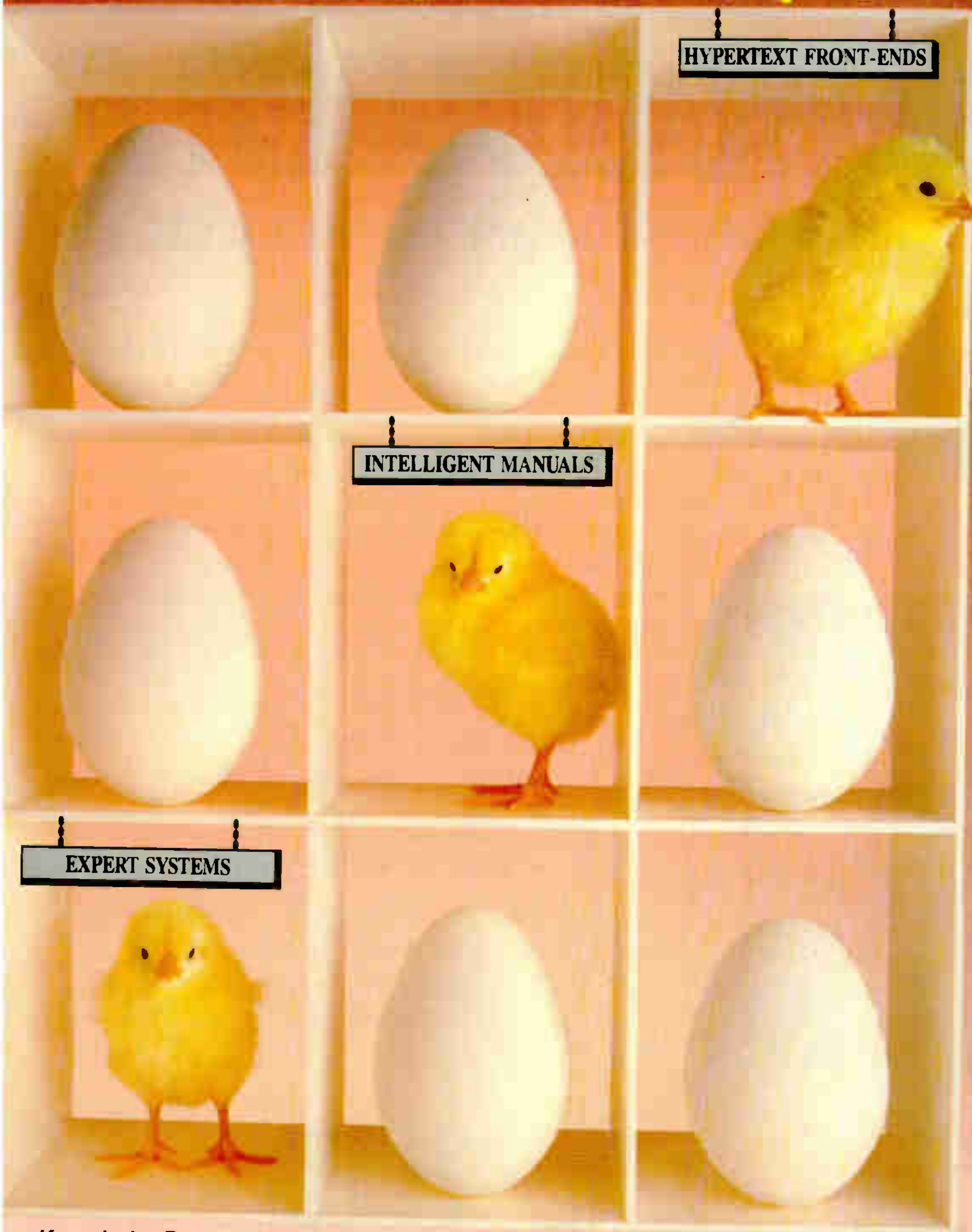

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Understanding NetBIOS

Hardware and software independence makes this interface an excellent vehicle for portable network software

Brett Glass

Whether you're writing a simple database manager or advanced groupware, expect it to at least accommodate a network and, ideally, to use the full potential that a local-area-network environment has to offer. As LANs proliferate, software products will be expected to keep pace by using these fast, convenient connections to good advantage.

For that reason, it helps to understand the IBM NetBIOS—the most widely implemented (and emulated) interface between application programs and LANs in the IBM PC world.

NetBIOS is the Application Program Interface (API) that lets an IBM PC program explicitly access LAN facilities. It's possible, of course, for any program to use the network while making the usual calls to the MS-DOS file system. NetBIOS calls, however, do more: They let you instantly transmit any sort of information to an application on another network machine.

NetBIOS calls are hardware-independent. The same commands that worked with the original IBM PC network (a broadband system made for IBM by Sytek) work with no changes on Ethernet, ARCnet, Token Ring, StarLAN, and even simple serial-port LANs.

These commands are also largely software-independent. Whether you run Novell's NetWare, 3Com's 3+, Network OS, Banyan's VINES, ViaNet, or any other IBM PC LAN software, chances are it has a NetBIOS API built in or as a no-cost option.

This combination of hardware and software independence makes NetBIOS an excellent vehicle for portable network software. The sample software for this article, for instance, was developed on an ARCnet LAN consisting of an IBM PC AT, an EarthStation I diskless workstation, and Wendy, a "home-brew" AT clone. It then ran on a large Ethernet, with many PCs and different network software, with no changes.

However, NetBIOS doesn't have everything. Novell's NetWare, for instance, has literally hundreds of commands to support user directories, network security, accounting, print servers, and remote job execution; NetBIOS has only 19. But this carefully chosen set of basic functions can handle the needs of sophisticated network applications. (For more details, see the text box "The 19 Commands" on page 303.)

NetBIOS and the OSI Model

The IBM NetBIOS API provides services on two layers of the Open Systems Interconnection (OSI) model: the Data Link Layer and the Session Layer. None of the

continued

PHOTO/ILLUSTRATION: RON BROWN © 1989

other layers are directly accessible to the application (see figure 1).

The Data Link Layer, the lowest layer supported by the NetBIOS API, simply sends packets of data between two stations on the network. The NetBIOS Datagram Support commands operate on this layer. Applications can transmit and receive *datagrams*—small packets of raw information—using these commands. However, the Data Link Layer will not acknowledge receipt of a datagram, or even give any assurance that a program at the receiving end was listening at the time. On the other hand, this mode of communication requires fewer resources from the network adapter and NetBIOS itself.

The Session Layer, a higher and more robust layer of the OSI protocol stack, is also supported by NetBIOS. The Session Layer coordinates interactions between applications and supports reliable transmission of data between them. When NetBIOS establishes a session between two running programs, each can tell that the other is there and whether or not its messages have been received.

It's up to the application program to provide any higher layers it wishes to use, including the Presentation Layer (which formats data for an application) and the Application Layer (which starts code running to service a request from across the network). When combined with a program such as the IBM PC LAN Program, DOS itself becomes a networked application and can implement features on these two layers.

The IBM PC LAN Program, like many others, uses NetBIOS as part of the mechanism that lets you share resources, such as disks and printers, across the network. Others, such as Novell's NetWare, use their own proprietary architectures for resource sharing and emulate NetBIOS for programs making NetBIOS API calls. In some cases, the emulation approach makes the network run faster, but it can also cause problems with software compatibility. You should test a program that uses NetBIOS on both types of systems to be safe.

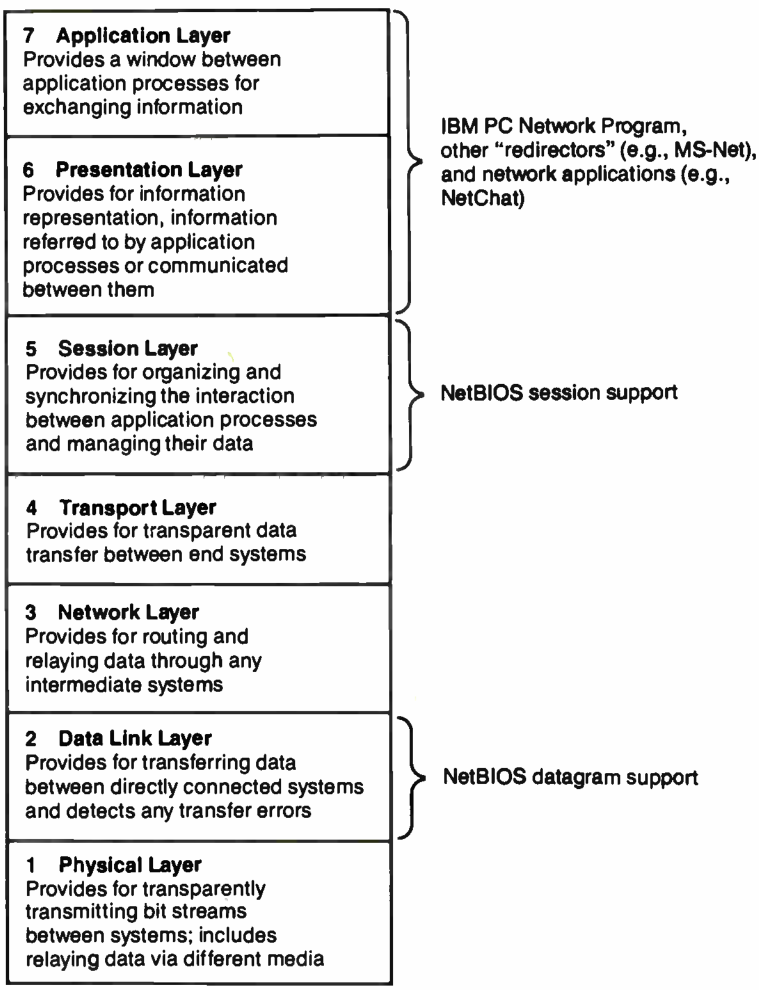

Figure 1: *The International Standards Organization OSI model. NetBIOS provides services on both the Data Link Layer and the Session Layer.*

In a Nutshell

Gaining a thorough understanding of LANs can take several years and a lot of effort. One of the advantages of NetBIOS is that it hides much of the LAN's complexity by providing a high-level interface to network functions. To program to NetBIOS, you need only understand a few simple concepts.

A fundamental part of NetBIOS programming is the concept of a *name*. Each LAN adapter card can have up to 17 names, each consisting of 16 bytes. One of these names is the *permanent node name*.

The permanent node name is the physical-adapter card's own unique name. The original IBM LAN Adapter derived this name from a 6-byte serial number written into an EPROM on the card; IBM guaranteed that each adapter had a unique number. Other types of cards may make other provisions to be sure the name is unique. The permanent node name consists of 10 bytes of binary zeros followed by the 6-byte serial number.

Each adapter also uses a *local name table* that holds up to 16 software-selectable names that are recognized on the network. Each may be a *unique name*, which the adapter reserves for its exclusive use on the network, or a *group name*, which other adapters can use. When a name is added to the local name table, the adapter attempts to claim the name by broadcasting its intentions to all other adapters on the network.

If other stations don't reject the claim, the name is registered in the local name table as being associated with that adapter. When a name is added to the name table, NetBIOS returns the number of the slot in which it resides. This *name number* is used by many NetBIOS commands as a quick way of referring to a name that's known to be in the table.

Datagrams

The simplest way that you can communicate through NetBIOS is with the datagram. A datagram is a block of raw data,

The 19 Commands

You can divide the 19 NetBIOS commands into four categories: general-purpose, name support, datagram support, and session support (see table A).

• *General-purpose commands*. The `reset` command resets the NetBIOS and hardware for one LAN adapter on a PC (the IBM NetBIOS supports up to two). It erases the local name table, aborts all sessions, and sets up buffers to handle specified maximum numbers of active sessions and outstanding commands.

Under normal conditions, you won't want to issue a `reset` command, since it drops the sessions used by any network program running on your machine and renders any network disks inaccessible. (You may be able to issue this command with impunity in an emulated NetBIOS environment, such as Novell's, but it's not recommended.) If you wish, however, to use a LAN adapter exclusively for your own application, this command frees all available resources for you to use.

The `cancel` command cancels a command that hasn't completed yet. This is useful when you are using `no wait` commands.

The `adapter status` command provides status information on any adapter in the network—not just the local one. Among the items it provides are the 6-byte unit-identification number, jumper status, traffic and error statistics, resource statistics, and the contents of the local name table.

The `unlink` command is used by a system that has booted from another's disk. During a remote boot, the network adapter intercepts read requests destined for the boot floppy disk and gets the data from a boot server on the network instead. The `unlink` call ends the boot-disk emulation.

• *Name support commands*. The `add name` and `add group name` commands add names to the local name table. An `add name` command requests exclusive use of a name; it succeeds only if the name is not already in use. An `add group name` command succeeds as long as no other station has been granted exclusive use of the name.

The `delete name` command removes a name from the name table. Pending operations and sessions may need to be terminated when a name is removed.

• *Datagram support commands*. The `send datagram` and `receive datagram` commands do the obvious: They send and receive datagrams. The `send datagram` command sends to a specific name, while `receive datagram` can receive messages for a specific name or for any name on the adapter. The `send broadcast datagram` and `receive broadcast datagram` commands handle broadcast datagrams.

• *Session support commands*. The `call` command is a request to initiate a session, and the complementary `listen` command tells an adapter to accept a `call`. During a session, you can use the `send` and `receive` commands to exchange messages. The `chain send` command sends a message that is concatenated from two sources—this comes in handy when messages have a header followed by a body. The `receive any` command receives a message from any name with which you have an active session, and the `hang up` command ends a session.

Table A: *The NetBIOS commands.*

Command	Function
General-purpose	
`reset`	Reset the LAN Adapter, clear name and session tables
`cancel`	Cancel a pending command
`adapter status`	Get information about the LAN Adapter, names, sessions, traffic and error statistics, and software version
`unlink`	Terminate a remote boot operation (end INT 13 redirection)
Name support	
`add name`	Add a unique name to the local name table
`add group name`	Add a group name to the local name table
`delete name`	Remove a name from the local name table
Datagram support	
`send datagram`	Send a datagram
`send broadcast datagram`	Send a broadcast datagram
`receive datagram`	Receive a datagram
`receive broadcast datagram`	Receive a broadcast datagram
Session support	
`call`	Attempt to open a session with another name
`listen`	Listen for a `call` to come in
`hang up`	End a session
`send`	Send data as a message within a specific session
`chain send`	Concatenate two buffers and send as a message
`receive`	Receive a message
`receive any`	Receive a message from any open session
`session status`	Get information about all sessions associated with a specific name or all names

from 0 to 512 bytes long, that can be sent to a unique name, a group name, or everyone on the network (a broadcast datagram).

Datagrams aren't acknowledged by the LAN card at the receiving end and are lost if the adapter they are intended for isn't ready to receive them. An application that requires confirmation that the message was received must arrange for the application at the other end to send an acknowledgment.

Broadcast datagrams are received by any station on the network that is listening for them (i.e., any having a `receive broadcast datagram` command pending). All other datagrams are sent to a specific name, and any station that has the name in its local name table can receive them.

continued

Listing 1: *The declaration for an NCB for the sample program.*

```
type
  NetName = array [1..16] of Char;
            {Format of a name used in net operations}
  {The following variant record supports the use of the
   callName field of an NCB for either a network name or
   buffer chaining.}
  NameOrBufInfo = record
   case Boolean of
     FALSE: (name : NetName);     {Network name}
     TRUE:  (nextBufLen : Word;   {Length of next
                                    buffer in a chain}
             nextBufPtr : Pointer) {Pointer to next
                                    buffer in a chain}
     end;
  NCB = record
    command,            {NetBIOS command}
    retcode,            {Return code}
    lsn,                {Local session number}

    num : Byte;         {Number of a local name}
    bufPtr : Pointer;   {Pointer to message buffer}
    len : Word;         {Message buffer length}
    callName:           {Destination name or info about second}
      NameOrBufInfo;    {buffer in a CHAIN SEND}
    name : NetName;     {Source (local) name}
    rto,                {Receive timeout in half seconds}
    sto : Byte;         {Send timeout in half seconds}
    post : Pointer;     {Interrupt completion routine address}
    lana_num : 0..1;    {Number of LAN adapter}
    cmd_cplt : Byte;    {Command complete flag}
    reserved : array [1..14] of Byte {Internal use only}
    end;
```

Listing 2: *Here, an in-line macro inserts the interrupt instruction directly into the code.*

```
function NetBIOS(var n : NCB) : Byte;
  {Call the NetBIOS with the given NCB. The function
   returns the  same value that appears in the retCode
   field of the NCB after the call. Note that commands
   issued with the no-wait option and no interrupt comple-
   tion routine will return their final result codes in
   the cmd_cplt field. A Turbo Pascal inline procedure issued
   here to generate efficient code.}
  inline($5B                {pop bx}
        /$07                {pop es}
        /$CD/$5C            {int $5C}
  );
```

Conducting a Session

While datagram communications are inherently one-way and unreliable, a *session* is a reliable two-way connection between two names on the network. A node on the network can be involved in more than one session, and the same pair of names can have more than one session running between them. Sessions provide reliable transport by confirming that the receiver is there, the receiver is listening, and each message is received. You can also send longer messages via sessions—from 0 to 65,535 characters.

To understand how a session works, consider this telephone metaphor. The station that initiates the session issues a `call` command, and the called station responds if it has a `listen` command pending (i.e., if it's waiting for a call to come in). If all goes well, a conversation is established, and each station can use the send and `receive` commands to communicate with the other. Like a phone call, the session terminates when one of the stations issues a hang up command.

You can execute many NetBIOS commands concurrently with other parts of your program if you invoke them with the No Wait option. The original IBM PC LAN Adapter had its own 80188 microprocessor on-board, which made concurrency easy; the adapter simply processed the command and interrupted the PC when it was done. It's not necessary to have a coprocessor to allow concurrent processing, however; NetBIOS implementations for less-intelligent hardware can "borrow" the main CPU during clock ticks and hardware interrupts.

Of the 19 NetBIOS commands, you can execute 16 with the No Wait option. If you do, the Network Control Block (NCB)—the block of memory containing the information about the command passed to NetBIOS—must not be disturbed until the command is complete.

To invoke a NetBIOS command, you must execute a software interrupt (IBM has reserved interrupt number 5C hexadecimal for this purpose) while the CPU's ES and BX registers contain a pointer to an NCB. The NCB is a data structure containing information about the command to be performed.

Listing 1 shows the declaration for an NCB used in the sample program. [Editor's note: *NetChat is a shareware program written in Turbo Pascal. It is available in a variety of formats. See page 3 for details.*] The two subsidiary types, `NetName` and `NameOrBufInfo`, build the name and `callName` fields of the NCB.

The uses of some fields, `command` and `retcode`, for instance, are implicit in their names. Some of the others have meanings that vary from command to command and are not 100 percent consistent. The details go beyond the scope of this article, but they are spelled out explicitly in the NetBIOS bible, the *IBM PC Network Technical Reference*.

Invoking Software Interrupts

Once the NCB for a command is filled with the requisite data, it must be passed to the service routine that handles interrupt 5C hexadecimal on your PC. The methods you use to set up the registers vary from compiler to compiler. In Turbo Pascal 4.0 and higher, it's especially easy: You can use an "in-line macro" to insert the interrupt instruction directly into the code. Listing 2 shows the declaration I used.

The function `NetBIOS()` (in listing 2) is a machine language function that pops the address of the NCB into the ES:BX register pair. It then directly invokes the interrupt via a hard-coded INT 5C instruction. NetBIOS processes the NCB, then sends back a return code in the AL register, which just happens to be where

Turbo Pascal expects the result of a Byte function to wind up. Hence, no further processing is needed.

If you're using a different compiler, you may not have in-line assembly language capability. However, most languages support a function (usually with a name like Intr or int86x) that can accomplish the same thing.

How Easy It Is

How simple can a useful NetBIOS application be? The program NetChat in listing 3 is only three pages long (not counting the unit that defines the NetBIOS calls), and it's not only useful, it's addictive. NetChat implements a CB simulator, similar to CBIX or CompuServe's CB, over a LAN, and it had the users at my test site typing happily to one another for hours.

The requirements I set for the sample program were as follows. It had to allow any station on the network to talk to any or all other stations; not affect other network functions, such as file access or peripheral sharing; and allow users to come and go at will without halting communications.

The need for any-to-any and any-to-all communications ruled out the use of sessions, which are essentially one-to-one connections. Likewise, sessions would be a poor choice because they would bog down the network. During a session, each message involves exchanging several packets to ensure that it arrives safely. Furthermore, ensuring that each recipient gets a widely distributed message multiplies the overhead by the number of stations involved. Finally, since a session ends when one station "hangs up," maintaining a conversation as a group of sessions would be difficult.

For these reasons, datagrams, which don't incur the overhead of acknowledgment for every message sent, were the clear choice for NetChat messages. The remaining choice was whether to use ordinary datagrams or broadcast datagrams for the "party line" traffic. As it turned out, this decision was simple as well. Because broadcast datagrams are often used for other network functions and might interfere with them, I elected to use ordinary datagrams—in combination with an agreed-on group name—for NetChat messages.

Join the Club

Each station that participates in a NetChat conversation needs to tell its network adapter to listen for NetChat messages, while those not involved should

continued

Listing 3: *The main NetChat loop.*

```
{Main loop}
repeat
  if KeyPressed then
    begin
    ch := ReadKey;
    case ch of
      ^C : Halt; {Exit program}
      ^H : {Backspace}
        if Length(editString) > 0 then
          begin
          Write(^H' '^H);
          Dec(editString[0])
          end;
      ^M : {Send the string}
        with sendNCB do
          begin
          repeat until cmd_cplt <> COMMAND_PENDING;
                                {Wait for prev send}
          if cmd_cplt <> GOOD_RTN then
            begin
            chatError := cmd_cplt;
            Halt
            end;
          sendBuffer := userName + editString;
                              {Add attribution}
          len := Succ(Length(sendBuffer));
                            {Size the datagram}
          case NetBIOS(sendNCB) of
            GOOD_RTN, COMMAND_PENDING:; {These codes OK}
          else
            chatError := retCode;
            Halt
            end;
          editString := '';
          ClrScr {Clear the bottom one-line window}
          end;
      #0: ch := ReadKey;     {Ignore function keys}

      #1..#31,#127,#255:;    {and non-printing characters}
    else
      {Check for full line. Add character if there is room}
      if Length(editString) < Pred(SizeOf(editString)) then
        begin
        editString := editString + ch;
        Write(ch)
        end
      end
    end;
  for i := 1 to RCVNCBS do
    with receiveNCBs[i] do
      case cmd_cplt of
        COMMAND_PENDING:;
         {Do nothing; no message came in for this NCB}
        GOOD_RTN: {Display a message from the network}
          begin
          tempBufferPtr := bufPtr; {Get msg address}
          bufPtr := freeBuffer;     {Find the free buffer}
          len := SizeOf(String);
             {Set buffer length field back to max length}
          case NetBIOS(receiveNCBs[i]) of
                       {Immediately start another receive}

            GOOD_RTN, COMMAND_PENDING:; {These codes OK}
          else
            chatError := retCode;
            Halt
            end;
```

continued

```
sendX := WhereX;    {Save location on bottom line}
Window(1,1,80,23); {Move to the upper window and position cursor}
GoToXY(1,rcvY);
Write(^M^J,tempBufferPtr^); {Write the message}
rcvY := WhereY;     {Go back to the bottom line}
Window(1,25,80,25);
GoToXY(sendX,1);
freeBuffer := tempBufferPtr;
       end
    else
      chatError := cmd_cplt;
      Halt
      end
until FALSE
```

simply be able to ignore them. To indicate to the adapter that it wants to join the conversation, NetChat uses the `add group name` command to add a name to the local name table—in this case, the word NETCHAT followed by 11 zeros. It then starts four `receive datagram` commands and waits for messages.

Why four `receive datagram` commands? Well, since datagrams are neither acknowledged nor guaranteed to arrive intact, the most likely way for them to be lost is if no `receive datagram` command is pending when the message comes in. NetChat makes sure that there are always buffers ready for incoming messages by issuing four commands with the No Wait option and checking frequently to see if any of the commands have completed due to an incoming message. If one has, NetChat starts a new command even before it displays the data from the last one. The result is a robust system that isn't likely to lose messages.

While it watches for incoming messages, NetChat also runs a simple line editor in a one-line window at the bottom of the screen. This editor accumulates the characters for an outgoing message until you strike the Enter key, whereupon it issues a `send datagram` and sends the string as a message to the group.

The sender's name and a colon are prepended to the message so that other participants will be able to identify the source of the message.

When a message goes out to the group, the local adapter receives it just like everyone else. The message is thus interspersed with the incoming messages on the top portion of the screen. The concurrent tasks of editing outgoing messages and displaying incoming ones are handled by a short, straightforward main loop (see listing 3). Most of the code in the loop is involved not with network transactions but with presenting a nice image on the screen. (Listing 3 also shows you how to fill the required fields for some of the more common NetBIOS commands.)

Shutting Down

When NetChat terminates, it needs to clean up and free the network resources it uses. To shut down all pending operations, NetChat issues a `delete name` command to delete the group name from the local name table. Since all `receive datagram` commands must be associated with a name, they terminate instantly when that name is deleted. An outstanding `send datagram` command will complete quickly.

Our example program uses an "exit procedure" (a procedure that's called when a program halts) to perform the `delete name` command; thus, the name will be removed (and the space in the name table freed) even if the program terminates abnormally. In NetChat, this procedure is called ExitChat.

A Good Foundation

NetChat is but one example of what an application can do using the resources of NetBIOS. While a factory-control program or a large-scale X.400 electronic mail package will be more complex than my simple CB simulator, the underlying principles are the same.

Regardless of the job at hand, however, the key virtues of NetBIOS—its hardware and software independence and its inherent simplicity—make it a good foundation on which to build any PC application that must communicate over a network. ■

Brett Glass is a freelance programmer, author, and hardware designer residing in Palo Alto, California. He was one of the original architects of the IEEE 802.5 Token Ring LAN and coauthored Living Videotext's ThinkTank 2.0. He can be reached on BIX as "glass."

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A Logical Choice

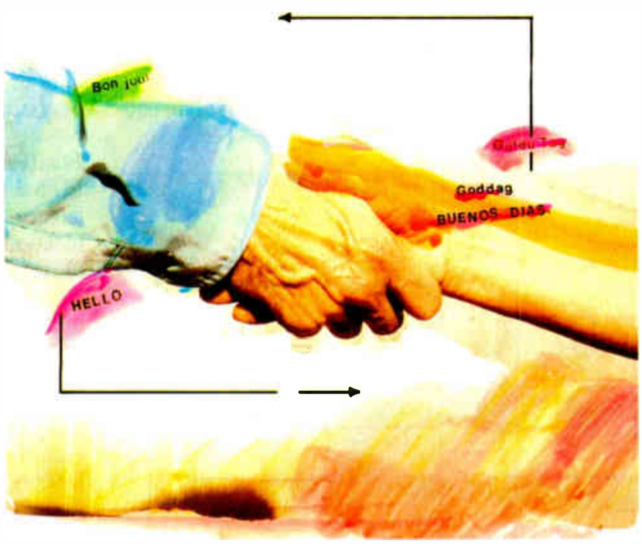
APPC, also called LU 6.2, provides a solid foundation for true distributed processing

Ralph Davis

Perhaps one of a kind among communications protocols, Advanced Program-to-Program Communication (APPC), also known as Logical Unit (LU) 6.2, is precisely defined *logically* apart from any of its actual implementations. This is natural for a protocol that is intended to support "any-to-any" communications.

There are many different ways of implementing APPC in the hardware and operating-system software of different systems. However, the completely logical definition of its functionality ensures its uniformity across a variety of platforms.

APPC provides a solid foundation for *true* distributed processing, where programs executing on different machines cooperate in a single distributed transaction. Indeed, its name reveals its purpose: It's intended as a vehicle for programs to communicate with each other.



What Is APPC?

APPC is IBM's strategic protocol for interprogram communication and a central protocol in its Systems Application Architecture (SAA). Although the terms *APPC* and *LU 6.2* are not exactly synonymous, they are used as if they were. APPC refers to the standard, the overall architecture and design of the protocol, whereas LU 6.2 is the software that actually executes in a network node and gives it access to the communications capabilities defined by the standard. (LU 6.2 also refers to APPC's historical position in the development of IBM's System Network Architecture [SNA] protocols, it being the immediate successor to LU 6.0 and LU 6.1.)

However, since IBM seems to use the two terms interchangeably, it seems unlikely that I'll cause any confusion if I do too.

When viewed from the perspective of concrete implementations, APPC appears to be extremely complex. Many of the verbs require large data structures as parameters. In addition, in its major PC implementations (i.e., IBM's APPC/PC and Novell's NetWare LU 6.2), APPC obliges the systems programmer to write a considerable amount of support code.

Therefore, it's helpful in trying to understand APPC to study its logical definition rather than its implementations. This will also let you appreciate its true power, as specific implementations may not incorporate all its features.

Intelligent Peers

LU 6.2 is the successor to earlier protocols that supported terminal-to-host communications. When they were developed, terminals were not capable of in-

continued

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telligent processing; all the intelligence resided at the host. The terminal, essentially, had only one function—input and output.

As PCs proliferated, users were no longer content with dumb terminals; they wanted intelligent processors on their desks. But those who were already communicating with hosts didn't want to give up this capability. Thus, terminal emulators came along.

Terminal emulators enabled PCs to pretend to be dumb terminals, but they didn't take advantage of the power that intelligent workstations offered. In particular, the terminal emulators still relied on the protocols that assumed an all-knowing host and a helpless terminal. Terminal-to-host protocols didn't offer any capability for peer-to-peer communication; they grew out of a master/slave environment, where the notion of peers was irrelevant.

LU 6.0 and LU 6.1 were early interprogram protocols that introduced many of LU 6.2's features. They allowed one program to load and execute another program through a partner LU and also provided distributed commit-and-rollback capability. However, LU 6.0 was limited to the teleprocessing monitor, CICS (Customer Information Control System), and LU 6.1 allowed communication between CICS and the database-and-communication system, IMS (Information Management System). Both LU 6.0 and LU 6.1 allowed interprogram communication only between one host (PU Type 5) and another.

APPC, on the other hand, assumes that intelligence is distributed around the network. It provides an avenue over which network nodes can communicate with one another without going through a host, and it also provides a solid foundation for true distributed processing. APPC is meant for program-to-program communication.

And that communication is not merely passive. APPC gives programs the ability to load and execute programs on other network nodes, a step beyond other protocols, which are mostly rooted in the Open Systems Interconnection (OSI) session layer or below. They concern themselves with sessions between machines, whereas APPC's realm is conversations between programs. (For a comparison between the OSI layers and the SNA layers, see figure 1.)

A full distributed transaction can involve any combination of participating nodes. Node A, for instance, might allocate a conversation with node B, which in turn allocates conversations with nodes C and D. As part of the transaction, D allocates a conversation between two different programs that it executes concurrently.

At its highest level of error recovery, *syncpoint*, APPC offers full protection for resources involved in a transaction. It implements true two-phase commit protocol, which is essential for distributed database systems. Thus, you don't have to worry about implementing this difficult—and crucial—component of distributed database systems.

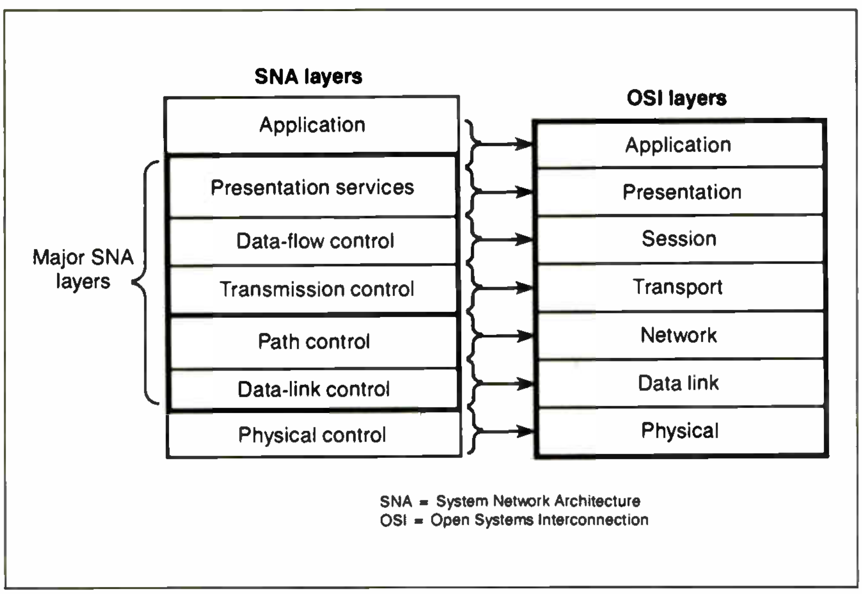

Figure 1: *The SNA layers versus the OSI layers. While the correspondences are very close, they are not exact.*

Coming to Terms

Before going any further, I want to define some basic terms. A transaction program (TP) is a program executing in a network node that, through LU 6.2, participates in a conversation with a program on another node. A logical unit (LU) is a set of software routines that control the details of creating and managing sessions.

Whereas the LU manages sessions (logical links) between nodes, the physical unit (PU) is software that manages the physical data links between them. LU 6.2 and PU 2.1 go hand-in-hand. Indeed, PU 2.1 was developed to serve as a platform for LU 6.2. Its predecessor, PU 2.0, permitted neither multiple sessions nor peer-to-peer communication.

Conversations (TP to TP) are links between concurrently executing TPs. The programs can reside at the same or different locations on the network. Sessions (LU to LU) are links between LUs over which conversations flow. The session details are transparent to the TPs; their view of sessions is limited to mode names, which are associated with such characteristics as level of data protection, maximum packet size, and so on.

Conversations use sessions. The LU will multiplex conversations over available sessions. Typically, sessions remain in an active state even when there are no active conversations. This ensures that a session will be available when a conversation is requested and improves performance.

Position within Layers

LU 6.2 provides TPs with a high-level interface for program-to-program communication. Because LU 6.2 executes verbs on the SNA presentation-services layer (corresponding to the OSI presentation layer), programs need not trouble themselves with any of the underlying data-link, network, or session protocols.

The presentation-services layer is where many of LU 6.2's most important functions reside. It's responsible for loading and executing ("attaching") programs, converting data records sent on mapped conversations to general-data-stream (GDS) variables, and coordinating error handling with partner LUs.

The term *half-session layer* is another name for the two levels immediately below the presentation-services layer: the data-flow-control and transmission-control layers. It's called "half-session" because it controls the local LU's contribution to a full session, which requires a partner LU. This layer is responsible for the pacing and sequencing of data packets and for encryption and decryption of data (where these functions are supported).

The Verbiage

The IBM literature identifies two components of APPC: the base set of functions and option sets. All implementations of APPC must include the base set. They don't have to support any of the option sets, but any that they do support must be supported in full.

There are two types of conversation verbs: those that support basic conversations and those that support mapped conversations. There is a one-to-one correspondence between them; the same verbs exist for both conversation types. Their names are the same except that the mapped-conversation verbs are preceded by MC_. Thus, the basic ALLOCATE is the mapped MC_ALLOCATE.

The basic-conversation verbs are lower level than the mapped verbs and frequently require more arguments. They require that you format user data in GDS variables, and they offer less automatic error recovery. They are used primarily by programs that provide network-control services (IBM's service-transaction programs).

Mapped-conversation verbs, on the other hand, offer TPs a somewhat higher level of insulation from the underlying details. Programs only transmit data records; LU 6.2 creates the GDS variables. The LU also offers a high level of error recovery. Mapped conversations also may offer a data-mapping capability whereby you pass user data through a mapping routine that performs transformations on it. Mapped-conversation verbs are used primarily by application programs. Only the basic verbs are required by the APPC specification.

The functions that LU 6.2 implementations must provide, and the basic-conversation verbs corresponding to those functions, are as follows:

- Initiate a conversation with a remote node and then load a TP at that node (ALLOCATE).
- Transmit data to the remote node (SEND_DATA).
- Receive data from the remote node (RECEIVE_AND_WAIT).
- Notify the remote node that an error has occurred (SEND_ERROR).
- Ask the remote node for permission to transmit data (REQUEST_TO_SEND).
- Provide request/response protocol (CONFIRM/CONFIRMED).
- Terminate a conversation (DEALLOCATE).

A variety of other verbs also cluster around certain categories: type-independent verbs, control-operator verbs, and LU-definition verbs.

You can issue type-independent verbs during either a basic or a mapped conversation. Indeed, BACKOUT, SYNCPT, and WAIT can apply to multiple concurrent conversations, without regard to their types.

The control-operator verbs are used to control session parameters, typically by service-transaction programs. The CNOS (change number of sessions) verbs deal, not surprisingly, with regulating the number of active sessions between two LUs. When you use them to define parameters for parallel sessions, they activate a basic conversation between the local node and its partner LU, over which they negotiate the session characteristics.

One of APPC's strengths is its multitiered data-security scheme.

The LU-definition verbs set parameters for the local LU. They don't involve any exchange with a partner LU. (See table 1 for details on all these LU 6.2 verbs.)

Insulated from the Details

LU 6.2 gives application programs an interface to the SNA presentation-services layer. Because it resides so high in the SNA (and OSI) architecture, it shields programs from any knowledge of the details of communications, such as session initiation, packet creation, data-link control, and so on.

TPs need only concern themselves with allocating and deallocating conversations, sending and receiving data, and reporting success or failure to conversation partners.

Although service programs communicate more directly with the half-session layer and therefore require more knowledge of the underlying details, their sole purpose is control and configuration of the local installation of LU 6.2. Thus, it is possible to concentrate this knowledge in a single person, a systems administrator or systems programmer, and in a few software tools available to that person.

Data Security

One of APPC's greatest strengths is its multitiered data-security scheme, which offers protection for sensitive data (and the option of no protection for data that doesn't need it). All the security features are optional. The components of this scheme are as follows:

- *Data encryption and decryption.* This is available at the session level and is one of the characteristics assigned to session modes. If an ALLOCATE specifies a session mode defined to support encryption (with the DEFINE_MODE verb), the data is encrypted and decrypted automatically. This security option is independent of the others; you may specify it even if you omit all others, and you may omit it even if you specify all others.
- *LU-to-LU passwords.* This is the most basic security level, and it is a prerequisite for all the more specific protection mechanisms. It enables the control operator to require a remote LU to provide a password when requesting a session. You activate it by specifying a password on the DEFINE_REMOTE_LU verb.
- *User IDs, passwords, and profiles.* These require a remote LU to provide user information on allocation requests directed to the local LU. The local LU verifies this information against a list of authorized users, passwords, and profiles, set up with the DEFINE_LOCAL_LU verb.
- *Already verified.* As an additional option, user IDs, passwords, and profiles may be "passed through" when multiple sites are participating in a distributed transaction if the security-acceptance level between two LUs is established as "already verified." For instance, if node A sends an allocation request to node B carrying the user ID "RALPH DAVIS" along with the password, node B may then pass that information through to node C on a second allocation request with an "already verified" indication. The willingness of an LU to accept "already verified" requests from another LU is set by DEFINE_REMOTE_LU.
- *Local restricted access to TPs.* The local LU can also restrict access to TPs. Thus, although you might be able to allocate a conversation with the local LU, you might not have access to all the programs resident at the local node. Those authorized to use a TP are specified with DEFINE_TP.
- *Privilege levels for TPs.* You can also

continued

assign privilege levels to TPs as an argument to DEFINE_TP, specifying which, if any, of the control-operator verbs the TPs can issue. This prevents unauthorized programs from changing user-access information.

Data Integrity

LU 6.2 offers two levels of data-integrity protection: CONFIRM and syncpoint, which means that, at a certain point in a transaction, participating nodes bring their resources into synchronization with each other. No protection (i.e., no automatic protection) is also an option; this requires the participating programs to do their own error checking.

The CONFIRM level is essentially a request-and-response protocol. When a participant sends a CONFIRM request to a partner, that partner must respond by issuing either CONFIRMED or SEND_ERROR. This is all the protection LU 6.2 offers at this level; the TPs must handle any further error recovery. CONFIRM-level protection is a required feature.

Syncpoint error recovery is an optional feature, and in some respects this is unfortunate. Syncpoint protection is one of APPC's most powerful features, and it would be nice if you could assume that it was always available. On the other hand, syncpoint protection also addresses the problem of maintaining the integrity of a distributed transaction, a difficult technology to implement.

Syncpoint protection provides for the integrity of data updated at multiple sites. In the terminology of database management, it extends the scope of logical units of work (LUWs) to all the machines involved in a distributed database system. Syncpoint protection provides full two-phase commit protocol with rollback and resynchronization capabilities. It thus makes LU 6.2 a solid foundation on which you can build distributed databases.

When syncpoint protection is in effect on a conversation, each participating LU keeps a log of its activity on that conversation. LUWs begin when the TPs are loaded and end at each syncpoint or when the programs terminate. With a nondistributed DBMS, transaction protection means that the system guarantees that it

Table 1: *The LU 6.2 verbs.*

Basic Verbs

ALLOCATE (MC_ALLOCATE)
Establishes a conversation between the local node and a partner node and attaches (loads and executes) a transaction program at the partner.

CONFIRM (MC_CONFIRM)
Asks the partner LU to confirm receipt of transmitted data.

CONFIRMED (MC_CONFIRMED)
Confirms receipt of data—issued only in response to CONFIRM (MC_CONFIRM).

DEALLOCATE (MC_DEALLOCATE)
Terminates a conversation.

FLUSH (MC_FLUSH)
Forces the local LU to send the data accumulated in its send buffer.

GET_ATTRIBUTES (MC_GET_ATTRIBUTES)
Returns a variety of information pertaining to a conversation, such as the following:
- the names of the participating LUs
- the session mode being used by the conversation
- the synchronization level in effect
- security information
- information used to synchronize or resynchronize participating LUs (if SYNCPT is in effect)

POST_ON_RECEIPT (MC_POST_ON_RECEIPT)
Causes the LU to set a flag when the requesting program receives a message on the indicated conversation. After issuing POST_ON_RECEIPT or MC_POST_ON_RECEIPT, the program must issue a WAIT or a TEST (MC_TEST) to retrieve the status information.

PREPARE_TO_RECEIVE (MC_PREPARE_TO_RECEIVE)
Forces the local LU into receive state and informs the partner LU that it can enter send state.

RECEIVE_AND_WAIT (MC_RECEIVE_AND_WAIT)
Causes the LU to suspend execution of the transaction program until data arrives on the indicated conversation.

RECEIVE_IMMEDIATE (MC_RECEIVE_IMMEDIATE)
Instructs LU 6.2 to receive any information that is available and to return immediately if no information has been received.

REQUEST_TO_SEND (MC_REQUEST_TO_SEND)
Asks the remote transaction program for permission to enter send state.

SEND_DATA (MC_SEND_DATA)
Places data to be transmitted to the partner LU in the local LU's send buffer. When the buffer becomes full, the LU will transmit it.

SEND_ERROR (MC_SEND_ERROR)
Sends an error indication to the partner LU.

TEST (MC_TEST)
Checks to see whether the indicated conversation has received either data or a request to send.

Type-Independent Conversation Verbs

BACKOUT
Only supported if syncpoint error recovery is implemented. A program issues BACKOUT during syncpoint processing if, in response to a SYNCPT request from a partner LU, it detects an unrecoverable error. BACKOUT propagates to all participating LUs, so that all stations roll the transaction back to the last successful syncpoint.

GET_TYPE
Reports whether the indicated conversation is basic or mapped.

SYNCPT
Requests or confirms commitment of protected resources on all conversations in which a program is participating. SYNCPT and BACKOUT are part of APPC's syncpoint level of data protection, one of its most powerful features.

WAIT
Suspends execution of a program until one of the indicated conversations posts receipt of data. When the program resumes, LU 6.2 returns codes indicating what has been received and the conversation on which it arrived.

will either execute an LUW in its entirety or cancel it in its entirety.

This guarantee is impossible in a distributed system because there are many possible points of failure. Two-phase commit protects against most failures, and for those it can't handle, LU 6.2 offers recovery through resynchronization.

Resynchronization guarantees that if you can't determine the success or failure of a distributed transaction, LU 6.2 will either automatically bring the participants into a consistent state or will offer the control operators the means for doing so.

Two Phases

In two-phase commit protocol, one node, designated beforehand as the transaction initiator, enters a Prepare record in its log, then sends each participating node a Prepare message. The participants attempt to complete the LUW and write the corresponding log records. If successful, they enter a Request to Commit record in their logs, then send a Request to Commit message back to the initiator. If unsuccessful, they will return an Abort message.

The initiator waits for the responses from the other nodes. If it doesn't receive them within its time-out period, or if any one of them is Abort, it writes an Abort message to its log, then tells all the nodes to abort the transaction. If all expected messages are Request to Commit, it writes a Commit message to its log, then broadcasts a Commit.

Upon receiving the command from the initiator, the participants write a Committed or Aborted record to their local logs, then send an acknowledgment to the initiator. When the initiator receives acknowledgments from all participants, it writes a Completed record to its log.

Syncpoint error recovery implements this protocol transparently to the TPs. But how does it operate in an LU 6.2 transaction?

The initiator issues the SYNCPT verb. This verb has no parameters; it synchronizes all the conversations in which the local LU is involved (i.e., all those conversations that are allocated with a protection level of SYNCPT). Then the LU at the initiator sends a Prepare request

continued

Control-Operator Verbs

CHANGE_SESSION_LIMIT
Changes the number of sessions of a particular mode allowed between two LUs. It also determines the maximum number of contention-winner and contention-loser sessions. When two LUs simultaneously attempt to allocate a conversation over the same session, LU 6.2 will honor the designated contention winner's request and deny the loser's. In addition, when the contention loser wants to allocate a conversation, it must ask permission from the contention winner. (All this is done automatically by the LUs—transaction programs are not concerned with it.) This verb may result in the activation or deactivation of sessions to accommodate the new limit.

INITIALIZE_SESSION_LIMIT
Sets the initial maximum number of sessions of a particular mode allowed with a particular partner LU. Also initializes the maximum number of contention-winner and contention-loser sessions. Like CHANGE_SESSION_LIMIT, INITIALIZE_SESSION_LIMIT can cause sessions to be activated automatically.

RESET_SESSION_LIMIT
Sets the maximum number of sessions with a particular partner LU, and the number of contention-winner and contention-loser sessions with that partner, to zero. As a result, it also deactivates all current sessions of the indicated mode or all sessions if no mode is specified.

PROCESS_SESSION_LIMIT
Used by the service-transaction program that is the target of a CNOS request to cause its LU to negotiate or accept the limits requested by the LU originating the request.

Session-Control Verbs

ACTIVATE_SESSION
Activates a session.

DEACTIVATE_SESSION
Deactivates a session.

LU-Definition Verbs

DEFINE_LOCAL_LU
Establishes the local LU's fully qualified network name; sets the maximum number of sessions it will support with all partner LUs combined; adds or deletes user IDs, passwords, and profiles; and identifies any data-mapping functions that will be available to transaction programs. The LU name is how other nodes on the network refer to the local LU.

DEFINE_REMOTE_LU
Similar to DEFINE_LOCAL_LU, except that it defines parameters for remote LUs with which the local LU will be communicating. For example, it sets the remote LU's fully qualified network name; its local "nickname"; whether multiple concurrent sessions will be available; an LU-to-LU password for session initiation; and the level of security required by the local LU.

DEFINE_MODE
Defines the parameters for a session mode.

DEFINE_TP
Identifies a transaction program and sets a number of parameters that control its execution during conversations.

DISPLAY_LOCAL_LU
Displays the following parameters relating to the local LU:
- the maximum number of sessions permitted
- the number of sessions currently active
- a list of user IDs, passwords, and profiles
- a list of data maps defined to the LU
- a list of the remote LUs known to the LU
- a list of the known transaction programs

DISPLAY_REMOTE_LU
Returns parameters governing the local LU's sessions with a given remote LU. The parameters include:
- its local "nickname"
- whether multiple sessions are supported
- the security level required by the LUs on incoming allocation requests
- the modes available for sessions between the LUs

DISPLAY_MODE
Reports the parameters assigned to the indicated session mode.

DISPLAY_TP
Reports information pertaining to a given transaction program.

out on all protected conversations.

The participating nodes receive a TAKE_SYNCPT indication. At this point, they can issue only the SYNCPT, BACKOUT, or SEND_ERROR verbs. If the participants are ready to proceed with the transaction, they issue SYNCPT. If they have initiated conversations that are part of the distributed transaction, the Prepare will be propagated down the line. If they haven't, SYNCPT causes the participant's LU to send a Request to Commit message to the initiator.

If any participant can't continue the transaction, it replies to SYNCPT with either BACKOUT or SEND_ERROR. Either of these causes the initiator's SYNCPT verb to return with an error code of BACKED_OUT. If all participants have reported that they are ready to commit, the initiator sends out a Commit command. The participants respond to the Commit with a Forget message, which tells the initiator that it can erase its log records pertaining to the current LUW.

If one of the participants has issued BACKOUT or SEND_ERROR, the initiator receives the BACKED_OUT return code on the SYNCPT verb. At this point, it must issue BACKOUT to propagate the backout to all participating stations. Indeed, any time a TP receives a BACKED_OUT return code on the SYNCPT verb, it *must* issue BACKOUT. BACKOUT, like syncpoint, affects *all* protected conversations in which the local LU is participating.

If a session or conversation failure occurs at some point in the distributed transaction, LU 6.2 will automatically initiate a resynchronization procedure. If the stations can reestablish a session, they will exchange log and status information and attempt to bring themselves back into synchronization. If they are able to, the transaction will complete, and SYNCPT will return OK. If for some reason they can't reestablish the connection, the initiator's SYNCPT will return a code of MIXED_HEURISTIC, indicating that you must undertake a manual resynchronization.

LU 6.2 handles almost this entire complex procedure automatically. The only verbs issued by the TPs are SYNCPT, BACKOUT, and SEND_ERROR.

The syncpoint manager, on the SNA presentation-services layer, handles the rest of the process. It thus offers application programs a significant level of transaction protection accessible through a very simple Application Programming Interface (API) (three verbs).

Transferring Funds

A frequently cited use of distributed processing is the transfer of funds from an account at one location to an account at another. For example, a bank wants to transfer funds between Chicago and New York. A third computer, also located in New York, is coordinating the activities of the two bank computers.

The controlling computer allocates conversations with the other two, then sends them APPC messages indicating the changes they need to make. The programs executing at the target computers can either perform the updates when they receive the messages or store the information in arrays until they receive a SYNCPT instruction from the master computer. Assume that they are both using the latter approach.

End users won't actually see APPC; it will be transparent.

Because of the number of messages exchanged during syncpoint processing, it would be highly inefficient to do a SYNCPT after each transaction. It makes much more sense to buffer a certain number of transactions and then do the SYNCPT. Assume that after the data for 100 transactions has been sent to the local nodes, the controlling computer issues a SYNCPT. When the local nodes receive it, they take the data accumulated in the arrays and issue update instructions against their local databases. If all the updates are successful, the local node issues its own SYNCPT. If any of the updates fails, the local node rolls back its updates, then issues a BACKOUT or SEND_ERROR.

The initiator's SYNCPT will terminate with a return code of either OK or BACKED_OUT. If the return code is BACKED_OUT, the initiator issues a BACKOUT. The dependent's SYNCPT also returns either OK or BACKED_OUT. If it returns OK, the TP acts to commit (make permanent) the changes it has made to its database. If it returns BACKED_OUT, it rolls back (cancels) its changes.

Suppose that the bank is transferring $10 million from 500 accounts in Chicago to 500 accounts in New York. The controlling computer in New York sends the data for the first 100 accounts to the two client computers, then issues a SYNCPT. On receipt of the SYNCPT, Chicago and New York perform their updates. They are all successful, so they both issue their own SYNCPT. At this point, all the SYNCPT requests terminate with return codes of OK.

The central computer now sends out the data for the next 100 transactions, then another SYNCPT. On receipt of the SYNCPT, Chicago and New York issue their updates. This time Chicago succeeds, but New York fails. This means that $2 million has been removed from the Chicago branch and not deposited in New York. Chicago issues SYNCPT, but New York rolls back its updates and issues BACKOUT. This causes the controlling computer's SYNCPT to return a BACKED_OUT status. It then issues its own BACKOUT, which notifies Chicago that the transaction could not be completed. Chicago then rolls back its updates.

A New Technology

APPC is a new technology. It is also systems software. Thus, before it becomes available to PC users, it must be implemented in PC systems software, and application programs that use the systems software must appear. Remember, end users will never actually see APPC; it will be incorporated into applications software and will remain transparent to them. Users will be aware only of the wider scope of applications software that APPC makes possible.

The first implementation of APPC on the PC was IBM's Advanced Program-to-Program Communication for the PC (APPC/PC). It enables two PCs connected by either an IBM Token Ring Network or a synchronous data-link-control (SDLC) link to communicate using LU 6.2 verbs.

In mid-1988, Novell released NetWare LU 6.2, which is compatible with APPC/PC and intended for PC-based LANs. Thus, the prerequisite systems software on top of which application programs can be built is now in place.

However, there are some problems with APPC/PC and NetWare LU 6.2 that mitigate their effectiveness as platforms for applications. APPC/PC is tremendously expensive in its demands on PC resources—it takes up about half the memory available on a 640K-byte machine. In large database applications, compiled or interpreted, this is a fatal limitation. Since it's targeted for single-user machines, APPC/PC can't distribute host sessions. Any PC using APPC/PC to communicate with the outside world must have all the necessary hardware and software.

NetWare LU 6.2 corrects these problems for PCs connected in a LAN by implementing a client-server architecture. It requires the presence of a Novell SNA gateway but can support any NetBIOS-compatible network operating system. Under the Novell scheme, a smaller version of the LU 6.2 software, requiring less than 100K bytes, resides in the workstation. The gateway contains the full software.

The workstation passes LU 6.2 verbs received from application programs to the gateway for execution. All the workstations on the LAN can contain LUs; only the gateway functions as an SNA PU 2.1. Workstations can communicate with each other. Also, the gateway distributes host sessions, so NetWare LU 6.2, unlike APPC/PC, permits resource sharing.

Thus, for installations with LANs, NetWare LU 6.2 is a leaner, more efficient implementation. Indeed, APPC/PC's memory demands disqualify it for almost all uses in the DOS environment.

However, both APPC/PC and NetWare LU 6.2 possess an important limitation, particularly as platforms for a distributed database system. Neither of them supports syncpoint transaction protection. This means that database developers are still required to implement their own two-phase commit protocol. In other words, a major feature of systems software that APPC promises remains the responsibility of applications software.

APPC-based applications software for the PC is currently either under development or of minor significance. IBM's Enhanced Communication Facility/Server-Requester Programming Interface (ECF/SRPI), which comes with IBM 3270-emulation software, uses a subset of APPC. ECF/SRPI gives PCs access to IBM's mainframe database systems DB2, SQL/DS, and IMS; host printers, disks, and files; and host programs.

Oracle Corp., developer of the Oracle relational DBMS, has announced plans to support APPC in a future version of SQL*Net, its distributed database software. At present, Oracle doesn't provide multisite transaction capability. In other words, returning to the banking example, it can be guaranteed that all the updates at either site are written as a whole or not at all. But it cannot be guaranteed that the accounts in Chicago will be debited and the corresponding ones in New York will be credited or that they will all retain their previous values. A version of APPC offering syncpoint protection would be a natural vehicle for this type of transaction.

A Paradoxical Standard

Indeed, APPC is a paradoxical standard. The base set of required features offers minimal functionality. The optional features offer rich functionality, but because they are optional, their presence or absence depends on the particular APPC implementation. And there are so many option sets that a proliferation of totally incompatible implementations is almost guaranteed. Thus, applications developers can't write to "the APPC standard"; they must choose a particular version of APPC and support it.

Serious PC applications are unlikely to appear until the APPC standard matures and its PC implementations become more supple—the support of syncpoint is an absolute must. ■

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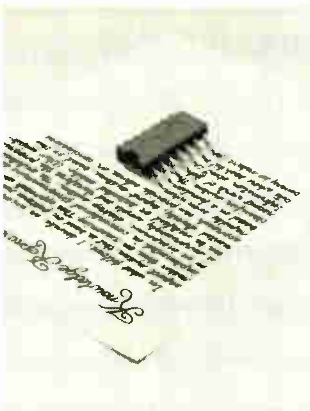

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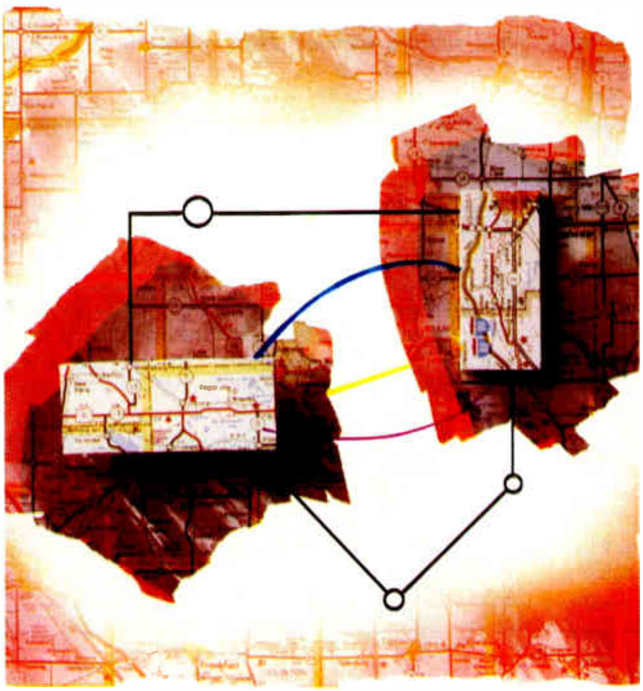
Making the Connection

Can IBM PCs, Macintoshes, and VAXes harmonize in the workplace?

Ed Tittel

There's a quiet revolution going on all over the desktops of America. Networking technology has become widespread enough to allow individual desktops to stretch their boundaries to encompass corporate resources and provide easy electronic company-wide contact.

The benefits of networking are gospel. It allows everyone to share data and move information around much more easily, quickly, and efficiently than do older methods (see the text box "Connecting . . . Cheap!" on page 318). Network access supports communications applications, like electronic mail, that make people more accessible to each other. And networking applications allow co-workers access to desktops other than their own, that is, to other computers over the network. This means that workers can use the machines best suited for particular activities (e.g., IBM PCs for spreadsheets and business applications, Macintoshes for desktop publishing and graphics, and VAXes for heavy number crunching or large database projects).



The focus of this article is the question of how three popular types of computers—the IBM PC and its many clones, the several varieties of Apple's Macintosh, and the DEC VAX family of minicomputers—can be brought together in order to take advantage of this desktop revolution.

Grafting Apples to Apples

When it comes to hooking computers together, the easiest connections to make are among like kinds (Macs to Macs, PCs to PCs, and VAXes to VAXes). Of the three, only one comes without some form of built-in networking. Curiously enough, it's also the one most widely used—the IBM PC. This is why the PC supports the largest and possibly the most confusing selection of alternatives for connecting like machines.

Both the Mac and the VAX arrive "network ready" from their manufacturers. The Mac comes with a "plug and play" network that is built around the AppleTalk protocol suite, and a built-in network interface that is ready to use with LocalTalk (a proprietary shielded twisted-pair) or compatible cable. Although you need to purchase one or more network-interface cards for the VAX to actually hook it up to a network that is its operating system supports the DECnet protocol suite, most commonly found running over Ethernet cable. This means that networking Macs and VAXes is pretty straightforward.

While the built-in network capability of a Mac or a VAX means that "there must be a way" for you to hook up to one of these machines using a network, it

continued

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Connecting . . . Cheap!

While it's true that communicating over a local-area network is fast and convenient, it can be overkill in some situations, especially where cost is the most important factor. Here's a look at some less-expensive alternatives to hooking up pairs of machines.

Most of these kinds of connections are temporary; some even require lugging machines around when the distance between them exceeds the length of the cables. The basic requirements are still the same, but they occur in different forms: You need a medium of exchange (not necessarily a cable), some software on one end to create output, and some software on the other end to read that output. Since you're not networking, you no longer need a network interface.

Updating SneakerNet

SneakerNet is a euphemism for walking floppy disks from one machine to another. Obviously, this is easy when both machines are the same, because they can directly share media. Sharing information among PCs, Macs, and VAXes is a little trickier, but the disk (or other magnetic medium) is still the means for moving information between machines.

Another method is media conversion. Because of the increasing popularity of microcomputers, most typesetting companies and service bureaus have conversion equipment that lets them read (and write) disks in a variety of formats. This kind of commercial service can work well for infrequent data moves, but it normally costs about $15 per floppy disk. These services can also take disks and create VAX-readable tapes, and vice versa; this may be the best approach to moving data between VAXes and PCs or between VAXes and Macs when no other connection is available.

Dayna Communications sells DaynaFile for moving files between PCs and Macs via disk. DaynaFile is a 360K-byte floppy disk drive (bundled with software) that attaches to the Mac so it can write and read IBM-formatted floppy disks. SneakerNet can then move these disks to a PC to exchange data. Another entry in this field is available on the Mac IIx, which supports IBM's quadruple-density 3½-inch disk formats as well as native Mac formats.

Hold the Phone

The old standby for creating temporary links is connecting computers via modem. This is the most popular way to join remote computers together, but it can also work in any setting as long as each computer has a telephone line and a modem of its own. There are numerous options for all three machines, so there should be no problem getting any two of the three to exchange data with this technology.

If computers are in close proximity, you can use telecommunications software to exchange data over a special cable as well as over the telephone. This cable is called a "null modem" cable; it's a standard RS-232C cable with 25-pin connectors where the DTR (data-terminal ready) and DSR (data-send ready) leads are crossed from one end to the other. This makes one end's send the other end's receive, and vice versa, permitting the cable to act as if a pair of modems were in the circuit (hence its name). These kinds of cables are widely available at computer supply and electronics stores, and they offer one of the cheapest available links between machines (hooking up to the Mac at one end will require a special cable with a standard RS-232C 25-pin connector on one end and a Mac modem connector on the other, or purchasing a 25-pin-to-Mac converter).

In addition to RS-232C cable, you can also find software and cable kits that let you connect pairs of machines on either a permanent or a temporary basis. Since these connections can be permanent, this could be considered a form of networking, but most of these products depend on running special communications software and run at speeds slower than those normally associated with full-fledged network connections.

Lap-Link Mac is a good example of this genre; it consists of software for both ends and a cable to run between a Mac and any IBM PC-compatible computer with a serial port. Its impetus was to let laptop-computer owners move data to and from their Macs, but it will link a Mac and a PC. Unfortunately, nothing similar exists to link the VAX to either microcomputer, but the "null modem" approach will work in a pinch.

Beware the Gotcha

Once you have moved the data from one machine to another, it still may need to be converted. Often, you will need to massage the file format into something recognizable to the software that will manipulate it. Fortunately, file-conversion programs abound that can translate between a wide variety of programs on various machines.

The important thing to remember is that where there's a will, there's a way; even when the means are not adequate to support true networking, there are lots of ways to move data between machines. Consider the frequency of exchange and the amount of data when choosing which method to use, and you'll be able to get the most out of the connections these options permit. Just make sure your target machine can actually read the data when it arrives, and you'll be able to share information among your computers with ease.

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doesn't necessarily make finding the right connection simple or easy. Note that while the Mac may come ready to hook up to a network, you'll still need to purchase additional software to use it for distributed processing, E-mail, and so on. That is, you'll need a product like AppleShare, TOPS, or PacerShare to fully exploit the Mac's networking abilities.

Different ways of interacting with networks make different demands on users. Choosing the method of interaction best suited to your environment often means trading functionality and ease of use for cost.

Network Essentials

Whatever your choice, three constants pertain to networking personal computers: First, you need some form of network interface (most commonly, an add-in card); second, some kind of cable needs to be strung between the machines you want to connect (and everything from telephone cable to fiber optics is available); and third, you need software that will allow the machines to communicate with each other.

Ultimately, it's the software that defines how you interact with a network and determines how it looks to you from your desktop. The questions of which interface and which medium are resolved, at least in part, when you choose your software. In many cases, the software will dictate, or at least limit, the set of possible alternatives.

For the purposes of this discussion, networking software can be divided into three categories: simple network-connection software, operating-system-supported networking, and application-driven networking. Each of these has strengths and weaknesses, advantages and disadvantages, and cost-benefit trade-offs.

Simple Network Connections

In this category, networking software resembles the kind of system you're used to encountering when you use a modem or an RS-232C connection to create temporary links between pairs of machines. The basic applications for this kind of software are file transfer, which lets you move files from one machine to another, and terminal emulation, which lets you establish a session on one machine and work on another as if it were a terminal instead of another computer. Some examples of this genre include the Transmission Control Protocol/Internet Protocol (TCP/IP) Lap-Link PC, applications suite (TELNET, FTP, SMTP, and so on); and a variety of other file-transfer or terminal-emulation programs.

As with the other two categories, simple network connections are established by running particular software applications. In this arena, you need to be aware of the network itself and of the operating systems on both sides of your connection.

For instance, running a file-transfer program means that you have to know the formats for specifying filenames for both operating systems, as well as the commands for running the file-transfer application itself. Likewise, running a terminal-emulation program means that you not only need to know the details of the operating system on the computer that you're using as a terminal, but you also often need to learn how your keyboard maps onto the host's standard keyboard.

This discussion of file transfer applies to all three types of machines, but in looking at terminal-emulation options, I'll consider just Mac-to-VAX and PC-to-VAX connections. Since both the Mac and the PC usually run single-tasking operating systems, I won't discuss emulating a terminal on them (programs like Timbuktu or Carbon Copy Plus, which allow a remote machine to take over a Mac or PC, are more common here).

Since the VAX is a multiuser, multitasking machine originally designed for terminal access, it supports a variety of

continued

C:> **ftp vax1**	Start up the FTP session; vax1 is a synonym that actually corresponds to a network address.
account name: **test** password: xxxxxxx	The VAX requires you to have a valid account name and password before it will permit access.
ftp> **cd [test.program]**	Change to the directory in which to put the file.
ftp> **put flocalc.dat**	Copy the file over the network to the selected VAX directory.
ftp> **quit**	Exit the FTP application.
c:> **telnet vax1**	Start up the TELNET session; again, you need to know the name of the network node you want to connect to.
account name: **test** password: xxxxxxx	The same account and password dialogue as before is needed to log on to the VAX.
$ set dir [test.program]	The VAX command to change directories is `set dir`.
$ program flocalc.dat	This sequence will cause the program named program.exe to run, taking flocalc.dat as input.
$ logout	Terminate the VAX session.
telnet> **quit**	Terminate the TELNET application.

Figure 1: *An FTP session. Boldfaced text is what you would enter, and plain text indicates screen information written by the VAX or one of the applications.*

terminal emulators for both PCs and Macs. Most of the major terminal-emulation companies—Kea Systems, Walker Richer and Quinn, and Coefficient Systems—support emulators for both PCs and Macs, while a variety of file-transfer applications among any or all of the three machines are also available.

Why bother to approach networking at this level? The greater the burden of managing the network that falls on the user, the easier it becomes to write the software to handle network communications. In a word, this approach is cheap! Because using simple network connections requires the knowledge or ability to work with several operating systems simultaneously, it has been widely used by computer professionals since networking's inception. For the same reasons, however, it isn't the best solution for novices; it burdens them with too many extraneous, unfamiliar details, and network access at this level is murkier than it is transparent.

This approach is best applied when the need to communicate with other machines is infrequent or irregular and doesn't involve moving large amounts of data. Since you must stop what you're doing, start up a terminal-emulation or file-transfer application, and then perform the operations necessary on the host to complete your tasks, this kind of communicating can be time-consuming. If it needs to be done often, the overhead may consume any productivity gains afforded by the network.

As an example, consider what's involved in running a program on a VAX against some data generated on a PC (based on public domain software from the National Center for Supercomputing Applications [NCSA] TELNET). The applications used are part of the standard TCP/IP applications suite.

The file-transfer application is called File Transfer Protocol (FTP). This application uses a Unix shell-like command set (which brings yet another operating system into the equation) to perform some basic operations. In this example, the task is to move a spreadsheet file named FLOTBL.DAT over to the VAX for further processing.

The terminal-emulation application is called TELNET, and it provides basic terminal-emulation capabilities (including several varieties of VAX terminals) in addition to its own set of capabilities and commands.

First, you must transfer the file from the PC to the VAX and then log on to the VAX to execute the program. The dialogue in figure 1 shows what you would see at your PC. This dialogue has been trimmed of some screen output (particularly related to logging on to a VAX), but it shows the essential operations that are needed.

Operating-System-Supported Networking

This kind of network software provides extensions to your local desktop that let you access remote resources as if they were local. This is accomplished by building network-access capabilities into the operating system (as has been done with the Mac and the VAX) or by adding software that extends the operating system to include network capabilities. For example, you could use a program such as Microsoft's MS-Net Redirector on PCs to create virtual drives or printers on remote servers. Networked operating systems or system add-ins like TOPS, MS-Net, or AppleShare represent this type of software.

One of the fundamental assumptions behind operating-system-supported networking or its cousin, operating-system-enhancement-supported networking (which applies to more than just the PC), is that the computers running such software are networked. Therefore, the software is set up to support networking much more reasonably than in file-transfer and terminal-emulation applications.

The buzzword for such capability is appropriate—this kind of networking is said to be "transparent" to the user. You don't have to concern yourself with the *how* of networking; you can simply concentrate on *what* you want to perform. Furthermore, transparency means that the activity looks familiar; it doesn't involve using the syntax of the host, just that of the more familiar machine on which you're currently working.

The most common kinds of services provided by networked operating systems or enhancements that support networking are called "distributed file systems." This means that you can see disk drives on file servers or on other ma-

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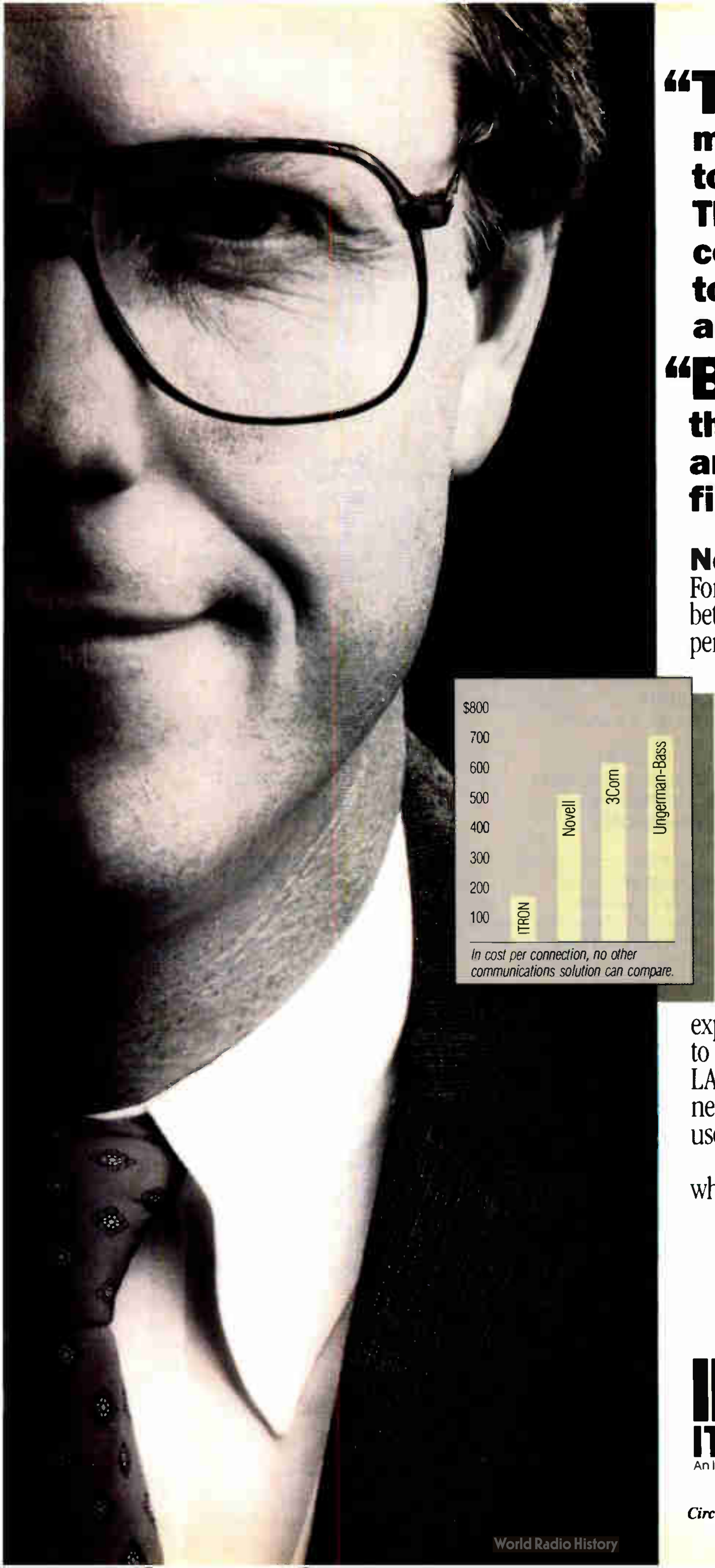

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Redirector....................OEM only
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Xenix 386 .... $695
Xenix-net 286 .... from $595
Xenix-net 386 .... from $695
The Santa Cruz Operation, Inc. (SCO)
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Santa Cruz, CA 95060
(408) 425-7222
Inquiry 1183.

Zstem 220 .... $150
Zstem 240 .... $295
VAX terminal emulators for the PC
Kea Systems, Ltd.
2150 West Broadway, Suite 412
Vancouver, BC
Canada V6K 4L9
(604) 732-7411
Inquiry 1174.

chines as if they were part of your own desktop. This kind of software also commonly supports such applications as E-mail or message-handling systems.

The VAX comes closest to providing these services at delivery. While the Mac supports communications through its LocalTalk port and the AppleTalk protocol suite, it doesn't come packaged with the ability to access remote file servers and built-in E-mail as the VAX does. None of these features is automatic on the PC.

Paradoxically, the PC has been the major platform for developing network servers and network operating systems. Several software companies have built their businesses around adding transparency to networking to make it easy for users to communicate with each other. These companies have tended to move away from homogeneous computing environments, such as "for PCs only," to heterogeneous ones, and PCs, Macs, and VAXes are the most common systems supported by network operating systems.

Novell, one of the most successful providers of network servers and network operating systems, began with a PC-only environment. Today, Novell's network operating system, called NetWare, includes services for Macs and VAXes, in addition to DOS and OS/2 PCs.

Sun Microsystems acquired the Transcendental Operating System (TOPS) when it bought the Macintosh-oriented company last year; TOPS currently runs on PCs and Macs, with Sun and VAX versions under construction. Banyan Systems' VINES network operating system runs on the PC and the VAX, and support for the Mac has been rumored, but not announced, for most of 1988. Likewise, 3Com's 3+Open network operating system currently supports VAXes and PCs, with Mac support (including full Apple Filing Protocol compliance) just around the corner.

Interestingly, Apple and DEC are also players in this game: They have begun to develop products based on their alliance, which occurred in 1988. For example, both companies have announced operating-system-level support for TCP/IP protocols along with software support for third-party developers. In addition, Apple and DEC both offer hardware and software add-ins to support their proprietary networking protocols and software for the PC.

Apple sells a board designed to plug into standard 8-bit PC buses, called the LocalTalk PC Card, which with its AppleShare PC software permits a PC to

continued

communicate over LocalTalk cable using AppleTalk protocols in an AppleShare environment. Likewise, DEC sells licenses for a product called DOS Services for VMS (virtual memory systems) that lets PCs use the VAX as a file server and execute applications stored on VAX disk drives.

A common tendency with Apple and DEC has been to create interfaces that cause the other computers on the network to look like their own. Apple's PC products are a good example, and there are add-ins for both Macs and PCs that make them look like DECnet computers to a VAX DECnet network as well.

For example, the CommUnity line from Technology Concepts offers products that include the necessary interfaces and software to turn Macs and PCs into DECnet hosts. For the VAX-to-Mac connection, Alisa Systems, Kinetics, White Pine Software, and Pacer Software offer a wide variety of network service applications for various protocols; some of them also offer PC-to-VAX connectivity software as well.

As an example, I'll use HostShare, a PC-based product from Excelan that extends DOS by using the Redirector, software licensed from Microsoft. The Redirector augments DOS so that you can define network devices, primarily disk drives and printers, and give them "normal" device names like F and LPT1.

Once you've performed the setup work to create these definitions (you can do this in the AUTOEXEC.BAT file), you can achieve the same results as the dialogue in figure 1 with this single command:

```
copy c:\data\flocalc.dat
f:\test\data
```

For this to work where drive F actually represents a directory on a VAX disk drive, you would also need to purchase software, such as SMBServer from Syntax, for the VAX side. (SMB stands for Standard Message Block, Microsoft's networking protocol for network data transfer that works with the Redirector to support network operations through DOS.)

Even though this example is brief, several things about it are worth noting. First, the command line looks entirely DOS-like. If you didn't know better, you'd think drive F was just another device installed on the PC. Also, notice that the directory specification for the VAX side of the transfer adheres to DOS terminology; the software handles the name translation for you, so you don't need to know that VAX filenames are delimited with square brackets and that subdirectories are separated by periods (i.e., `\test\data` on DOS is `[test.data]` on VMS). If you were talking to a Xenix or Sun server, the notation would be unchanged. (Please note, however, that the terminal-emulation portion of figure 1 would remain the same.)

This transparency comes at a price. It often means buying more expensive software to get the increased functionality and buying additional software for servers and other pieces of network paraphernalia that you don't need for simple network communications. It also means that your choices about the kinds of hardware and software you can graft together to make a single, coherent network become more and more limited.

> *The age of distributed applications is almost upon us. Leading this trend are the DBMS companies.*

Options in this arena start at about twice the cost per connection when compared to simple network communciations software, and they go up from there. For most users, though, the added expense is worth it. The primary additional cost comes from needing to buy a network operating system add-in for each networked computer (e.g., Sun's TOPS); networked server applications (e.g., Syntax's SMBServer) add to that cost as well.

Application-Driven Networking

In this category, you run applications on desktops that access network resources but completely hide the details for managing the access, making it look as if all the data and operations used by the program are local. Such applications are called *distributed* because they essentially run over the network and coordinate multiple resources, both local and remote. Applications belonging to this category include the LANServer Oracle DBMS and Applix's Alis office-automation package.

Application-driven networking is totally transparent by this definition; you fire off an application on your local computer, and it handles all the processing needed to move files across the network and execute remote programs. Whereas with either simple network connections or operating-system-supported networking, you would have to explicitly move the results back from the VAX, with application-driven networking the results can automatically be reported back to your node and displayed to you as you need them.

Such applications are clearly the most desirable for average users, since they don't need to be aware of the network at all, let alone interact with foreign operating or file systems. However, just as introducing operating-system support for network services limited the options regarding what could safely be put together to build a network, so also does the choice of a distributed application limit what can safely be assembled.

Leading the Way

Fortunately, the age of distributed applications is almost upon us. Leading this trend are the DBMS companies, which currently have the greatest number of products available and which support the largest variety of computers and operating systems.

Many of the relational DBMS companies coming from the Unix world currently offer products that can run on PCs and VAXes, most notably, Ingres, Sybase, Empress-32, and Informix. Oracle is presently alone in offering a DBMS that runs on all three machines, but the others have announced plans to support the Mac within the next year (the introduction of A/UX, the Unix operating system for the Mac II, makes this a necessity). Odesta's Helix VMX covers an interesting subset; it supports VAX servers with Mac clients—and even includes the ability to store and reference Mac graphics files on the VAX.

Another interesting niche in the distributed-applications world is occupied by office-automation packages. Like the early PC network companies, most office-automation companies are growing out of a homogeneous computing environment and are just beginning to grapple with the challenge of supporting multiple computers.

Right now, Applix offers an office-automation package, Alis, that supports Unix or VAX servers for PC clients, and other such packages are under development. These promise to deliver on the productivity and communications gains provided by networks by taking basic, everyday work and supporting it over the network. By combining E-mail, word processing, spreadsheets, and other specialized applications into an integrated working environment, these office-automation packages may foreshadow the electronic desktop of the 1990s.

Returning to my example, assume that you want to move a spreadsheet file to the VAX to make use of its more powerful number-crunching capabilities to run a financial forecast involving a number of variables and several thousand data points. If your office-automation package supported a link to a forecasting module on the VAX, all you would have to do would be to prepare your data for the forecast and wait for the results to appear. Everything else—the file transfer to the VAX, running the forecast program, and returning the results to your workstation—would be totally invisible.

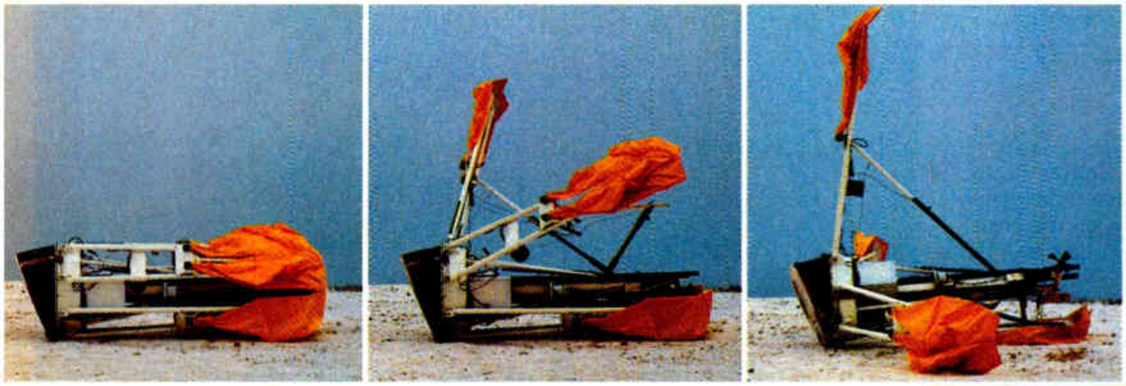
The simplicity and power of this approach are appealing, but today's costs can make it somewhat prohibitive. Client copies for all your PCs and Macs will cost from $200 to $1000 per node, and the server software for the VAX will run in the tens or hundreds of thousands of dollars. Part of that cost is to fund a still-emerging technology. In a few years, as the technology matures, networking will be more affordable, and offerings will also be better tailored to individual users' and companies' needs.

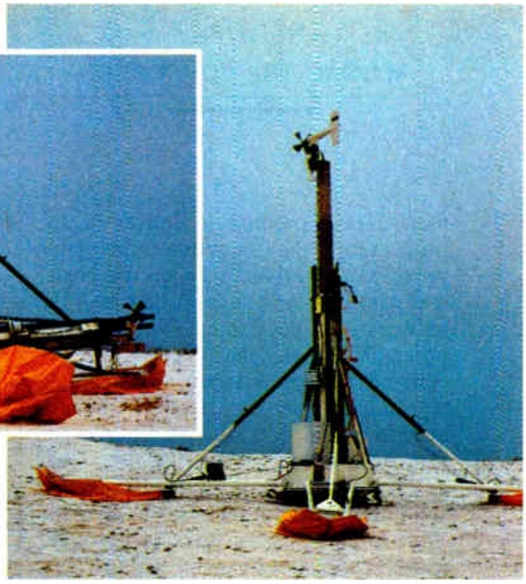
A Growing Appetite

Networked software is beginning to connect more and more electronic desktops. As users participate in networking more fully, their appetite for the power and synergy provided by shared information and ideas will certainly grow. As the technology to support that appetite also grows, everyone will experience more and more benefits from being linked together.

Don't let the infancy of distributed-application technology deter or delay an investment in networking; the simple communications and operating-system-supported technology currently available is very useful, as are the distributed applications already available. Today's network investment should continue to pay off as networking's uses and the software to exploit them expand to embrace more and more desktops in the future. ■

Ed Tittel is a field applications engineer with Excelan Corp. in Austin, Texas. He can be reached on BIX c/o "editors."





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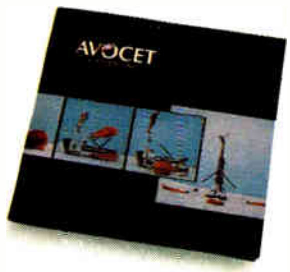

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THE BYTE AWARDS

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In the course of a year, we see a lot of products at BYTE—the good, the bad, the ugly, the innovative, the inane, and the endlessly delayed. We objectively rate these products in our Products in Perspective section to help you separate the wheat from the chaff.

But of the hundreds and hundreds of products we see, test, and evaluate, only a relative handful are good enough and exciting enough to make an editor go out and get a copy for him or herself. Fewer still ultimately prove to be so useful, trustworthy, and generally handy to have around that they're put into daily use as office workhorses.

Another class of products separates itself from the pack through a combination of factors such as outstanding value, exemplary innovation, and technical elegance. These are the ones that bridge to the future and truly advance the state of the art.

In recognition of these outstanding products, we announce the first BYTE Awards. The awards fall into two categories. First, a BYTE Award of Excellence goes to those products our editors and columnists judge to be the year's most significant and outstanding offerings.

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For our first year only, we have not limited our choices to products released within the calendar year 1988. A handful of our favorite products from 1987 are still significant and deserve recognition.

Note that we haven't merely based our selection on press releases or on second-hand information from outside reviewers. All our selections are based on personal, in-house evaluations by BYTE editors and expert columnists.

Note also that we've made no attempt to define arbitrary categories, or to force-fit products into some preconceived, predictable, and ultimately indefensible lineup of "the best word processor," "the best spreadsheet," and so on: "best" is simply too slippery a term. But these products—every one of them—are ones we wouldn't hesitate for a moment to recommend.

And now, the envelopes, please.

EXCELLENCE

A/UX

A/UX is Apple's version of System V Unix for the Mac II. As such, it signals a new chapter in the history of Unix that may change the development of that operating system forever.

Version 1.0 of A/UX was essentially a plain-vanilla implementation, providing multitasking, virtual memory, and network access, and of course, the ability to run Macintosh programs and access the Mac Toolbox routines. Future releases promise to bring more of the Mac's interface to Unix (e.g., incorporating a Finder to launch applications and manage files). This could help make Unix the multitasking operating system of choice during the next decade, especially if other vendors pick up the basic interface items.

The presence of A/UX will help Unix challenge OS/2 and drive Apple's own native-mode multitasking operating system for the Mac. We find A/UX to be significant because of its potential and the changes it heralds.

EXCELLENCE

Compaq Deskpro 386/25

Compaq's 25-MHz Deskpro is the best representative of a fine field of machines that moved the high-speed frontier up another 25 percent in 1988. Though edged out in performance by ALR's entry, the 386/25 combines power with flawless operation and dependability rarely found in systems so close to the forefront of technology.

The 386/25 retains the Flex architecture and hardware cache controller of its outstanding predecessor, the Deskpro 386/20. Peripheral and expansion support is excellent. In addition to the wide range of expansion cards designed for the Deskpro, the system comes with a 16-megabyte memory ceiling and simultaneous support for both the Weitek 1167 and 80387 coprocessors. High-speed ESDI (enhanced small device interface) drives bring the disk performance in line with the rest of the system. For an ideal mix of state-of-the-art performance with proven reliability, the Deskpro 386/25 deserves recognition as the premier DOS system of 1988.

EXCELLENCE

HyperCard

HyperCard merges the concepts of hypertext and object-oriented programming into a free-form database system that just about any Macintosh user can learn to browse and program. Its strengths are its powerful index-card metaphor, its compact but useful HyperTalk scripting language, and its user interface. Like any first entry, it has some flaws: it can be very slow, it lacks specialized data structures, and it needs a full-blown script editor and a real error handler.

Still, HyperCard opened up a new category of software. It's an outstanding product that really came into its own during 1988. Apple should be applauded for bundling it free with every Macintosh sold.

EXCELLENCE

Microsoft Bookshelf

Microsoft Bookshelf is the first substantial application of CD-ROM (compact disk read-only memory) technology.

The quantity of information provided by Bookshelf is numbing: A disk the same size as an audio compact disk contains *The World Almanac and Book of Facts*, *Roget's II Electronic Thesaurus*, *The American Heritage Dictionary*, *The Chicago Manual of Style*, *Bartlett's Familiar Quotations*, a spelling checker, a ZIP code directory, and more. It's a writer's El Dorado.

But it's not just the quantity of information that makes Bookshelf work: Considering how many megabytes are on the disk, piles of ASCII text wouldn't cut it. Bookshelf's user interface lets you skip through the references like an electron shot through a card catalog. Best of all, Bookshelf can operate as a terminate-and-stay-resident (TSR) program, so you can conjure it from within your favorite word processing program.

The amount of data stored on Bookshelf is surprising only until you see the amount of *unused* space the disk still has. Microsoft's release of its Programmer's Bookshelf (with electronic versions of most of its programming manuals) proves that the original disk is only a harbinger of personal library systems of the future. If so, we're off to a good start.

EXCELLENCE

NeXT Computer

The NeXT Computer shows what can be done when a personal computer is designed as a system, and not a collection of hardware elements. It features the latest-generation high-speed components: Motorola's 25-MHz 68030 CPU and 68882 floating-point unit, and a 4-megabyte-per-second SCSI (small computer system interface) port. A built-in digital signal processor (DSP) chip provides powerful array and signal-processing capabilities. It also has 12 dedicated direct-memory-access channels that move data throughout the system without degrading its performance.

The NeXT Computer is truly innovative in three areas. First, the standard 256-megabyte optical drive eliminates the coming storage crunch that will be brought about by the huge databases we'll be working with in the 1990s. Second, the DSP lets the NeXT Computer tackle tasks such as voice recognition and synthesis, three-dimensional graphics, real-time data acquisition, and signal processing, plus future applications not yet dreamed of. Third, the object-oriented programming environment, plus kits supplied by NeXT, promise to hide hardware details from the programmer and thus accelerate the development of new applications. The NeXT Computer is worth every penny of its $6500 market price.

EXCELLENCE

OS/2

OS/2 is today where the Macintosh was in 1984: It's a development platform in search of developers. Naysayers notwithstanding, that's likely to change. For better or worse, DOS and its myriad applications are synonymous with computing for the majority of PC users. Because users require multitasking, virtual memory management, and graphical interfaces (and because DOS doesn't support those things), applications have had to bear the burden. The results have been chaotic.

Under OS/2, developers won't have to play tricks to create the illusion of multitasking, won't have to manage memory, and won't have to invent proprietary and monolithic schemes for getting applications to exchange data. They can simply develop applications. Programmers now engaged in porting DOS programs to OS/2 report excellent results—a tribute to Microsoft's determined effort to make OS/2 backward-compatible with DOS.

Some planks of the OS/2 platform—Presentation Manager and LAN Manager—are still being hammered into place. When it's complete and bug-free, when it can really use the 80386, and when more desktops sport OS/2-capable PCs, OS/2 will—deservedly—supersede DOS. But even as it stands, OS/2 is a milestone product.

EXCELLENCE

Sun386i

The line between powerful 32-bit personal computers and small workstations has all but vanished. Some 80386-based PCs are starting to take on the duties of more expensive workstations, such as high-resolution graphics and networking capabilities. In an interesting twist, Sun's latest 80386-based workstation, the Sun386i, has taken on some of the abilities of IBM PCs: It can run MS-DOS in one or more windows under SunOS, its Unix multitasking operating system.

This Sun shines best in its ability to run DOS windows as processes under Unix. Each DOS window acts as a virtual PC, and if necessary, it can access Unix files on a hard disk or PC peripheral cards in three AT-compatible slots or one XT-compatible slot.

The Sun386i's memory management is excellent: A PC program that runs amok is cleanly killed off by SunOS without disrupting other processes. Sun's efforts to shield the casual user from the intricacies of Unix are good, despite a few gaps. CPU performance in a DOS window is also good, although (as you might expect) PC I/O in the DOS window and peripheral boards lags.

Nevertheless, the Sun386i stands out as an attractive machine in its own right, one that reveals the true potential of the 80386 by running multiple copies of virtual 8086 machines while operating in its protected mode.

continued

EXCELLENCE

The Toshiba T1000

This machine sticks to the basics and takes portability to the limit. If a well-traveled portable-computer user had designed his dream machine, he couldn't have done better.

The designers addressed the one feature that users on the road value most: convenience. At 6½ pounds and 2 inches thick, the T1000 doesn't even fill a whole briefcase and won't add seriously to its weight. In addition to being tiny and featherweight, it is as self-contained as you can get and still have a real computer that can handle real-world workloads. The T1000's 4.77-MHz 80C88 CPU and 512K bytes of RAM can handle any DOS application. DOS is in ROM, so you don't need a boot disk. You can add an internal 1200-bps modem, as well as a 768K-byte nonvolatile RAM disk to carry your applications programs.

The T1000 has a perfectly normal keyboard and a very good nonbacklit LCD display (made even better if you get the backlight retrofit made by Avonix for $295). The nickel-cadmium battery will run the computer for up to 5 hours.

Finally, though the T1000 lists for $1249, BYTE staffers have paid as little as $850 for it through discount outlets. Many of us are in love with this one.

EXCELLENCE

TrueScan

Unless you're willing to spend upwards of $15,000, the optical scanners available to you can read only a limited variety of documents. Also, these scanners can display them only as bit-mapped images and have little or no ability to convert the scanned image into a file that you can further manipulate with commercial word processing, spreadsheet, or graphics packages. Even many of the most expensive systems have serious limitations.

Calera Recognition Systems has brought forth a solution to this problem called the TrueScan document recognition system.

The top-of-the-line 100-character-per-second version costs $3500; a second version that reads at 70 characters per second and costs only $2500 works only with portraits. For these breakthrough prices, you get an IBM PC–compatible add-on board and document-recognition software that interfaces to most low-cost ($1000 or less) optical scanners.

Among TrueScan's features are the ability to recognize tabular data and convert them into spreadsheets; to scan text only, image (graphics) only, or text and image combined; and in text-and-image-combined mode, to convert the text to ASCII format and the graphics to whatever file format you specify.

TrueScan is indeed an impressive product.

EXCELLENCE

Zenith FTM monitor

The Flat Tension Mask monitor from Zenith Data Systems is the first significant improvement in traditional shadow-mask monitor technology for high-resolution color monitors.

All color CRTs use some form of shadow mask, which is suspended just behind the screen and controls the points where the electron beams strike the surface. The shadow mask will heat and deform under high enough power, making the color become less pure and limiting the levels of brightness that can be displayed.

The Zenith FTM has changed the fundamental design of the shadow mask by putting it under tension and installing it—still under tension—into the CRT. This change creates a front surface that is completely flat. Because the shadow mask is under tension, the heat created when the electron beams strike it does not deform it, and much higher power levels can be used. This improvement permits greater brightness, which in turn permits the use of better antireflective coatings.

The result is an extremely high-resolution monitor with a flat screen that is virtually free from reflections. If there is a problem, it is that users of FTM monitors find it difficult to return to conventional designs.

◀

continued

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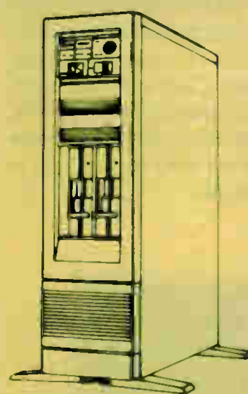

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DISTINCTION

Battery Watch
Battery Watch is the first in a new class of software for laptop computers. For the first time, a software product is available that will reliably monitor your use and predict the remaining battery time on a battery-powered laptop. Battery Watch also lets you drain your nickel-cadmium batteries completely, which is the only way to avoid recharge-limiting "NiCad memory."

Choice Words
Proximity's Choice Words is a hard-disk version of the *Merriam-Webster Dictionary*. It is, in fact, the first major implementation of a dictionary for a hard disk. The program sells for only $99 and includes pop-up definitions for 80,000 words and a thesaurus. Putting a reference dictionary on a hard disk is such a practical idea that Choice Words may seem less than exciting, but the fact that Proximity has done so in such an easy-to-use way is significant.

Compaq 386s ▲
Intel's new 80386SX chip, a less-expensive version of the 80386 with a 16-bit data bus, is used in only one system as of this writing. Not surprisingly, it's a Compaq: the 386s. As the leader, the Compaq 386s will be the proving ground for the new technology that promises to cut costs by reducing power requirements while retaining compatibility.

DESQview 3.0
When people say they want multitasking, often what they really mean is that they want a painless way to go instantly from one program to another. They also want a way to load up machines with memory-resident programs and still have enough room to run large applications.

DESQview accomplishes all that by extending traditional DOS. Unlike OS/2, DESQview lets you run the programs you've already paid for. Add the Phar Lap extension and you can write programs bigger than 640K bytes as well. Many users will find that DESQview is all they need.

Documentor
Documentor is specialized: If you don't do dBASE programming, you don't need it; but if you do program in dBASE, you can't live without it. Documentor makes documenting dBASE programs easier, faster, and better, and does it without muss or fuss. It will save a dBASE programmer many hours a month.

Epsilon Editor
Epsilon is a fast and completely extensible EMACS-like programmer's editor available for both DOS and OS/2. It supports large files, multiple windows and buffers, file- and command-name completion, keystroke macros, regular-expression searching, and syntax-sensitive modes. But the *pièce de résistance* is EEL, a C-like extension language that comes with its own compiler. Lugaru Software has implemented Epsilon's entire user interface in EEL so you can, for example, create your own syntax-sensitive modes or program the help system to browse through your source libraries.

Excel
Excel, Macintosh's extraordinary spreadsheet, has been ported to the IBM—and it shines. It takes up just about all the 640K bytes of memory on an AT compatible because the program is large and comes with its own run-time version of Windows 2.0. Excel's most impressive feature, its user interface, functions as well as or better than its Macintosh relative.

The spreadsheet's keyboard support lets you access every one of Excel's commands and functions. And if you prefer not to use a mouse, you can do without one with this program. Excel is fast and easy to learn and use.

Fastback Plus
Fastback—a program that backs up your hard disk—*is* fast, and it is reliable. Now Fifth Generation has improved it. The company fixed the manuals and then put in help files that make the manuals nearly superfluous. Then it added data compression to save disk space and a utility that estimates how many floppy disks and how long the job will take.

With this program, we've copied 38 megabytes of data from one machine to another in 28 minutes (which included formatting the disks). Fastback Plus will also read backup disks made with older versions using an option called Old Restore Program. If you have a hard disk drive, we recommend this package.

Fast Trax
Frequently written files tend to end up scattered around your disk. When you load the file, DOS has to hunt for these fragments, and that can slow you down. Disk unfragmenters put the files back together in contiguous blocks, speeding up disk I/O.

And there are a million of them: the Norton Advanced Utilities offers a bulletproof but inflexible defragger; DOG, a shareware utility, is flexible but not simple to use; then there's VOPT, the Polyboost unfragger, SST, and many others—every one good.

But after trying them all, we've found Fast Trax to be fast, rock-solid, easy to use, and highly configurable—your disk gets organized the way you want it in minutes.

Gateway 386 ▲
The outstanding value of the Gateway 386 was one of the most pleasant surprises produced by our October roundup of affordable 80386 systems. Selling for $2995, the Gateway machine combines power and room for expansion at a price that brings the expanded capabilities of the 80386 to individual as well as corporate users. Its 20-MHz performance (though built around a 16-MHz chip), high-speed memory, coprocessor support, and 12-megabyte memory ceiling sets it apart from the rest of the 80386 clones.

GrandView
You could say this is many packages combined into one—word processor, outliner, and project-tracking software. GrandView, a new type of program, is so packed with goodies that you have to really study the manual to see how to get around in this labyrinth. In "document view," GrandView's outliner is even more powerful in many respects than ThinkTank, and its word processor is complete with spelling checker. In "category view," GrandView has a feature that lets you attach keywords and priorities to

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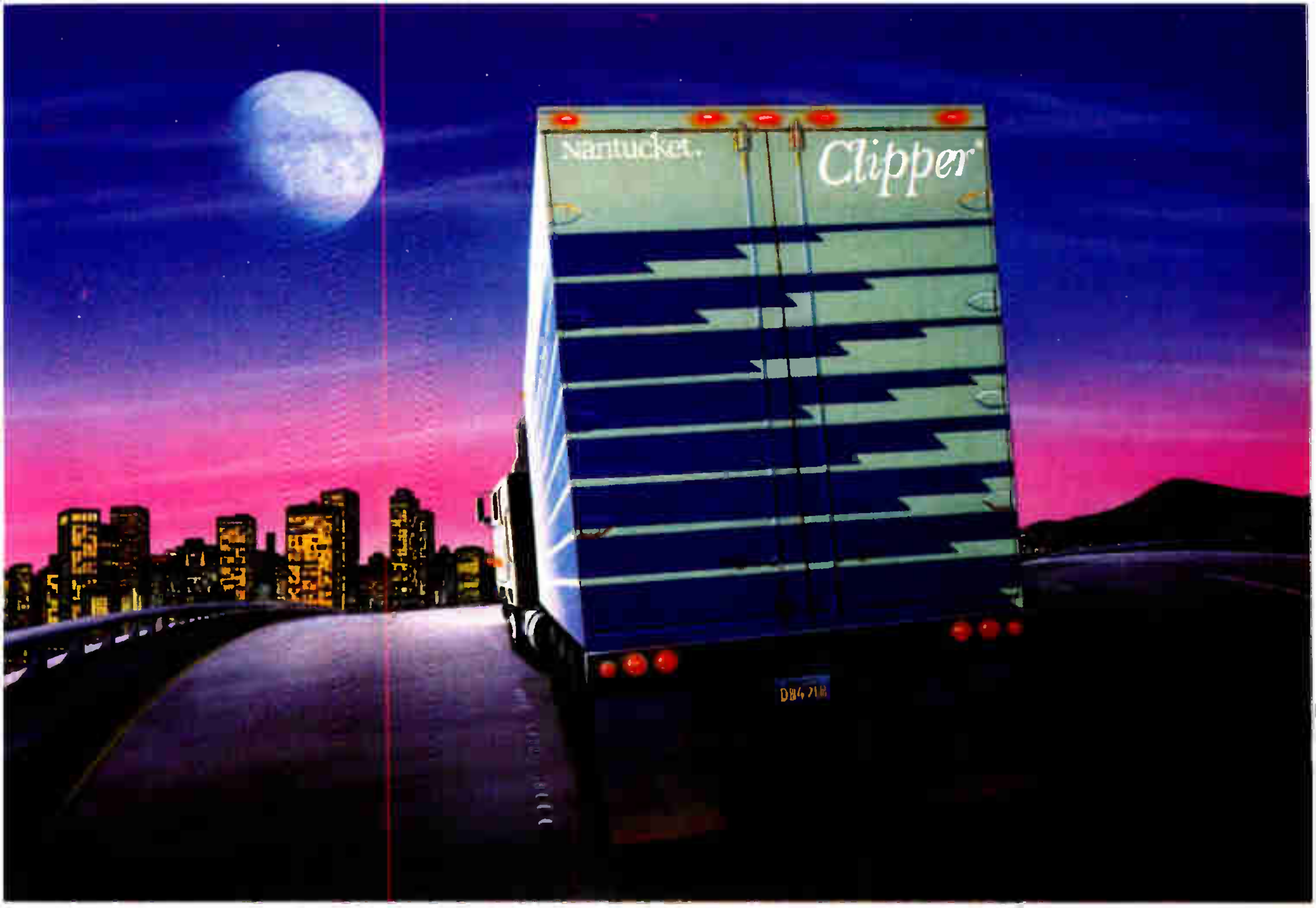

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VALID function	Yes (1985)	No	Just Intro'd
Improved Execution Speed	Yes (1984)	No	No
Link in Other Languages	Yes (1984)	No	Limited
Null Character Support	Yes (1987)	No	No

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And once you have created them, Clipper gives you an equal measure of control over distribution by creating .EXE files — there are no runtime modules, licensing or royalty fees, or additional software requirements. You can even add stations to a network without adding to your costs.

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items. While it'll take you a long time to find out all the bells and whistles of this information-management package, we think it'll be worth it.

HP DeskJet Printer ▲

If you're looking for a truly silent printer, this HP ink-jet will suit you. The DeskJet's output is close to laser-printer quality at a much more tolerable price of $995. It comes with 128K bytes of built-in RAM, a 16K-byte buffer, and both parallel and RS-232C input. In draft mode, it runs at 240 characters per second with 300- by 150-dot-per-inch resolution; in letter-quality mode, it does 120 cps at 300 by 300 dpi.

The DeskJet comes with Courier, Courier Bold, and Courier Compressed fonts at 10, 16.67, and 20 characters per inch, and you can make all your font selections from the printer's front panel.

Illustrator 88

Adobe Illustrator was the first of a new class of drawing programs that use PostScript to create artwork made up of lines and Bézier curves. With Illustrator 88, Adobe pulled ahead of its chief competitor, Aldus's Freehand. Illustrator 88 includes a new freehand drawing tool and an automatic tracing tool that makes tracing a rough image fast and painless. Illustrator 88 can now do four-color separations and uses the Pantone palette of colors to let you customize.

If you have a Mac Plus or II and you're ready to move beyond MacPaint, Illustrator 88 can let you create professional-quality graphics.

LANtastic

LANtastic is a half-slot, NetBIOS-compatible networking board for the IBM PC and compatibles. If you need raw speed, other networks are faster, but they cost a lot more and aren't as easy to install and work with. The manufacturer, Artisoft, offers a starter kit that includes two LANtastic cards, cable, bus terminators, and NetBIOS, at a price of $399. That's a lot of LAN bang for the buck. It also lets you access a CD-ROM drive over the network without DOS extensions in the remote machine. Columnist Jerry Pournelle uses LANtastic (despite the silly name) every day at Chaos Manor.

Lightspeed C

This C compiler for the Macintosh wins our respect because of its powerful features and low price. New features in version 3.0 include MultiFinder resource and trap support, 68020 and 68881 code generation, and access to Color QuickDraw. A new source code–level debugger gives you windows that track your progress through a program and display the values of selected variables or structures. If you're using a Mac II, you can direct the debugger output to a second monitor. The documentation has been revised and updated. Lightspeed C is compatible with the Mac Plus, SE, II, and IIx.

MacDisk

This 330-megabyte hard disk drive by Priam is a joy to have on a Mac Plus, SE, or II, and it works just as well on other systems such as the Cheetah 386. It's a SCSI device about the size of a shoebox with two lights on the front and a window on the back. In spite of the documentation, which leaves installation in some machines to your imagination, installing it is the simplest thing in the world. It comes already formatted; it's lightning fast, with an 11-millisecond average seek time; and it's rugged: You can transport it from one machine to another, and you can daisy-chain it with any other SCSI device.

MacInTax

Of the tax-preparation programs we've used, several of us have found MacInTax to be our favorite. You enter information, and MacInTax automatically enters it (and updates it, if you change the value) everywhere else that it's relevant. You can expand lines to allow for multiple entries (such as more than one W-2 form). MacInTax adds the entries and inserts the total on the correct line. The screen display looks just like a real 1040 form, and the printout is perfectly acceptable to the IRS. A must if you're doing your own taxes.

Mark/Release

Mark/Release is a pair of public domain terminate-and-stay-resident programs that let you painlessly manage your other TSRs. You place a "mark" in memory before loading a new TSR program. Later, you can remove any TSR loaded after the mark using "Release." With multiple marks, you can selectively purge and load TSRs to run with various applications you use, or you can instantly clear your RAM of all TSRs with one command. No, it's not the neatest thing since sliced bread, but it's one of those little programs that soon become indispensable. And hey, it's free; how can you go wrong?

Mathematica

Mathematica is another breakthrough Macintosh application. It does for students of calculus, symbolic algebra, and some discrete mathematics what calculators did for those learning arithmetic. Confirmed mathphobic students may very well be drawn into Mathematica's impressive displays and its ability to solve equations quickly and display graphical results. It could enable you to absorb the algebra and calculus that seemed impossible to comprehend from a textbook.

Maximum Storage WORM

We have looked at a number of WORM (write once, read many) optical drives. These drives create permanent copies of files. If you change a file, the drive makes a new copy; your old version is safe and can be retrieved—a boon for writers who need archival backup.

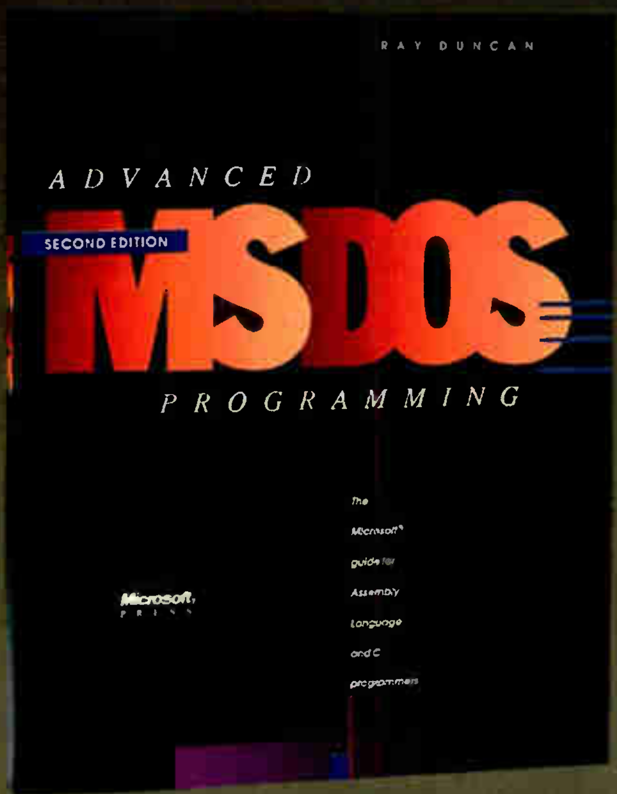
With a number of initial problems corrected, we lean toward the system made by Maximum Storage; the drive is simple to install (you modify your CONFIG.SYS file), and the MAXSYS software is easy to use. By default, it displays only the latest version of a file, but it lets you go back and retrieve any version you like. Using the drive is much like using any other hard disk drive; you can even use it to store compilers, word processing programs, and anything else you don't normally write to.

NEC P5XL Printer

In April 1988, we conducted extensive tests of 24-pin dot-matrix printers that produce near-letter-quality output at acceptable speeds. Among the medium-price dot-matrix printers, the NEC P5XL model came out tops in both high-quality text and graphics output. It was also among the quietest of the mid-price printers, though its throughput lagged somewhat behind that of competing models. If printing quality is your prime consideration, the P5XL is a best buy at $1295.

continued

We couldn't have said it better.



"Advanced MS-DOS PROGRAMMING exemplifies how a highly technical book can be both informative and readable . . . . Duncan's strengths include a style that is at once easily read, a thorough coverage of the subject matter heretofore unknown, and the frequent use of examples in the form of assembly language programs and code fragments."

BYTE magazine
John Unger, IBM Issue 1986

"Makes good reading out of even the most elaborate technical descriptions."

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"One of the most authoritative in its field . . . . The book deserves a place on the shelf of everyone who has ever given a fleeting thought to programming the IBM PC and compatibles."

PC Magazine

And you can bet they'll be saying it again. ADVANCED MS-DOS PROGRAMMING—the preeminent source of MS-DOS information for assembly-language and C programmers—has just been expanded and completely updated. Included is a wealth of new data and programming advice in several significant areas:

- ROM BIOS for the IBM PC, PC/AT, PS/2, and related peripherals including disk drives, video adapters, and pointing devices
- MS-DOS through version 4
- version 4 of the Lotus/Intel/Microsoft Expanded Memory Specification
- writing "well-behaved" vs "hardware-dependent" applications
- compatibility considerations for OS/2

Ray Duncan, DOS authority and noted columnist, explores key programming topics including character devices, mass storage, memory allocation and management, and process management. In addition to his expert advice, he has packed his book with a healthy assortment of updated assembly-language and C listings that range from code fragments to complete utilities. These include a fully functional terminal-emulation program, a nifty DOS shell, and the framework for customized critical-error interrupt handlers.

And the reference section in ADVANCED MS-DOS PROGRAMMING, detailing each MS-DOS function and interrupt, is virtually a book within a book.

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The Norton Commander version 2.0

The Norton Commander is a DOS shell program. It simplifies using DOS by providing a convenient user interface that is programmed to automatically do many common tasks. For example, you can view, edit, copy, rename, move, and delete files by simply scrolling through a directory and hitting a function key. You can just as easily create, rename, or remove directories. Navigating through a crowded hard disk is a breeze; just highlight any subdirectory in a tree display to move to that subdirectory.

Norton Utilities version 4.5 and Norton Utilities Advanced Edition version 4.5

The Norton Utilities is an essential first-aid kit for all IBM PC-compatible computers. The package is famous for its program for recovering erased files, and modifying and viewing files. The Advanced Edition features the Norton Disk Doctor, a disk-diagnostics program that can repair damaged boot records, media-descriptor bytes, and file-allocation tables. Both versions include the Norton Control Center, which lets you set screen and color attributes, adjust the keyboard rate, and set other system parameters.

PC Outline

PC Outline is an outstanding example of shareware. It's an outline processor that's functionally equivalent to commercial products such as ThinkTank: a tool for building, rearranging, and selectively viewing an outline. The program features a superior user interface that seamlessly blends pull-down menus (making it accessible to novices) with command keys that experts will prefer.

Brown Bag software, which now owns the rights to PC Outline, is planning a new version called PC Outline Plus. We're looking forward to it.

PageMaker 3.0

PageMaker is still one of the finest desktop publishing packages, and Aldus has continued to improve it. PageMaker 3.0 lets you combine text and artwork created with other programs and integrate them into finished layouts. The new version also lets you automatically do long publications using several design functions at a time instead of one operation at a time. It fully supports style sheets and can exchange named styles with Microsoft Word 3.01.

With PageMaker, you can cut and paste on-screen as you would on an artist's drawing board. PageMaker is the program that showed many of us how to use the Macintosh to its full potential.

PixelPaint

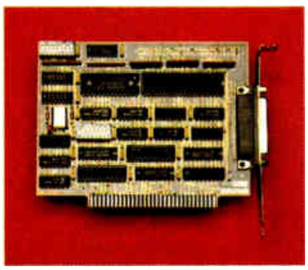
PixelPaint has helped establish the Mac II not only as a machine for engineering and scientific problems, but as a tool for serious graphic art. Its drawing tools are quite similar to MacPaint's and even use some of the MacPaint conventions for copying and constraining the movement of objects that you work with on the screen. However, it does it all in color, and the special-effects capabilities of these tools using blended or shaded colors are simple but well done.

PolyBoost II

PolyBoost II is actually a suite of several programs including a very fast cache for your hard disk, a keyboard enhancer (speeds up keyboard response and includes a command-line editor), a screen speed-up program (for monochrome or color displays), a disk unfragmenter, and several other utilities. The combination of disk, keyboard, and screen speed-ups is impressive—enough to make your computer feel like a new and faster animal. It will accelerate almost any Intel-based machine and can exploit conventional, extended, or expanded memory. In everyday use, you can figure on an average I/O speedup factor of three or four. At $80, this is one of the most cost-effective ways to wring extra performance from your PC.

Procomm Plus

There are many communications software camps. The one most of us use here is Procomm Plus. It is rich with features and is easy to crank up and use. The program supports almost any telecomputing application with its 11 standard protocols, 14 terminal emulations, every common data-transfer rate up to 115,200 bps, host mode, split-screen chat mode, an automated phone book, macros, and a good script language. At $75, the cost/performance ratio is outstanding.



QuickShare ▲

QuickShare is one of those products you look at and say, "Of course—why didn't I think of that?" QuickShare gives your Mac Plus, SE, or II another hard disk. Here's the trick: That additional hard disk is in your IBM PC or compatible. The package comes with a TSR that sits inside your PC, watching for requests coming from the Macintosh to QuickShare's SCSI board in the PC. You create a single large file on the hard disk, to which the QuickShare board maps all Macintosh disk requests; that file on the PC's hard disk now looks like a volume to the Macintosh. QuickShare also features an elegant file-transfer system that makes sending information back and forth between the two machines about as painless as it gets.

SideKick Plus

Talk about bang for the buck. SideKick Plus is jam-packed with useful features. It has nine memory-resident notepads/editors, a calculator, an ASCII table, a disk navigator/manager, a clipboard/cut-and-paste buffer, an outline processor, a calendar/alarm clock and appointment scheduler, and a full-blown telecommunications package that rivals many stand-alone telecomm programs. You can set up SideKick Plus to use Lotus/Intel/Microsoft Expanded Memory Specification (LIM/EMS) or to write to disk to conserve your precious 640K bytes; it can run in as little as 64K bytes.

Soft-ICE

Soft-ICE is an 80386-based debugger that does in software what hardware-based debuggers do: It runs 8086-based programs in emulation mode and can halt and inspect them when they access specified regions of memory or execute specified DOS interrupts. As a bonus, Soft-ICE works with existing debuggers such as CodeView. You can trap an event that your debugger wouldn't have caught, and then transfer control to your debugger and investigate the problem in a familiar environment. If you're developing 8086-based applications on an 80386 machine, this is an essential and affordable tool.

continued

We Just Made Choosing Your Graphics Card

As Easy As 1,2,4.

You've probably seen our TrueVista products, or you've heard about their powerful features like the real-time frame capture, on-board TI 34010 coprocessor, large frame buffer, NTSC/PAL compatibility and more. Recently, we announced several new products in the series, each with unique potential for your applications from video to digital pre-press to image processing. So now, whether your choice is an AT-class platform or the Macintosh® II, you only need one source for your graphics needs, the TrueVista series. The chart below outlines several key differences in the 5 products.

TrueVista Series

FEATURES		ATVista 1M	ATVista 2M	ATVista 4M	NuVista 2M	NuVista 4M
BUS		AT	AT	AT	NuBus	NuBus
MAXIMUM ADDRESSABLE RESOLUTIONS	32 bits/pixel	512 x 512	1024 x 512	1024 x 1024	1024 x 512	1024 x 1024
	16 bits/pixel	1024 x 512	1024 x 1024	2048 x 1024	1024 x 1024	2048 x 1024
	8 bits/pixel	1024 x 1024	2048 x 1024	2048 x 2048	2048 x 1024	2048 x 2048
VMX EXPANSION		2-10 Mbytes	2-10 Mbytes	2-10 Mbytes	TBA	TBA
PRICE		$2995.	$4250.	$5995.	$4250.	$5995.

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SpinRite
The Gibson Research people did their homework on this one. SpinRite can repair bad sectors on your hard disk, find your disk's optimum interleave, and reset the interleave via a low-level format while leaving your data intact. All interaction is via an easy-to-navigate window system. The package comes with a 40-page booklet, but the program is so well put together you'll have little need for it. Other packages (such as the new version of Disk Technician, which we've only seen in beta version) may give SpinRite a run for its money in 1989; but for now, SpinRite is our pick.

Sprint
Sprint lets you produce anything from plain-ASCII text files to desktop publishing-style documents with text in snaking columns. Like Microsoft Word, Sprint allows you to manually embed formatting commands or use style sheets to clone formats from one document to another. It lets you have up to 24 documents and up to 6 on-screen windows open at once.

Sprint has a built-in dictionary and thesaurus. It can semiautomatically generate indexes and tables of contents for long documents. It's fast, and it automatically and unobtrusively stores your work every 3 seconds or so to save your bacon in the event of power failure or similar disaster. All it lacks is true WYSIWYG. If you can live without that, Sprint may be all you need in word processing software.

Toshiba T3100/20 ▲
While this Toshiba laptop isn't as lightweight as the T1000—it weighs in at 15 pounds—its 16-bit 80286 processor running at 4 or 8 MHz benchmarked faster than some other laptops operating at higher speeds. One of the reasons for its hefty weight is the T3100's 20-megabyte hard disk drive. This is a feature many of us lust over until we've lugged it around for awhile.

The T3100 has an amazingly clear gas-plasma display. The full 25-line by 80-column screen has a resolution of 640 by 400 pixels. It's expensive, almost $5000, but it has power, speed, a hard disk drive, and a terrific display all wrapped up in a totable package.

Turbo Debugger
A good product sometimes makes you do crazy things. Turbo Debugger is so easy to handle, we've run working programs through it just to see what's going on. If you're used to the menu-driven command system of Turbo C and Turbo Pascal, you can maneuver through Turbo Debugger with rare glances at the manual.

Turbo Debugger is adaptable enough to tackle most errant programs. Its 80386 protected-mode operation stores the debugger above the 1-megabyte limit in shielded memory. It has a remote debugging feature; the debugger runs on one machine and controls the target program via a serial port to another. Throw in its support for math coprocessors and integration with Turbo Pascal and Turbo C so you can do source *and* object code–level debugging, and you've got a programmer's Swiss army knife.

Turbo C and Turbo Pascal
In a world where language packages get bigger and bigger, it's nice to see the Turbo Pascal and Turbo C getting better and better. The real charm of the Turbo languages springs from two sources. One is the user interface. The other is Borland's philosophy that to improve a language is not simply to tack on support for the latest member of the Intel chip family. These languages were built from the start with an eye for the lowly 4.77-MHz PCs as well as the latest 80386 micros. For rapid prototyping, there's not much better.

Turbo Prolog 2.0
Borland's Turbo Prolog 2.0 may not be what the academic community expected in Prolog, but that may be why it's an exceptional product. In the same way that Borland took the academic Pascal and made a useful and affordable development system, the company has taken the concepts and strengths of a much different language and developed a system for real-world applications programming.

Video Seven VEGA
Though there were some bugs in the first Video Seven VEGA VGA we tested, we kept on trying and found that the VEGA has some very nice features. A half-length card, it is the smallest board of the VGA group we tested. Also, the company furnishes software that can automatically load the ROM code into faster RAM for better performance. At $499, this is a winner.

Windows/386
Windows/386 was one of the first programs to take advantage of the advanced architecture of the 80386 microprocessor. As such, it is serious competition for OS/2. While OS/2 is held back because it was designed to run on 80286 machines, Windows/386 taps into the power of the 80386 to support multitasking of DOS applications and break the 640K-byte memory barrier. The graphic user interface of Windows/386 resembles that of Presentation Manager, a benefit for those considering making the switch to OS/2.

▲

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Here's a battery-powered portable computer that's easy to be happy with. It has a great display, intelligent power management (IPM), and excellent throughput. The TurbosPort's fluorescent backlit supertwist liquid crystal display produces black-on-white images that are easily readable because of its contrast ratio, 10½-inch diagonal image area, resolution, and gray-scale CGA compatibility.

The IPM reduces recharge time and prevents the power-robbing "NiCad memory" effect. This Zenith runs the 80386 with no wait states at a nonstandard 12 MHz, but its slower speed is satisfactorily offset by fewer idle cycles yielding superior throughput.

Zortech C++
The first IBM PC-based C++ compiler (not translator) aims to do for C++ what Borland has done for Pascal and Prolog: popularize a language by providing an inexpensive high-quality compiler embedded in a useful environment. The toolset includes the optimizing compiler, a linker, an editor that's integrated with the compiler, a Make utility, and a graphics library. This product will play a significant role in the imminent ascendancy of C++. ■

continued

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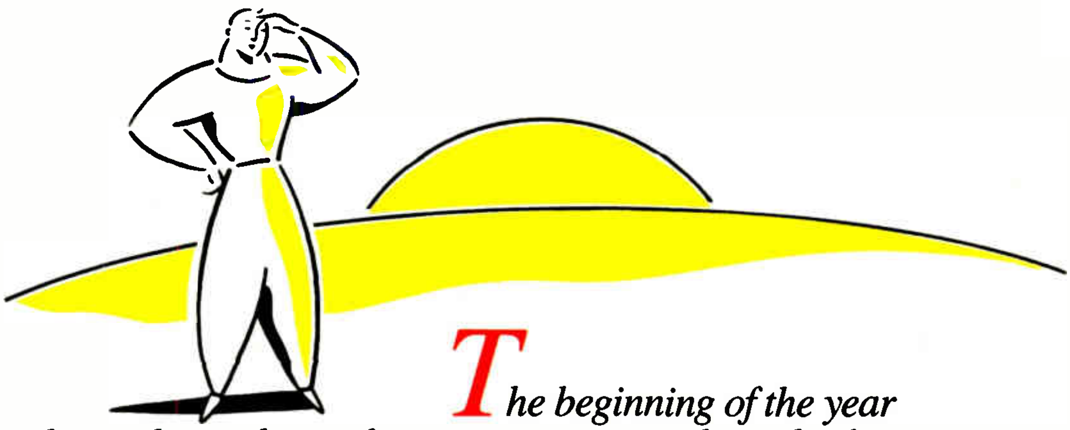


The beginning of the year is the traditional time for prognosticating about the future. Rather than give you our predictions for the year ahead, we thought it would be a whole lot more interesting if we asked some of the pioneers and visionaries of computer science what they think lies ahead, in their areas of expertise, and in computer science at large. Here are their thoughts, in their own words.

Marvin Minsky

Jack Kilby

Grace M. Hopper

Dennis Ritchie

Ryoichi Mori

Ray Kurzweil

Jerome Feldman

Terry Winograd

Charles Simonyi

Marvin Minsky

Donner Professor of Science, founder of the Artificial Intelligence Laboratory and Media Laboratory at MIT. Professor Minsky is a pioneer in the field of artificial intelligence.

It is easier to predict what computers will do in the far future than what they'll do in the next few years. This is because we can see some trends in current research, but can't really guess how long it will take to apply the results of past research. The first computer programs did only what they were programmed to do. The programs we use today are more resourceful, because they exploit the knowledge in specialized databases.

The trouble is that present-day expert systems are devoid of what we call common sense, so each such program is like an idiot savant—proficient at some specialty but incompetent at anything else. So, for example, robots are good for commercial applications in factories, where everything is so uniform. There, the tasks are so repetitive that machines need little common sense.

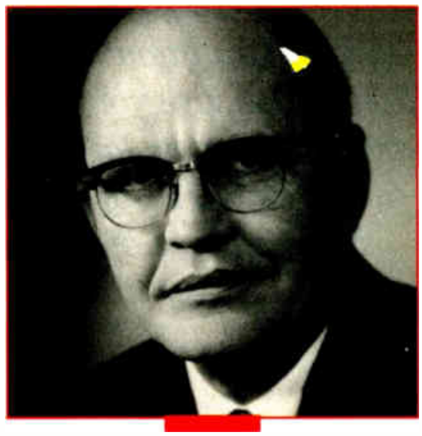
But consider the problem of making a robot physician. We already have some parts for this. For example, there already exist some computer programs that can read a patient's medical history and then, in certain kinds of disease, diagnose and plan the patient's treatment—and they can do this more reliably than the average doctor can. When it comes to the real world, studies have shown that in a horrifying proportion of hospital cases, the wrong treatments and medications are given to the wrong patients.

But today's computerized robots still cannot see well enough to look out at you and see who you are. Nor do they yet have good enough eye-hand coordination to put your pillow into a clean pillowcase. Worst of all, they can't yet handle speech well enough to distinguish your words and know what they mean. Our medical robots can compete, in some particular specialty, with a doctor's decade of advanced education—but not with what a 5-year-old child can do!

What can we do to make smarter machines? First we'll have to build up huge databases of the kinds of knowledge that humans have. One such attempt is already under way, with a program called Cyc, directed by Douglas Lenat at Microelectronic and Computer Technology in Austin, Texas. The goal of the Cyc (from the word "encyclopedia") project is to give a computer enough knowledge to be able to reason about typical subjects in an encyclopedia. At present, this is being done by programming, but eventually we'll want machines that learn from experience. Fortunately, the past few years have seen increasing attention given to research on machine learning, and this should produce many useful applications in the future.

But factual knowledge will not be enough. We'll also need systems that "manage" themselves—that can decide which knowledge to use in different circumstances, what to do about uncertainty, when not to believe what they have been told, and how to learn better ways to learn. Our machines must also know about how to pursue goals, how to resolve conflicts, and how to make sensible economic decisions about how to proceed when the resources at hand are limited, as they always are in the real world.

Although computer-based artificial intelligence already does many useful things, we still know very little about these higher-level aspects of thinking. In my research, I propose several theories about how the great computers in human brains do many commonsense sorts of things. But none of these theories is proven yet. All we can be certain of now is that there will be years of thrilling research ahead.



Jack Kilby

Inventor of the integrated circuit, Kilby was recently honored with the installation of a historic marker commemorating the thirtieth anniversary of the IC at Texas Instruments' headquarters in Dallas.

The development of integrated circuits has always been a horse race between the circuit designers and the process people—the people who actually make the chips. At the moment the process people are somewhat ahead, permitting much higher yields and much larger chips.

This scenario is pressuring circuit designers to develop more complex CAD systems for ever-larger digital designs. Today, the existing tools permit development of chips with 50,000 to 100,000 gates per chip. Tools now under development will permit designs of up to 1 million gates per chip, or the design of several chips with that number of gates.

In principle, this situation should permit the continued decrease in the cost per gate of logic, both in terms of nonrecurring engineering costs and production costs. There is some evidence that this decrease may be slower than the projections of the past would suggest. As the line widths approach one micron, the processes seem to become more complex and more costly. The need for extreme cleanliness also has a price.

Integrated-circuit research and development is still very active and, in the future, will result in many new products. Gallium arsenide is becoming practical and will find significant applications—particularly in the microwave area. Superconductors will play a part, as will entirely new methods of computing, such as neural networks. Optical computing may also find significant applications.

Grace M. Hopper

A Rear Admiral retired from the U.S. Navy, Hopper is now senior consultant for Digital Equipment Corp., Washington, DC. She created the first compiler, which converted a high-level (human-readable) language into the binary code of the Univac computer.

It's difficult to predict the future in this business. When I stood in front of the Mark I, there was no way I could have guessed that there would be magnetic core storage. When I stood in front of a Univac III that had magnetic core storage, I couldn't imagine transistors—we didn't have them yet. No matter what I look at today, there's something totally unknown that isn't in our vision yet that will happen.

I can say I think that within the next 5 to 10 years we'll have photonics—light-driven computers—because Bell Labs already has one. That's probably the most exciting coming development. We're making the transition from the Model T to the Model A, but I can't guess what's coming up next. There are, however, some possibilities that look quite promising.

I wrote the first compiler back in 1952, so I suppose I can claim to have started computer-assisted software. When I look at this object-oriented programming they're talking about, all I see is bigger globs than I thought up for the subroutines of the first compiler. That direction should continue.

I think we're facing an information overload. We're putting information out of systems without looking carefully at how it's going to be used. Does it feed to another system? Or is the data going to people and are we giving them the information in the best format possible? We've been letting the programmers run riot, and we've forgotten about the systems analysts and systems designers—we're not using them. Big banks and big insurance companies have them, but a lot of people are just depending on programmers.

I recently heard of a case where two companies merged and needed to merge their data processing systems. The programmers just added things together and forgot to notice that one company started a new year on January 1, and the other one started its new year on April 1. They ended up just adding the year-to-date together.

I'm fascinated by some of the best of the expert routines, but at intervals I have to remind people that no computer will ever ask a new, reasonable question. That's what people do. I'm skeptical of neural networks because people are writing the programs and designing the networks that are designing the programs. I wish we knew more about how we think.

I think our biggest problem in the foreseeable future, and it's serious, is that we're not going to have enough trained young people. Within 5 years, we'll be acutely short of electronic and electrical engineers, technicians, professors—we're going to be short of everything. Companies are going to have to hire people and then train them. In this regard, we ought to make use of retirees. I'm trying to set up retiree clubs to encourage people—people who no longer want to work 5 days a week, 8 hours a day but might be very glad to work 3 days a week, 4 hours a day—to train these young people coming up.

Planes started flying in 1903, and by 1943, we had a DC-2. The computer first ran in 1943. We're at the DC-2 stage. We're only at the beginning. We haven't half gotten started yet.

Dennis Ritchie

An AT&T Bell Laboratories Fellow, Ritchie was codesigner of the Unix operating system and the C programming language.

This is a very interesting period in Unix standardization. We're in the middle of two important developments and it's quite exciting to guess how they will unfold.

The first concerns AT&T, Sun, and the OSF (Open Systems Foundation, a collection of major computer manufacturers formed to counter what they see as an attempt by AT&T and Sun to corner the growing Unix market). AT&T supplies Unix System V, while Sun's system, SunOS, was originally based on a version of Unix called BSD (Berkeley Software Distribution).

continued

The tension between the System V and BSD variants has been annoying to everyone. A bit more than a year ago, AT&T and Sun announced that the next versions of their operating systems would be merged. The appearance of OSF at the beginning of 1988 suggested the possibility of a new pair of partly incompatible versions of Unix. Since the summer, however, it's become apparent that AT&T, Sun, and OSF have become sensitive to this problem and seem to be trying to work out a solution.

The other set of events is equally important—or maybe more so. This is the work, parts of which are nearly complete, that the official standards bodies are carrying out. In 1989, we may expect to have an official ANSI C, and the ISO (International Standards Organization) standard should follow soon after. The ANSI X3J11 committee working on the draft for the new specification of the C language has just transmitted the draft to its parent body.

Likewise, some of the IEEE standardization work on POSIX (IEEE's name for its system) is nearing completion—especially the system services part of the operating system. The specification for the user interface to the core applications isn't far behind. It seems that most of the major suppliers of Unix and Unix-compatible systems are serious about complying with the ANSI and IEEE standards. I believe this development is very important and very promising.

I don't see significant changes in languages in the lower-level areas such as systems programming. Some newer languages such as Modula-3 are coming into prominence and finding applications over older languages such as Pascal. Presumably, Ada will be growing due to forces such as the government and others that are picking it up.

More changes will be occurring in high-level areas other than traditional languages. When I say higher-level languages, I'm talking about products that are not often thought of as languages. In some ways, the method in which you talk to spreadsheets is a language. In another way, interfaces, such as the Mac interface, are languages. They're very different than text-based languages, but they can be thought of as languages.

In the middle area are environments such as Unix shells. They are akin to fourth-generation ideas—they have very powerful underlying primitives. That sort of approach means that more people will be able to program. As Unix continues to spread, people will learn to encapsulate short series of commands, add a few tests, and soon find themselves programming.

What's happening in languages today has been influenced by the work that came out of Xerox—work such as graphics interfaces and Smalltalk. As more computer power becomes available at less cost, more people will be able to use higher-level languages.

Ryoichi Mori

Professor at the Institute of Information Sciences and Electronics, University of Tsukuba, Japan, Professor Mori has been in the forefront of the Japanese microelectronics industry and the TRON projects.

Over the past 20 years, I have seen two important innovations come along. In 1973, I predicted that the microcomputer would be the most important issue for many decades. In 1978, I came to the conclusion that the first Japanese word processing machine, the Toshiba JW-10, would change the history of Japanese documentation work. I predicted that the Japanese word processor would reach not only to the offices, but also to personal document work.

Now I believe that "superdistribution" will be the most interesting and important issue in the field of personal computing in the foreseeable future. Superdistribution is a way of distributing programs, using a tamper-resistant module to keep track of usage rights and billing charges.

Steve Weingart of the IBM Watson Research Center and I have designed these tamper-resistant modules. His module uses analog detection of attacks. An IBM system to utilize the module, ABYSS (A Basic Yorktown Security System, created by Steve White and Liam Comerford), uses a token card. My method uses digital detection and has a system architecture—thus, I named it "superdistribution."

In one way, superdistribution is analogous to superconductivity. In superconductivity, *electrons* flow without resistance; in superdistribution, *digital information* flows without resistance. The key to eliminating the resistance is to eliminate copy protection and piracy so as to safeguard the interests of users, manufacturers, and distributors, who will then promote free distribution rather than hinder it.

Superdistribution is different from conventional distribution in that it allows users to obtain and test software from anywhere in the world before paying for it, as well as to rent and purchase full usage rights anytime. At the same time, a software vendor can restrict software implementation to a set of qualified users without any need for active verification. No explicit contract is needed. With this system, running new software will be like turning on a faucet and getting water. Billing will be automatic for both user and vendor.

The information that accompanies the superdistribution software includes controls on its usage and testing. The billing information collected by the module can be retrieved by means of telecommunications, a system analogous to reading a water meter.

Although software superdistribution resembles the distribution of electricity, gas, and water, it is even more convenient. No material medium is needed for superdistribution, and the information is transmitted at the speed of light. Superdistribution can be used not just for computer programs but for compact disks and digital-audio tapes as well.

continued

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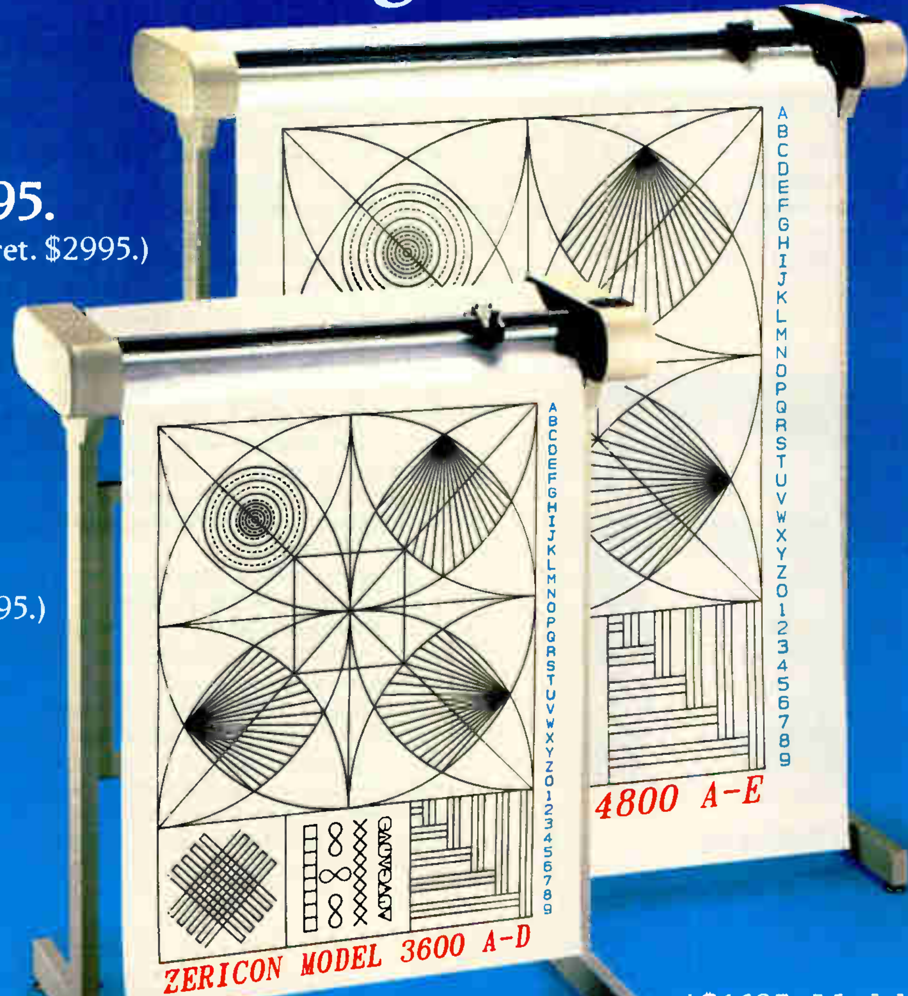

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Over the past 5 years, the Japan Electronic Industry Development Association has intensively investigated the superdistribution concept. (Among the other projects initiated by JEIDA are VLSI technology research, the Fifth Generation Computer, and TRON.) In April of 1987, JEIDA established the Superdistribution Technology Committee, which I chair, to actively pursue this concept. The committee, which includes experts from Nippon Telegraph and Telephone and from all the major Japanese mainframe manufacturers, foresees no major obstacles to realizing superdistribution in the near future.

Ray Kurzweil

Chairman and CEO of Kurzweil Music Systems and Kurzweil AI, Kurzweil played a crucial role in the development of digital synthesis of music and sound.

Einstein said, "I never think of the future, it comes soon enough." Unfortunately, those of us who attempt to apply science have little choice but to contemplate the rapidly changing trends of technology.

I believe the coming year will see the culmination of a number of trends that have been in gestation for many years. In speech recognition, for example, progress has continued to accelerate since it first became a practical technology in the early 1980s, principally as a means of entering simple and repetitive inventory data and control commands. Now, with the advent of large-vocabulary discrete word-recognition systems, and aided by knowledge-engineering software (software that encodes the structure and context of specific domains of knowledge), printed documents in large quantities are being routinely generated solely by voice. In the next few years, we will see a rapid increase in the acceptance of such systems, particularly in fields with highly structured knowledge bases, such as medicine.

We will also see significant research gains in large-vocabulary recognizers that can simultaneously handle continuous speech and large branching factors. These systems will emerge commercially during the next several years and will begin to achieve a much-anticipated ubiquity during the 1990s.

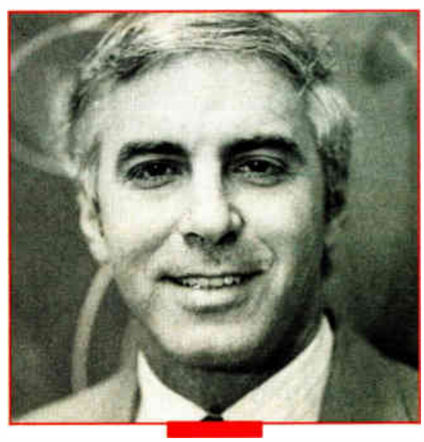
The application of advanced digital signal processing techniques and artificial intelligence technologies to the creation of music is moving even more quickly. Now that computer-based instruments can capture the rich time-varying tonal qualities of complex instruments such as the piano, we are beginning to see a trend away from the historical link between playing technique and the sounds generated. It is now possible, through the industry's standard communications protocol called MIDI (musical instrument digital interface), to play a guitar on a piano keyboard or vice versa.

In 1989, we will see electronic music "controllers" emulating the playing techniques of many other acoustic instruments including many wind and string instruments, drums, and others. We will also see progress toward a more ideal generation of controllers, where human factors are no longer limited by the physical requirements of creating sounds acoustically.

At the same time, we will see the emergence of a new genre of software for computer-assisted improvisation. Unlike their crude "easy-play" forebears, these intelligent accompanists will be programmed with an understanding of musical theory. Professionals will use such software to assist them with many chores of the composition process: to automatically generate a walking bass line, expand a harmonic progression, or compute a rhythmic sequence.

Beginners will use other versions of this type of software to generate musically satisfying multi-instrumental "works" in the early stages of their learning to play and to understand musical theory. By combining the new controllers with intelligent sequencing software, musicians will be able to surpass the limitations of human fine motor coordination.

In another area, the advent of low-cost "intelligent" character-recognition software will fuel continued expansion of desktop publishing and on-line database systems, as well as provide affordable sensory aids for the visually impaired. The entire imaging field will begin a major expansion in 1989, culminating in a multibillion dollar industry by the early 1990s.



Jerome Feldman

Director of the International Computer Science Institute, Berkeley, California, Feldman has been called the "father of connectionism."

In the near future, I see a large and growing interest in massively parallel computation of a somewhat granular nature. Systems that perform this kind of processing are called neural net-

continued

works, connectionist systems, and parallel-distributed-processing (PDP) systems.

The basic idea, and I think it's a good one, is that because of advances in the fields of computer science, electronics, biology, and psychology, we're learning enough about the way animal's brains work to judge whether some of this might apply to technology. There may be some practical uses for neural networks in the areas of vision, sound analysis, motor control, and others, if we understand how the brain makes these things happen. Animals are much better at certain kinds of tasks than any computer or software you can build.

But it would take a large investment to solve these problems. There's enormous potential, but I think a lot of the excitement in this field is based on the potential rather than technical know-how. The big question is, is this the appropriate time to try to exploit ideas from the life sciences and technology?

I've been doing research in this area for over a decade. Some people think neural networks will become practical in 5 years. I've seen a number of commercial and military ventures based on the assumption that this technology will be here soon. There's no way that's going to happen. I don't think we can put a time frame on complex systems because there are large areas that we don't understand. But with some breakthroughs, it could happen more quickly.

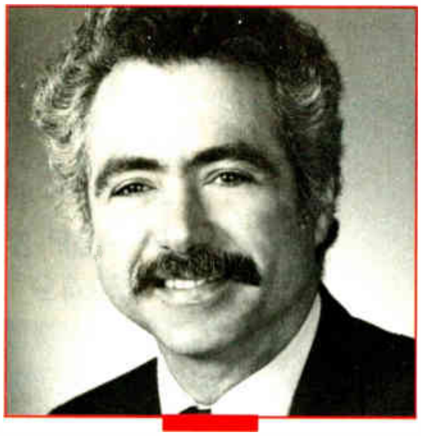
On the other hand, billions of dollars are spent each year on computing and software, and some small neural-network-type applications will come along. But it doesn't make sense for government or private enterprise to invest heavily in neural networks where the returns will be a very long time in coming.

A lot of people are doing this now, based more on hope rather than a technological foundation. This hope takes two forms. The first is the belief that if you build computers more like a brain, you should be able to solve brain-like problems more naturally on them. The other is that techniques in machine learning, which have indeed improved, are going to be good enough to be able to use any old brain-like machine; that if you train it with these techniques, it'll get smart. But both of these hopes have no technological basis.

We don't yet have the scientific understanding about what's needed for a vision or a speech machine. If we understood the problem, we could build the appropriate machine. A lot of the hype has been based on the hope that you could somehow short-circuit this process—that we wouldn't have to understand speech or motor control or vision; the learning rules alone would make neural computers smart.

One thing I do know: With excellent scientists working on this, there will be good progress in the next couple of years: mathematical theories, hardware, software—all you would expect out of an active area of research. Some simple applications will become practical that won't even scratch the surface of scientific understanding. No one knows how long it will be before there will be major applications in this area.

People in this field are saying that the greatest danger to the progress of the technology is exaggerated expectations. As long as people doing the work have patience and don't claim outrageous things, I think the field has a long and productive future.



Terry Winograd

Associate Professor at Stanford University. Winograd has been a leading investigator in the field of natural language processing, and is coauthor of Understanding Computers and Cognition.

The year 1989 will see an acceleration of the progress from "connectivity" to "compatibility" to "coordination."

Connectivity, the first step toward integrated communication, is well under way, with widespread networking and universal low-level protocols rapidly gaining acceptance. Soon, the basic connectivity of computers will be taken for granted in the same way as the connectivity of roads and of telephones.

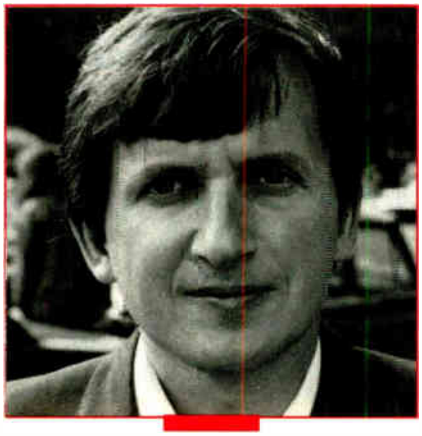
Next there is compatibility. It is useless to connect two machines if the document prepared on one cannot be printed or viewed on the other or if applications on one cannot work with the other. We are beginning to see progress through the creation of comprehensive standards for languages, databases, communication protocols, and interaction architectures. Standards based on SQL, SAA, Unix, X Window, and the like will still take a while to reach the uniform acceptance that we see at lower levels, but the process is well in motion.

The third level, coordination, is just coming to be recognized as a central issue. For users, the purpose of integration is not to share data or connect processors, but to integrate the work. Work is not about files and databases or spreadsheets and forms. It is customers, orders, products, designs, and the myriad of specialized things that appear in different lines of endeavor. The emergence of groupware reflects a growing recognition that the industry needs to move away from thinking about integration of the devices and data, and turn its attention to the integration of work activities.

This shift requires addressing the nature of work in organizations. Organizations are structures for the social coordination of action, generated in conversations based on requests and promises, and associated with times for completion. This scenario works regardless of whether the request is the placing of an order or a memo asking for a design team to be formed.

By directly addressing this universal dimension of human communication, we can design action/coordination systems that apply principles of conversation management to keep track of what is going on and what needs to be done. By doing so, we create a coherent principled structure around which the details of activities, interfaces, data files, and printouts make sense.

Over the next few years, the development of conversation/action systems will create a new level of standards and integration, making it possible to create people-centered systems that bring new clarity to the coordination of human action.



Charles Simonyi

Manager of Advanced Languages at Microsoft. As chief architect of applications, Simonyi oversaw the development of many of the firm's most popular applications.

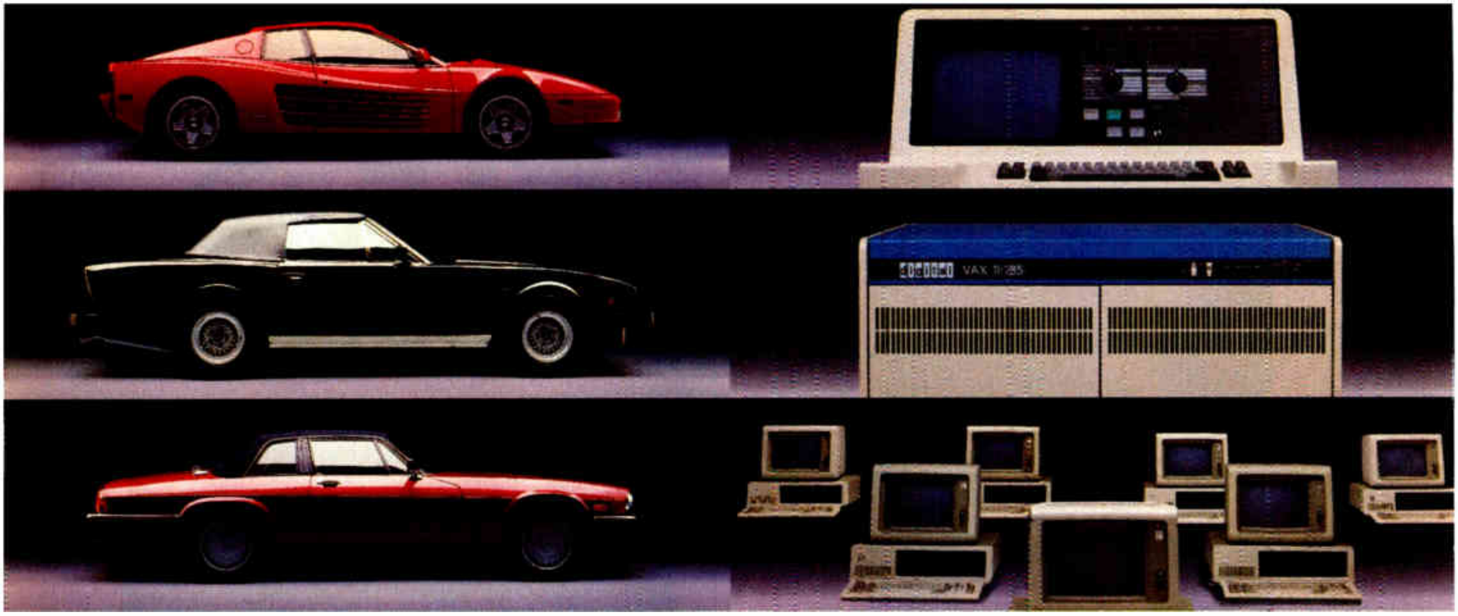
Just as the strength of a rope is derived from intertwined fibers, each shorter than the load-carrying length, the health of the microcomputer industry is built on the myriad of developments and controversies that emerge, interact, and complete in a never-ending pattern. On the whole, I believe 1989 will be a year of delivery more than a year of new promises.

A Grand Consensus has emerged, and in 1989 the consensus is that the future belongs to the graphical user interface, to the mouse, and to networked personal computers. For example, I often see the drawing of a mouse as an illustration to set the mood for some popular article where personal computing is mentioned. Other pointing devices will be developed—especially for use with laptops.

Computer networks will continue to grow and groupware will become much more common, not only as E-mail and file or printer servers, but also as specific features in standard word processors, spreadsheets, and the like. These will be but a few of the many innovations in the already established categories of personal computer applications. New categories will be rare, and current applications such as document processing and desktop publishing may even lose their separate identities.

On the implementation side, the industry already has a remarkable consensus on using C. At the same time, the object-oriented programming paradigm is emerging as the most widely applicable software engineering advance since structured programming. It will be very exciting to see how these two trends interact and reinforce each other in C++ and in other C derivatives. Of course, the original motivation for C was a desire for simplicity and elegance, so C purists will object to the elaboration of the language. My feeling is that while the C pioneers made an incredibly valuable contribution, the trend is toward the emergence of several variations of C and the dominance of a single, very powerful, object-oriented superset of C.

In hardware, we'll see investments in RISC (reduced-instruction-set computer) architectures because of the promise of performance gains. The speed of traditional-architecture chips will also be greatly improved, despite difficulties such as the requirement for software compatibility. Many clever RISC ideas, such as reduced-cost subroutine linkage, could enhance non-RISC or even high-level-language performance. ■



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THE X WINDOW SYSTEM

Born as a means to network graphics workstations, MIT's X Window is gaining ground as a windowing system for Unix

Dick Pountain

Windowing user interfaces are now the accepted way of interacting with computers. People may still argue about whether they prefer icons or filenames, pull-down or pop-up menus, but no one disputes the usefulness of splitting the display screen into several areas that clearly separate different software functions.

Though purely character-based windows are quite workable (consider pop-up utilities like Borland's SideKick), the industry trend is to adopt the full overlapping-windows metaphor that treats the screen like a bit-mapped graphics image with "soft" typefonts and a mouse-driven pointer that can move around by single-pixel increments. Windows then appear to be active objects that can obscure one another, can be moved and resized, and can contain pointer-activated controls for scrolling and zooming. Special kinds of windows (e.g., menus and dialog boxes) present you with choices from which to select by pointing rather than by typing commands.

Examples of such interfaces familiar to us are the Apple Macintosh interface; Microsoft Windows for IBM PC-compatible systems; Digital Research's GEM, used on the Atari ST and some PC compatibles; and the Intuition interface of the Commodore Amiga.

Two features that are common to all these interfaces is that they are for single-user systems and they are closely tied to the hardware of the computer on which they run. This is partly because such graphical displays impose a much larger computational burden than traditional character-based systems do; thus, their implementation tends to be highly optimized for speed by using direct video memory accesses and even, in the case of the Amiga, custom hardware assistance in the shape of a blitter chip.

In the world of engineering workstations, windowing interfaces have been the norm for several years now. In that world, the almost universal adoption of the Unix operating system combined with the need to share data over networks has generated more pressure for standardization than in the personal computer world.

The goal has been a network-transparent, device-independent way for a program running on a network workstation to create windows on the screen of another workstation that might have been made by a different manufacturer.

Despite the emergence of some proprietary systems, such as Sun's NeWS, it looks as though the workstation world is settling on the X Window System that was developed at MIT.

continued

ILLUSTRATION: TOM FOTY © 1989

The significance for personal computer users is that the worlds of the PC and the workstation are very rapidly converging (see the article "Sun's Newest Workstation: the Sun386i" by Tom Thompson in the July 1988 BYTE). Top-end PCs already use the same processors (i.e., the 80386 or the 68020/30) as leading workstations. Networking is now widespread among larger PC users.

Meanwhile, CAD and desktop publishing applications have created a need for true high-resolution graphics. These latter two application areas are also beginning to make people want a portable, device-independent way of exchanging graphical information. So far, that demand has been met by Adobe's PostScript Page Description Language, which has now spawned Display PostScript as a possible video graphics standard in apparent competition with X Window (but see below).

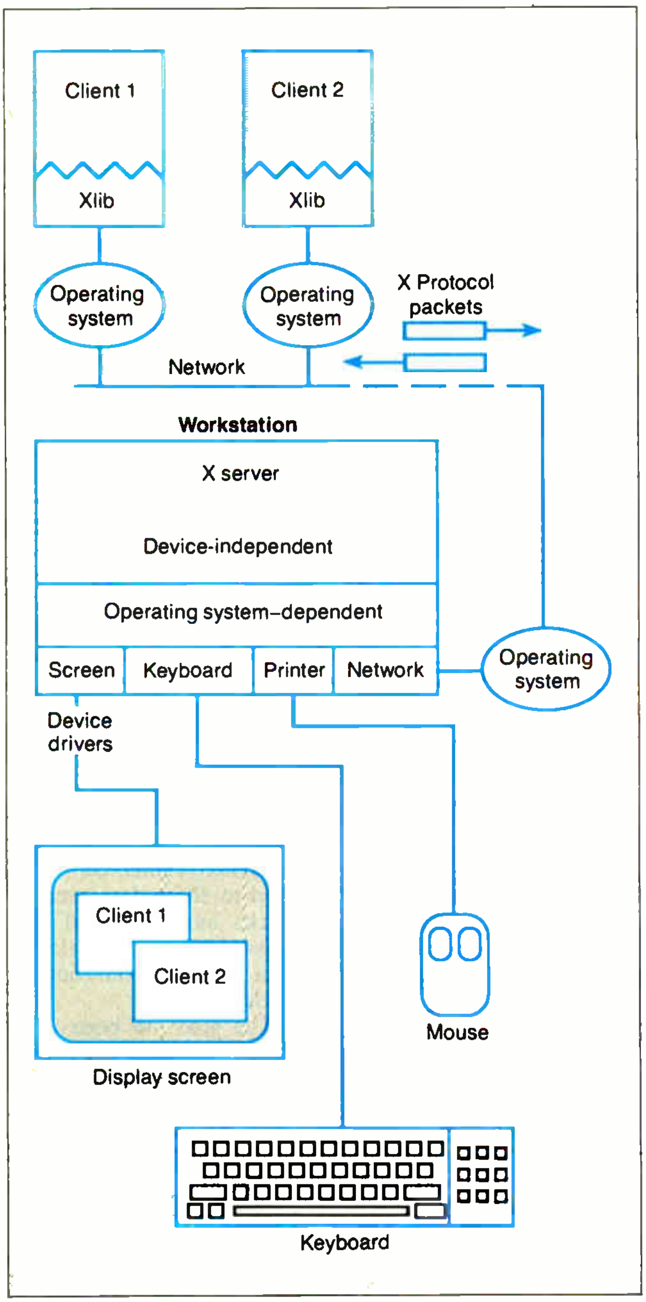


Figure 1: *The client program sends packets of instructions to the server, which contains the hardware-dependent drivers for that workstation. An X server controls not only the screen but also the keyboard and a pointing device with up to five buttons.*

X History

The X Window System has sprung up in a mere 4 years, thanks to the enthusiasm of a group of programmers at MIT and elsewhere. It arose in 1984 out of an MIT project called Athena, which investigated the use of networked graphics workstations as a teaching aid for students in various disciplines.

The idea was that each student should have a windowing graphics workstation on which he or she could run local tools like word processors and spreadsheets while simultaneously being able to call up library pictures and documents from remote sources.

Since MIT has a mix of hardware from Digital Equipment Corp., IBM, and other manufacturers, it was clear that the students needed a hardware-independent protocol for sending graphics around the network. The development of this protocol by Bob Schiefler, along with work by Jim Gettys, Ralph Swick, and others, led to the X Window System. It has progressed in those 4 years from version 4 up to the current release, which is version 11.2.

In 1986, the Athena team decided to release version X10.4 on tape to other interested parties for a nominal charge (reminiscent of the way Unix was spread in its early days). The positive response was overwhelming. Hewlett-Packard and DEC even designed new workstations around X Window.

Finally, in January 1988, MIT formed a consortium with most of the leading workstation manufacturers to develop X Window further and have it adopted as an ANSI standard. The members of the X Consortium included Apollo, Apple, AT&T, DEC, HP, Sun, IBM, Televideo, and Tektronix. The copyright for X Window is held by the consortium members, but permission for its use is granted to any party interested in implementing it.

What Is X Window?

The MIT team designed X Window as a distributed, network-transparent, device independent, multitasking windowing and graphics system. It permits you to display multiple applications on the same screen, and it lets one application use many windows. It supports overlapping and hidden windows, text with soft fonts, and two-dimensional graphics drawing.

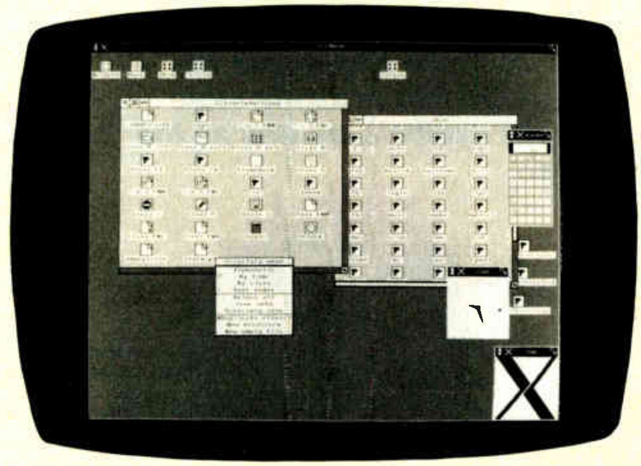
X Window achieves device independence by splitting the job of drawing windows into two parts, using the increasingly familiar client/server model (see the article "A Personal Transputer" in the June 1988 BYTE). The client is an application program making requests of the server to draw windows, text, and other objects. The server program runs on each workstation, drawing the required objects on the display.

The client communicates with the server by sending packets of instructions conforming to the X Protocol, which is, in effect, a high-level graphics-description language. Each workstation has its own server, which contains the hardware-dependent drivers for that workstation. An X server controls not only the screen but also the keyboard and a pointing device with up to five buttons (see figure 1). The application programmer links the client program with X Window using Xlib, a library of graphics and windowing functions.

The client and server might be resident on the same worksta-

continued

Managing the X Window Desktop



While the X Window System provides the mechanism for drawing windows and sending graphics around a network, it doesn't mandate the user interface that runs on top of it. The user interface specifies what windows and icons will look like, how the user will interact with them, and so on. Examples of user interfaces for other windowing systems are the Macintosh Finder and the OS/2 Presentation Manager, while Open Look (see the article "Face to Face with Open Look," by Tony Hoeber in the December 1988 BYTE) provides a user interface for Unix windowing systems like X Window and NeWS.

X.Desktop, another window manager, is a complete desktop manager for Unix systems based on X Window, written by the Cambridge, England, firm IXI Ltd. X.Desktop is a client application that runs on your workstation for the duration of a session. It completely hides the normal spartan Unix shell, though you can call up an ordinary shell in a window any time you need to.

The icon-based desktop (see photo) will be familiar to anyone who has used a Mac or GEM system, but X.Desktop adds a few refinements of its own to the metaphor. For example, you can give parameters to a program by dragging the icon for the data file to the program icon and dropping it on top. To edit a file, you drag its icon on top of the icon for the required editor.

What really distinguishes X.Desktop is its configurability. You can change not only the icons that represent a file type, but also the actions performed when an icon is clicked on or dropped onto another. By modifying rule files and by providing alternative X Window managers, it is possible for X.Desktop to emulate the behavior of any other desktop system with great precision.

IXI is offering X.Desktop as an OEM product, and it is currently being considered by several major Unix vendors.

tion, as when a single user is executing a program locally, or they may be very widely separated. For example, a person with a graphics terminal in London, England, could execute a program on a Cray-2 in Berkeley, California, by using a satellite link in a wide-area network. The physical means of communication is immaterial to X Window since the X Protocol is the same in all cases, that is, network-transparent. Communication schemes used with X Window include shared memory, message passing, and transputer links at the local workstation level and RS-232C, Ethernet, token ring, and many others between workstations.

Though X Window has been developed mainly under Unix, it is not dependent on any particular operating system. It can be implemented on top of any operating system, as it has been for VAX/VMS. However, where possible, X Window uses operating system calls to establish the connections between the Xlib functions and the network, and between the network and the X server. This implies that some operating systems, notably multitasking ones with network support, will be far more suitable than others. It is also possible to create mixed operating system networks by implementing an X server for the "foreign" system. MS-DOS microcomputers have been added as X Window terminals to Unix-based networks by just this kind of hybridization.

The X Server

The chain of communication in opening a window under X Window has seven links, depicted in figure 1 but summarized as follows:

```
Application -> Xlib -> OS -> X Protocol -> OS -> X server ->
Screen
```

An X server program controls the display screen, keyboard, and mouse on the workstation. A single workstation might have several screens driven by the same server (like those big screens for the Macintosh), or a single computer might run more than one server with different graphics terminals attached. More likely, each workstation will have its own X server.

Since a single X server can service requests from many client applications, the screen might have several windows containing the output from different programs. The client programs might be running on the server machine or on several others in the network. Equally, programs running on the local machine or workstation can open windows on other workstations. This means you can create very sophisticated electronic mail systems under X Window.

For example, the leader of a workgroup might pop up a menu window on the screen of each member of the group. They would have to click a preference from the menu, and the results of this "ballot" would be returned to the application program on the leader's workstation, where it would be displayed in a table. This is an illustration of two-way communication in which the X server returns user input from a keyboard or mouse to the client program.

The X server's primary job is to share scarce resources among the client applications that request them. The two principal resources are processor time, for drawing and text manipulation, and screen space. An intermediary program, the window manager (see below), doles out the screen space. The server is responsible for scheduling work performed on behalf of the client programs, for memory management, and for such subsidiary processes as maintaining the communications links with each client.

The server performs all these functions by using the services of the underlying operating system. X Window can be used for a truly distributed system; when it opens a window on another workstation screen, it is the remote CPU that is doing the drawing.

The current X11 version of the server can perform two-dimensional drawing of lines, rectangles, circles, arcs, text, and arbitrary bit maps on monochrome or color displays with up to 32 bits per pixel. The X server also loads new fonts from operating system files, stores them in memory, and makes them available for text writing.

From a structural point of view, an X server consists of a device-independent layer that receives and translates client request messages in the X Protocol format, an operating system–dependent layer that interfaces to a particular operating system, and a device-dependent layer that is a collection of device drivers for the specific hardware supported. To port X Window to a new system, only the latter two layers need rewriting.

Window Hierarchies, Events, and Window Managers

When you open a window under X Window, it becomes part of a hierarchy just like the DOS subdirectory structure. Each screen has its own hierarchical structure and a "root" window that fills the whole screen. The root window can have "child" windows that occupy part of the screen. These in turn can have further children. The overlap and visibility of windows is controlled by the stack order of siblings of the same level, but children always stay in front of their parents. (Figure 2 illustrates this principle.) The number of windows you can create (and destroy) is almost limitless. Each window has attributes such as foreground, background, and border color, cursor shape, and a color map.

Pop-up menus, radio buttons, and dialog boxes are implemented as trees of child windows, since windows are used for all screen interactions. The X server can only output via a window, and it can allow more than one client to output via the same window.

Input from the keyboard must also go into a window, normally the one in which the cursor currently resides. However, X Window has an "input focusing" feature that allows a client program to specify some other window as the source for input. In addition, a client can grab the mouse pointer under certain circumstances.

X Window applications, like those of Microsoft Windows or the Macintosh, are event driven. The main part of a window application program is a loop that waits for an event to happen and then jumps to the appropriate action. The X server recognizes many event types including pointer motion, key press, button press and release, window entry and exit, input focus switching, exposure of previously covered windows, color map event, and status change. Also, communications from the client programs can cause events.

The stated philosophy of the X Window System is to provide only the mechanism for drawing windows, not the policy for using them. This differentiates it from Microsoft Windows, Macintosh, GEM, and other systems that provide both. Under X Window, the policy must be provided by a separate program called a "window manager," which is just an ordinary client program.

Client programs have to negotiate with the window manager, which has the last say in all matters of screen usage. The proper protocol is for clients to offer the manager "window hints" of their wishes (something like "I want a 20-row-by-30-column window at row 10 column 10 in the foreground"). The manager can then use any available algorithms to satisfy these requests as fairly as it can. It can, for example, resize existing windows or alter their stacking order. Windows can be restacked, moved, resized, closed, or reduced to an icon via the attentions of a window manager. A window manager can also alter the way events are delivered, grab the mouse pointer, and change the input focus.

In fact, a window manager can impose any policy its implementer can dream up. It might forbid the overlapping of windows altogether and send a rude message to any client program that asks for too much screen.

More sensibly, a window manager can emulate other windowing systems. If you have several window managers present in your system, you can switch from the Macintosh look, complete with scroll bars, to the Microsoft Windows look just by running a new manager. Several development firms are presently working on window managers that emulate the OS/2 Presentation Manager.

Xlib, X Toolkits, and X Protocol

A programmer wishing to write applications that run under X Window must perform all windowing and drawing by using

continued

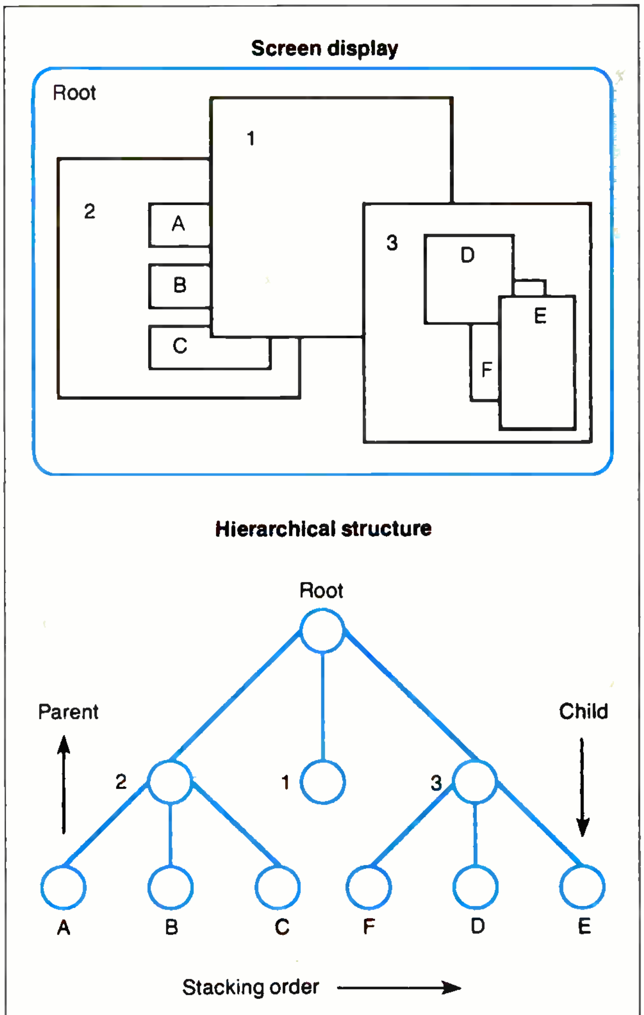


Figure 2: *X Window treats overlapping windows as a hierarchy.*

only procedures from the Xlib library, which is available in C, Pascal, FORTRAN, Modula-2, and Ada. If you write your program this way, you should be able to port it to any hardware that supports an X server by simply recompiling without altering the code.

X Window's main competition is Display PostScript, which offers more powerful typographic functions—though the two systems are not exclusive and might even complement each other.

Xlib contains more than 200 procedures, many of which resemble those found in any graphics library. For example, the drawing primitives include XDrawPoint, XDrawRectangle, XFillRectangle, and XDrawArc.

Xlib supports clipping, stippling, and tiling operations as well as the manipulation of raw bit maps. It supplies other procedures to create and configure windows (XCreateWindow, XResizeWindow, XDestroyWindow), and still others concerned with events, queries, font manipulation, keyboard, pointer, and color control.

Opening an X Window application involves eight steps in sequence:

1. Open a connection to the server with XOpenDisplay.
2. Create a top-level window with XCreateWindow.
3. Set standard properties for the top-level window, including hints for the window manager.
4. Create window resources such as graphics contexts.
5. Create any other windows needed.
6. Select the desired events for these windows.
7. Map the windows.
8. Enter the event loop.

The "graphics context" referred to in step 4 is a data structure that contains information about a drawing: the foreground and background colors, line width, and clipping region. Mapping is an initialization process that makes a window viewable. The C source code in listing 1 shows how this initial sequence looks for a simple application that prints the traditional "first" program of any language, "Hello World."

Closing an application properly involves killing all windows, freeing all resources, and then calling XCloseWindow. Should you fail to do this and merely exit, the server will eventually notice and close the windows down itself, since it is responsible for maintaining the client connection.

If you have linked your application to the required Xlib routines, at run time X Window will generate the equivalent X Protocol requests to send to the X server. These requests corre-

continued

Listing 1: *An X Window program for a window that displays* `Hello, World.` *If you press a mouse button, it responds* `Hi!`.

```
/*********** X include files **********/
#include <X11/Xlib.h>
#include <X11/Xutil.h>

/*********** declarations ************/
char hello[] = {"Hello, World."};
char hi[] = {"Hi!"};

/************ main *****************/
main(argc, argv)
int argc;
char *argv[];
{
Display *mydisplay;
Window mywindow;
GC mygc;
XEvent myevent;
KeySym mykey;
XSizeHints myhint;
int i, done;
char text[10];

/* initialization */
mydisplay = XOpenDisplay("");
myhint.x = 200;
myhint.y = 200;
myhint.width = 350;
myhint.height = 250;
myhint.flags = PPosition | PSize;
mywindow = XCreateSimpleWindow(mydisplay, DefaultRootWindow(mydisplay),
        myhint.x, myhint.y, myhint.width, myhint.height, 5, 0, 1);
XSetStandardProperties(mydisplay, mywindow, hello, hello, None, argv,
        argc, &myhint);
mygc = XCreateGC(mydisplay, mywindow, 0, 0);
XSelectInput(mydisplay, mywindow, ButtonPressMask|KeyPressMask|ExposureMask);
XMapWindow(mydisplay, mywindow);

/* main event-reading loop */
done = 0;
while( done == 0)
        {
        XNextEvent(mydisplay, &myevent);
        switch(myevent.type);
                {
                case Expose: /* repaint window on expose events */
                        if(myevent.xexpose.count == 0)
                                XDrawImageString( mydisplay, mywindow, mygc,
                                        50, 50, hello, strlen(hello) );
                        break;
                case MappingNotify: /* process keyboard mapping changes */
                        XRefreshKeyboardMapping(&myevent);
                        break;
                case ButtonPress:
                        XDrawImageString(mydisplay, mywindow, mygc,
                                myevent.xbutton.x, myevent.xbutton.y,
                                hi, strlen(hi) );
                        break;
                case KeyPress:
                        i = XLookupString(&myevent, text, 10, &mykey, 0);
                        if( i==1 && text[0] == 'q')
                                done = 1;
                        break;
                } /* switch (myevent.type) */
        } /* while (done == 0) */

/* Termination */
XUnmapWindow(mydisplay, mywindow);
XFreeGC(mydisplay, mygc);
XDestroyWindow(mydisplay, mywindow);
XCloseDisplay(mydisplay);
exit(1);
}
```

Further Information

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spond quite closely with the Xlib routines that generate them (though there are fewer of them, since many routines generate the same request). For example, the XDrawRectangle routine generates a PolyRectangle request, and XCreateWindow generates a CreateWindow request. X Protocol requests are variable-length data packets that begin with an 8-bit op code that identifies the type of request, followed by a 16-bit field specifying length, and one or more bytes of additional data (see figure 3). The added data might be numeric parameters and coordinates, text strings to write, or raw bit-map data in scan line order.

Requests that are queries (e.g., QueryPointer, which asks for the current location of the mouse pointer) return a 32-byte reply packet back to the client. All the requests sent during a particular connection are sequentially numbered so replies can be linked to the request with which they belong. Because network communication is such a slow process, X Window programmers try to minimize the number of these "round trips" (i.e., replies from the server to the client). Most requests do not require a reply and receive one only if they terminate with an error. Events are transmitted back to the client as 32-byte packets that contain an 8-bit code specifying the type of event.

Above the level of Xlib lies the realm of X Toolkits. These are sets of prefabricated routines, built out of Xlib functions, that allow rapid program development. Several toolkits already exist in the public domain. One, called Xtk, is supplied on the X Window tape. Xtk lets you quickly prototype user interfaces by bolting together ready-made components.

There is a well-defined style for writing X Toolkits, set down in the Standard Supplement of the X Window System Manual Set. The style is a model of good modern software engineering practice, being object-oriented in a very strong sense.

The basic data type is a structure called a *widget* (which, in Smalltalk parlance, would correspond to an object) that holds information about the state of graphical objects. Widgets belong to classes, with a full inheritance mechanism. Applications are built out of instances of widget classes.

Widgets are active entities; a widget can take input from the user and alter its display appearance by using procedures common to its class. Pop-up widgets are for representing dialog boxes and other interactive components.

Toolkits are written in plain, ordinary C. The object-oriented structure of the widget is implemented solely by careful design of the data structure and meticulous naming conventions. This demonstrates that object-oriented programming can be as much a frame of mind as a property of the language. The only drawback to the scheme is that the manual reads like a sequel to *Through the Looking Glass.* You may have to save a child from a cascade of widgets. Even pickled widgets make an appearance.

Competitive and Complementary Standards

Anyone who uses BIX regularly must surely, at some time, have bemoaned the fact that you can't send graphics in your messages. As communications become more sophisticated with the eventual introduction of public ISDNs, protocols for sending graphics material over a network will take on great importance. With X Window, it looks as if, for once, we have a chance of achieving a standard quite early in the cycle, rather than after the customary bloody war of attrition between competing proprietary systems.

The main competition to X Window appears to be Adobe's Display PostScript; but, in fact, the two systems are not exclusive and might even complement each other. It's possible to write X servers that generate PostScript output to drive PostScript devices, and it's equally possible to write interpreters that translate PostScript output into X Protocol requests so that X Window and PostScript clients can address the same server. Because PostScript offers far more powerful typographical functions than does X Window, the two could prove to be synergistic.

Sun, whose NeWS windowing system is based on Display PostScript, has indicated its intention to build in X Window support. Microsoft has also put out feelers about a possible X Window implementation of the Presentation Manager.

As for the future of the X Window System itself, the X Consortium has agreed to freeze the core specification at the X11 level for at least 3 years. This will allow software developers to work unhindered by upgrades. The principal development activity until then will be bug fixing, internationalization, an ANSI standard, extensions such as three-dimensional graphics support to the PHIGS standard, and inclusion of live video in X Windows. ■

(a) Generic Request Packet

Opcode	Data byte	Request length	More data types . . .
1 byte	1 byte	2 bytes	

← 4-byte header →

Note: Request length is measured in 4-byte units and includes the header.

(b) PolyLine Request

65	cmode	3 + *n*	Drawable	GC	List of *n* points . . .
1	1	2	4	4	4*n* bytes

← Header →

Notes:
Opcode 65 = PolyLine.
"Cmode" is the coordinate mode; 0 = relative to origin
1 = relative to last position
"Drawable" is a pointer to a window or pix map (i.e., multiplane bit map).
"GC" is a pointer to a graphics context.

Figure 3: *X Protocol request packets contain a 4-byte header and as many additional bytes as needed to communicate the request. The PolyLine request contains the information to draw a series of lines with a given line style and thickness within the graphics context.*

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THE TOKEN RING

Our newest column takes a hard look at the nuts and bolts of current technology

Editor's note: *In this issue, we inaugurate a new column by Brett Glass, a hardware designer, programmer, and author with some impressive credentials. Brett was one of the architects of Texas Instruments' TMS380 chip set (which implements the IEEE 802.5 Token Ring local-area network) and coauthored Living Videotext's ThinkTank 2.0. He founded BADGE, the Bay Area Amiga Developers' Groupe, and is an instigator of the Hackers' Conference, an annual get-together for the pioneers of the microcomputer revolution. Brett holds a BSEE from the Case Institute of Technology and an MSEE from Stanford University. In Under the Hood, Brett will present in-depth analyses of significant new technology, as well as provide technical background for understanding the material that appears elsewhere in BYTE. We feel fortunate to have a writer of Brett's caliber on-board, and we welcome your response to this new column. If you'd like to contact him personally, see the note at the end of the column.*
—KS

The IBM Token Ring has captured more than 50 percent of the microcomputer local-area-network market and more than 20 percent of all LAN applications worldwide. This specification (also known as the ANSI/IEEE 802.5 standard) got a late start relative to other LAN standards. IBM released it in late 1985, years after Ethernet and ARCnet. Why has the Token Ring become so popular so quickly? And what's really going on under the hood? In this article, I'll tell the "inside story" of the Token Ring and show why it's likely to be the dominant LAN standard by the end of this decade.

Token Ring Fundamentals

Before I go any further, it's vital to understand where the term Token Ring comes from. The nodes in a Token Ring, which can be microcomputers, minicomputers, mainframes, or other types of computer equipment, are electrically connected to one another in a "ring" configuration, as shown in figure 1.

Each node receives information from one of its neighbors (its nearest active upstream neighbor, or NAUN for short) and transmits it to the node immediately downstream. Unless a node is transmitting its own data, it passes on whatever information it receives from its NAUN verbatim. Thus, any node can transmit information to any other node by sending it through some or all of the others. The total effect resembles an endless, circular version of the party game Telephone, in which players occasionally add their own information to the circle. This is the ring part of the Token Ring.

But what is a token, and what role does it play in making the network function? Well, as mentioned above, each node on the ring can either transmit its own data or retransmit the data it receives from its NAUN. As you might expect, however, it can't do both at the same time. Thus, if two nodes on the ring try to transmit simultaneously, it's probable that one will "swallow" the other's data and keep it from propagating to the entire ring. To avoid this, the nodes take turns transmitting, keeping track of whose turn it is to talk by passing around an electronic "baton" called a token.

A token is a short (24-bit) message that says to the node that receives it, "It's your turn to send data if you want to." When a node that wants to transmit receives a token (see figure 1a), it changes the token into a frame, appending its address, the recipient's address, and the data (see figure 1b). The transmitting node is said to be in possession of the token. No other node can talk; each must obediently retransmit the data as it sees it. When the frame reaches its destination node, it is passed on (see figure 1c), with status bits within the frame changed to indicate that it was received. The frame continues moving along the ring until it arrives back at the sender.

Now, it isn't very useful for the frame to go around the ring more than once: On its initial circuit, it has already visited every node on the ring. Therefore, the sending node doesn't retransmit its own data. Instead, on recognizing its own frame, it "strips" the frame from the ring and passes a token to its nearest downstream neighbor (see figure 1d). The cycle repeats, with each node getting a chance to speak in turn.

This explanation is a bit simplistic (it doesn't include the notion of priority, for instance), but it covers the basics of the Token Ring architecture. The true brilliance of the Token Ring design lies in the subtleties added by IBM's scientists in Zurich and engineers from both IBM and Texas Instruments.

The Token Ring has the ability to prioritize access to the ring, "heal" after a cable breaks, disconnect malfunctioning nodes, and identify the locations of noisy connections within the network—capabilities absent from most other popular network standards. In the sections that follow, I'll explore some of these features in greater depth.

The Physical Layer: Logical Ring, Physical Star

I'll start my tour of the Token Ring with the lowest layer of the Open Systems Interconnection reference model: the phys-

continued

ical layer. The first thing you'll notice if you look at the hardware of a typical Token Ring is that it doesn't look like a ring at all; rather, it resembles a star (see figure 2). Each network node uses a single two-pair cable to connect to a device called a wiring concentrator, or, in Token Ring parlance, a medium access unit (MAU). One pair is for receiving data, the other for sending data.

The star-shaped wiring topology has two advantages. First, only one cable is needed from each station on the network to a single, centralized location. (Telephone systems are wired the same way. In fact, IBM suggests that the same conduits and wiring closets be used for both.) This design requires more cable than if you were to simply connect successive nodes, but it makes it much easier to add new nodes and remove old ones.

The second advantage is that it's easy to bypass an inactive or malfunctioning node at the MAU by connecting its upstream node directly to its downstream neighbor (see figure 3). When you turn a workstation off or when a node leaves the ring because of a malfunction, current ceases to flow in the "phantom circuit" (see figure 4) associated with that node. A relay opens in the MAU, and the ring reconfigures itself without the inactive machine.

If only one MAU is in the network, the MAU configures all the stations attached to it into a ring. If there is more than one MAU, each links its stations into a single ring that runs through all the MAUs.

Each node attaches to the MAU via a special four-conductor connector. The connector is hermaphroditic; that is, it can mate with identical connectors. When a connector is unplugged, shorting bars inside join the send circuit to the receive circuit, allowing the attached device to perform loopback tests on itself and the cable.

The connections between a node and the remainder of the Token Ring are transformer-coupled. This limits common-mode voltages and breaks ground loops that could cause harmful interference on the ring.

Longer Distances

In a bus-based network, like ARCnet and Ethernet, each network node must be able to be heard by all the others, thereby limiting the total size of the network to the distance that a single adapter's signal can reach. But since each node on the Token Ring needs to send a signal only as far as the next node, a Token Ring can be much larger. A Token Ring node can be

continued

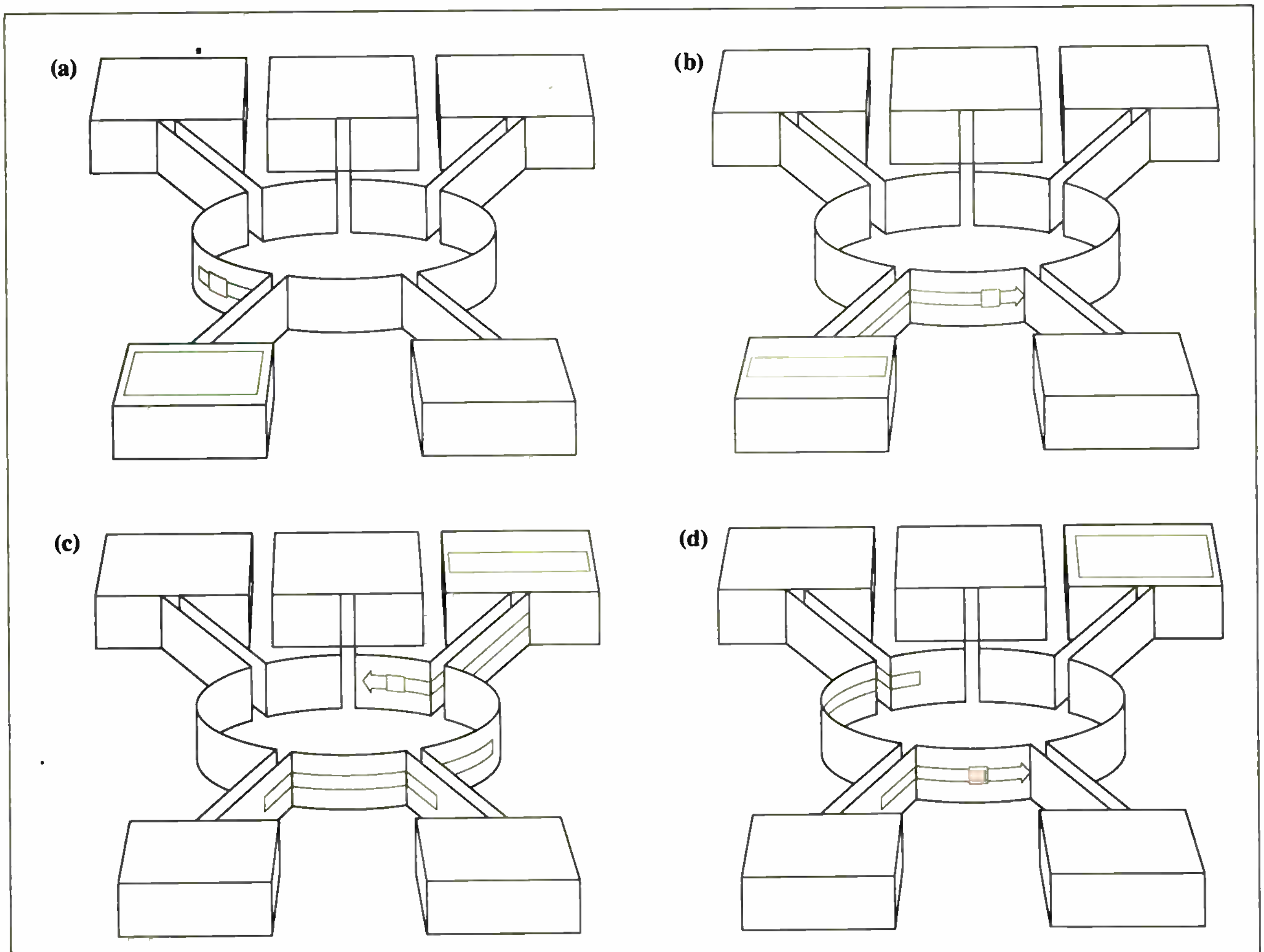

Figure 1: *A functional overview of the Token Ring.* **(a)** *The sending station waits for a token;* **(b)** *the sending station makes the token a frame by adding addresses and data;* **(c)** *the receiving station copies data and sets the "copied bit"; and* **(d)** *the sending station removes the data and generates a new token. (Figure courtesy of IBM Corp.)*

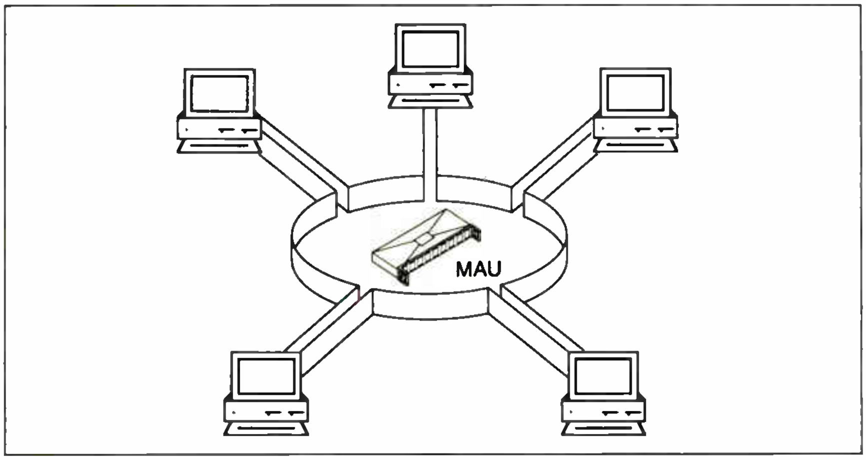

Figure 2: *At the lowest level, the physical layer, a Token Ring looks like a star (hence the term "star-wired ring topology") in which each node is connected to a wiring concentrator, the medium access unit.*

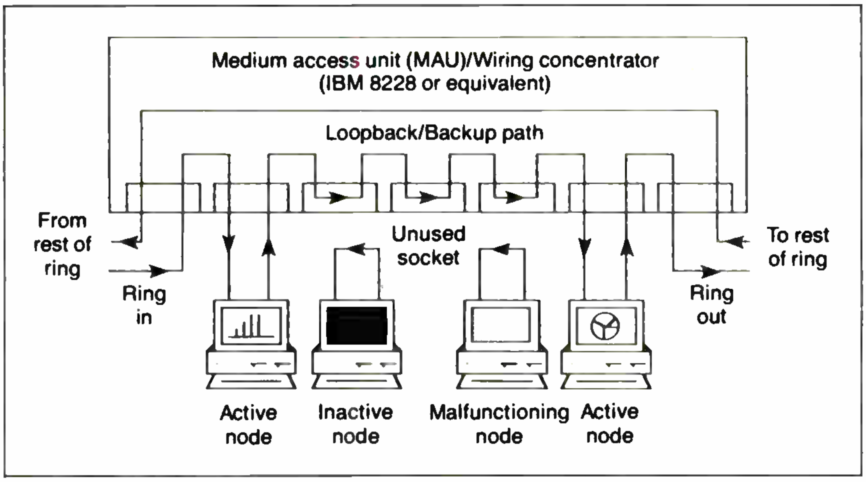

Figure 3: *Signal flow in the medium access unit. Note that any or all nodes in the star-wired ring can be bypassed if necessary.*

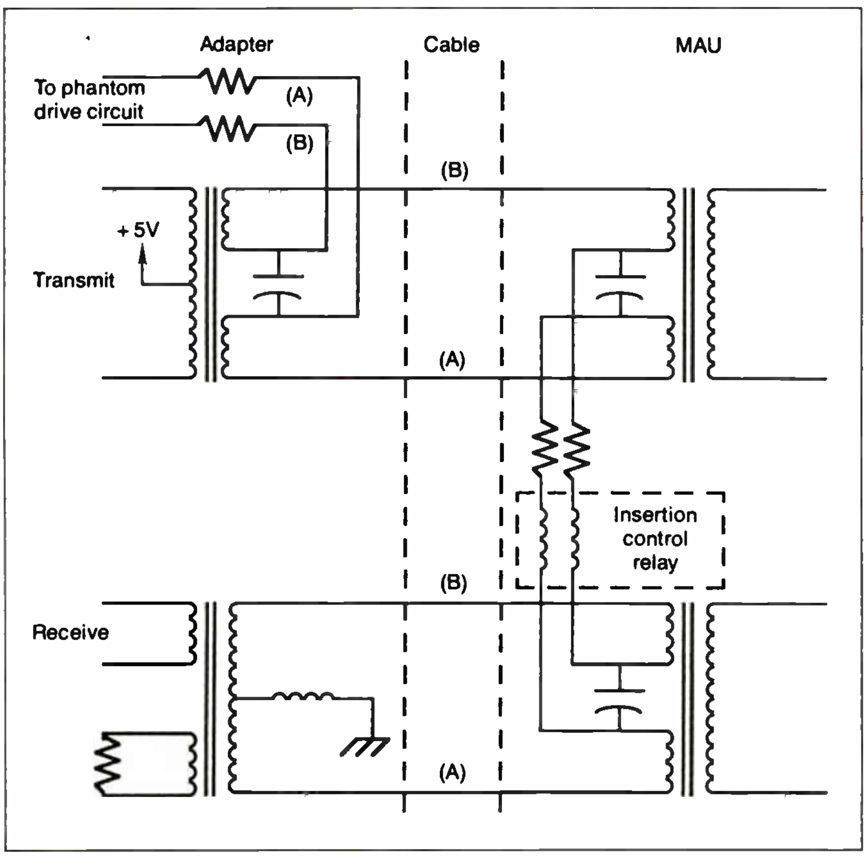

Figure 4: *The "phantom circuit" is essential to ring maintenance. If a node is on a damaged section of the ring or if requested by the local-area-network management program, a node removes itself from the ring by removing its voltage from the circuit (deactivating the phantom circuit). The presence of too much or too little current in the phantom circuit indicates a wiring problem. (Figure courtesy of Texas Instruments.)*

Encoding

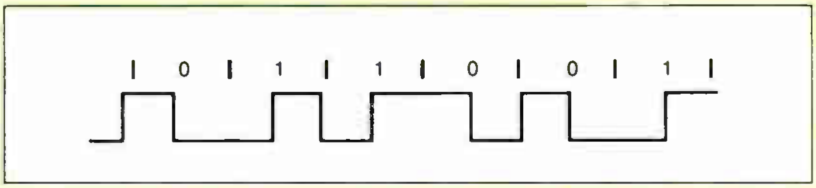

Figure A: *Manchester encoding.*

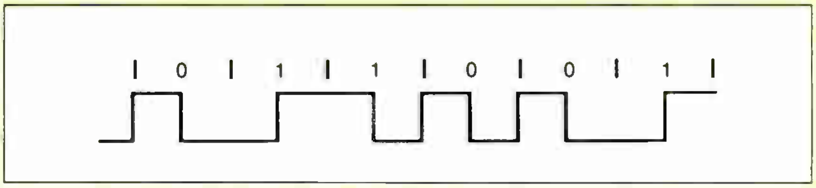

Figure B: *Differential Manchester encoding.*

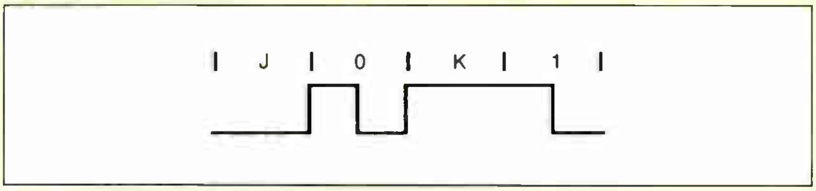

Figure C: *Manchester code violations.*

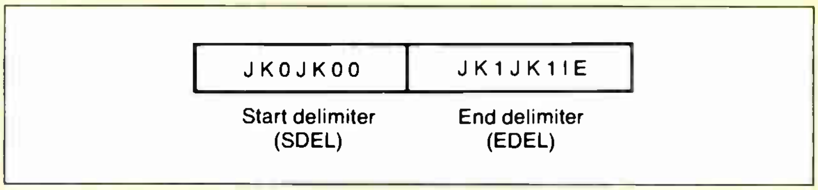

Figure D: *The abort delimiter consists of a start delimiter and an end delimiter together.*

The Token Ring uses differential Manchester encoding to transmit bits on the ring. Manchester encoding schemes are "self-clocking"—they attempt to guarantee enough up-and-down transitions in the incoming signal so that it's easy to predict when the next transition is going to occur.

Manchester and differential Manchester encoding require that there be a transition in the middle of each bit. In Manchester encoding (see figure A), the direction of the midbit transition determines whether the bit was a 0 (high-to-low transition) or a 1 (low-to-high transition).

In differential Manchester encoding (see figure B), the bit is a 0 if a transition occurs at the beginning of the bit time and a 1 if there is no transition at the beginning. Differential Manchester encoding was chosen for the Token Ring because it is polarity-independent, making the Token Ring easier to wire. The transmit and receive pairs and the transformers that drive them can be connected without keeping track of "positive" and "negative" leads.

The Token Ring also uses Manchester code violations—occasional bits without transitions in the middle—to make delimiters completely unambiguous (see figure C). Besides 0 and 1, the Token Ring standard defines two "non-data" bits: J, a 1 bit without the middle transition, and K, a 0 bit without the middle transition.

When it's not sending data, a node "idles"—usually by transmitting 0 bits continuously. This provides the downstream node with a large number of transitions with which it can synchronize its clocking circuits. In no case should a station ever transmit more than 5 consecutive half-bits without a transition. If a node does not see a transition on its input after 5 half-bit times, a "BURST5 Error" has taken place. The node assumes that a serious ring problem has occurred and attempts to reestablish contact with its neighbors.

When the ring is idle, the stations on the ring continuously relay a token. A token consists of 3 bytes: a start delimiter, an access control field, and an end delimiter (see figure D). The most-significant bit of each byte is transmitted first; this is the reverse of Ethernet, RS-232C, and most other serial communications standards. The start delimiter and end delimiter contain Manchester code violations (Js and Ks); this guaran-

up to 300 meters away from its MAU, while an Ethernet (without repeaters) can span 500 meters maximum.

The MAC Sublayer

Let's examine the signals the Token Ring's physical medium carries and the techniques used to arbitrate access to the ring: the media access (MAC) sublayer.

Data is transmitted on the ring using differential Manchester encoding (see the text box "Encoding" above), typically at 4 megabits per second (IEEE will release a 16-Mbps Token Ring standard soon). When the ring is idle, the stations on the ring continuously relay a token (sometimes called a "free token") to one another.

When a node that wishes to transmit receives a token, it examines the priority bits to make sure its message has a priority at least as large as that of the token. If it does, it converts the token into a frame. Occasionally, a node will "decide" to abort a transmission in the middle. To do so, it sends an abort delimiter sequence, which consists of the start delimiter and the end delimiter together.

Addressing on the Token Ring

The IEEE 802.5 specification allows address sizes on the Token Ring. Besides a 6-byte address (the same length as in

JK0JK00	PPPTMRRR	JK1JK1IE
Start delimiter (SDEL)	Access-control field (AC)	End delimiter (EDEL)

PPP — Priority bits. Identify the minimum priority level for a message to use the token.
T — Token bit. Identifies the data as a token rather than a frame.
M — Monitor bit. Identifies the token as a "priority token."
RRR — Reservation bits. Normally used only in frames.

The end delimiter has two fields:

I — The Intermediate Frame Bit. Indicates that the frame is part of a sequence. (Not used in most implementations.)

E — The Error Detected Indicator (EDI). Set if an error is detected. Any node on the ring that finds an error can set the indicator.

Figure E: *Token format.*

	SDEL	AC	FC	DEST ADDR	SRC ADDR	INFO	FCS	EDEL	FS
Length (bytes)	1	1	1	6	6	Varies	4	1	1

SDEL — Start delimiter. Same as in the token.
AC — Access-control field.
FC — Frame-control field.
DEST ADDR — Destination address field.
SRC ADDR — Source address field.
INFO — The data in the frame, possibly preceded by routing instructions.
FCS — Frame check sequence. A 32-bit cyclic redundancy code for the FC, DEST ADDR, SRC ADDR, and INFO.
EDEL — End delimiter. Same as in the token.
FS — Frame status. Result of frame's trip around the ring.

Figure F: *Frame format.*

tees that they will not be mistaken for ordinary data bytes.

When a node that wants to transmit receives a token, it changes the token into a frame, appending its address, the recipient's address, and the data (see figure E). The frame also contains a frame-control field, a cyclic redundancy code, and a status byte.

In the event that a node needs to abort a transmission in the middle, it sends an abort delimiter sequence, which consists of the start delimiter and the end delimiter together (see figure F).

other IEEE standards), "short" 2-byte addresses are available for small networks.

The source address and destination address fields of a frame can do more than identify a single sender and recipient for the frame. The most significant bit of a source address is the routing information indicator, used when two or more rings are interconnected by nodes called bridges. When this bit is a 1, it indicates that the frame will specify not only the address of the destination node, but also a route to it—possibly spanning several rings. This technique is called source routing. Because the route is already worked out, the job of a bridge is simple. All it needs to do is follow the sender's routing instructions, which are tacked onto the beginning of the INFO field.

Destination addresses also have bits and bit patterns with special significance. It's possible to earmark frames for a server, a group of nodes, or all nodes (a broadcast address).

Functional addressing is a powerful feature built into every Token Ring adapter. By sending a frame to a functional address, a node can use network services—like a parameter server, an error monitor, or a network manager—without knowing the address of the nodes that provide those services to the ring.

The Active Monitor

So far, most of the features I've looked at assume that the ring is up and running properly. But what if something goes wrong? When you first bring the ring up, or when any malfunction requires reconfiguration, the nodes on the ring test their equipment and send signals to one another to identify their NAUNs.

The nodes select one node (normally the active node with the numerically largest address) as the active monitor. This node is designated to perform special "watchdog" functions. The process by which neighbors are identified and the active monitor is chosen is called "beaconing." Once the active monitor has been chosen, it clears the ring and issues a token to restart normal ring operation.

The most basic function of the active monitor is to provide a clocking signal for the Token Ring. All other stations on the ring "listen" to this signal and synchronize with it. (The active monitor uses its own crystal to clock the data it transmits.)

The active monitor's next responsibility is to ensure that a token is circulating on the ring. First, the active monitor has to make sure that the token "fits" on the ring by introducing a 24-bit shift register into the ring. (Each node is designed to incur a minimal delay, typically 1 to 2 bit times. The wiring of the ring may not have 24 bits of delay all by itself. If the signal travels on the ring at two-thirds the speed of light, the ring needs to be $\frac{2}{3} \times 3 \times 10^8$ meters/second $\times$ 24 bits / $[4 \times 10^6$ bits/second$]$ long, or at least 1200 meters long, for the wiring to delay the signal 24 bit times.)

The active monitor also watches for "lost tokens." If it does not see a frame or a token go by within any 10-millisecond period, it clears the ring and starts a new token circulating. These actions keep the token from being irretrievably lost if a station fails to retransmit it.

The active monitor checks for frames and priority tokens (tokens with a priority greater than 0) that circulate around the ring more than once. It does this by

continued

checking the setting of the monitor bit in the access control (AC) field of each token or frame it sees. If the active monitor receives a priority token or frame with the monitor bit cleared, it sets the bit as it passes on the information. If the token or frame returns when it should not, the active monitor will discover that the monitor bit is already set to 1, and it will immediately purge the ring of data and restart the token-passing process.

Finally, the active monitor must "reassure" the other stations on the ring that it is present and working. To do this, it broadcasts an active-monitor-present frame to the rest of the ring. If an AMP frame fails to circulate every so often, another station (the standby monitor) takes over the active monitor's job.

A Matter of Priority

On most other LANs, all nodes compete on an equal basis for use of the physical medium. For instance, there's no way for an Ethernet station to say, "I have a very important message to send; please let me go next!" As an Ethernet gets crowded with traffic, it becomes likely that collisions, or just bad luck, will cause a delay of high-priority messages. We say that networks like the Ethernet are not "deterministic"—there's no upper bound on the amount of time it will take a node to gain access. In some situations, like sensitive control applications, the delays can be disastrous.

Some networks are deterministic but lack priority structures. ARCnet, which is a token-passing bus network, guarantees that each node can talk in turn, but the turns are always distributed evenly. There's no provision for getting an urgent message to its destination faster.

The Token Ring, however, has a unique scheme that provides for multiple priority levels *and* egalitarian, round-robin access on each level. The key to this scheme is the AC field present in each token or frame, which carries priority information and accepts "reservations" for the next use of the token.

After a station transmits a frame, it examines the AC field when the frame returns. If the reservation bits of the AC field contain a number greater than the priority level on which the station is currently transmitting, it means that one or more nodes wish to transmit at the higher priority as soon as possible. The sender emits a token with the higher priority. Since a station can use only a token that has a priority less than or equal to the priority of the frame that it wants to transmit, the token travels the ring until it reaches the station that urgently needs it.

Figure 5 shows an example of the Token Ring's reservation system at work. In the simple three-node ring shown, with nodes at 5, 7, and 12 o'clock, station 5 is transmitting. Station 7 would normally use the token next, followed by station 12. But since station 12 has an urgent message to transmit, it changes the reservation field at the beginning of station 5's frame. Station 5 honors the reservation, emitting a priority token that station 7 cannot use.

Once station 12 is through transmitting and the frame has completed its circle, station 12 strips its frame from the ring and passes the priority token onward. The priority token completes its loop (being used in turn by any other nodes having urgent messages) until it returns back to station 5 (which originated the priority token). Station 5 then demotes the token to a lower priority and gives station 7 its turn.

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The Token Ring priority system has some especially nice properties. First, the priority of the token is always restored by the same node that raised it. Thus, a request for a high-priority token does not destroy the round-robin scheme on a lower level.

Second, it can recursively nest on all eight possible priority levels. Suppose, for instance, that station 5, from the previous example, had placed a reservation for priority level 6 while station 12 was transmitting (see figure 6). Station 12 would elevate the priority of the token exactly as station 5 did and allow it to circulate. Station 12 would then restore the priority to 3. Station 5, in turn, would restore the priority of the token to 0 again.

You can now see why the active monitor watches for recirculating priority tokens. Since each station that raises the priority of a token is responsible for lowering it again, a recirculating priority token indicates that a node has malfunctioned.

This scenario demonstrates only two levels of nested priority, not the most complicated (seven-level) case. But no matter how deeply priorities are nested, the result is the same: Round-robin order is maintained on each level, and the next node to transmit is always the one with the highest priority. These orderly and evenhanded procedures for selecting the next node to transmit pay off especially well under heavy loads. When many nodes contend for use of the network, a 4-Mbps Token Ring can perform nearly as well as a 10-Mbps Ethernet, while a 16-Mbps Token Ring can provide more than double the throughput.

I've already discussed one way in which faulty equipment can be removed from the Token Ring: the phantom circuit. Nodes that don't pass a thorough self test verifying that they can communicate properly with the rest of the ring remove themselves from the network. A more subtle feature, however, is the Token Ring's ability to localize intermittent faults and noisy links.

As you may recall, each node examines every token or frame it sees and sets the error-detected indicator if it detects any errors. The error-tracking process does not stop there. Each node maintains an internal count of how many times it set the EDI. Network management software can access this counter. If there is an intermittent or noisy path in a Token Ring network, the system can always track it down to a specific stretch of cable (a "failure domain") by determining which node is just downstream.

In certain cases, it's also possible to

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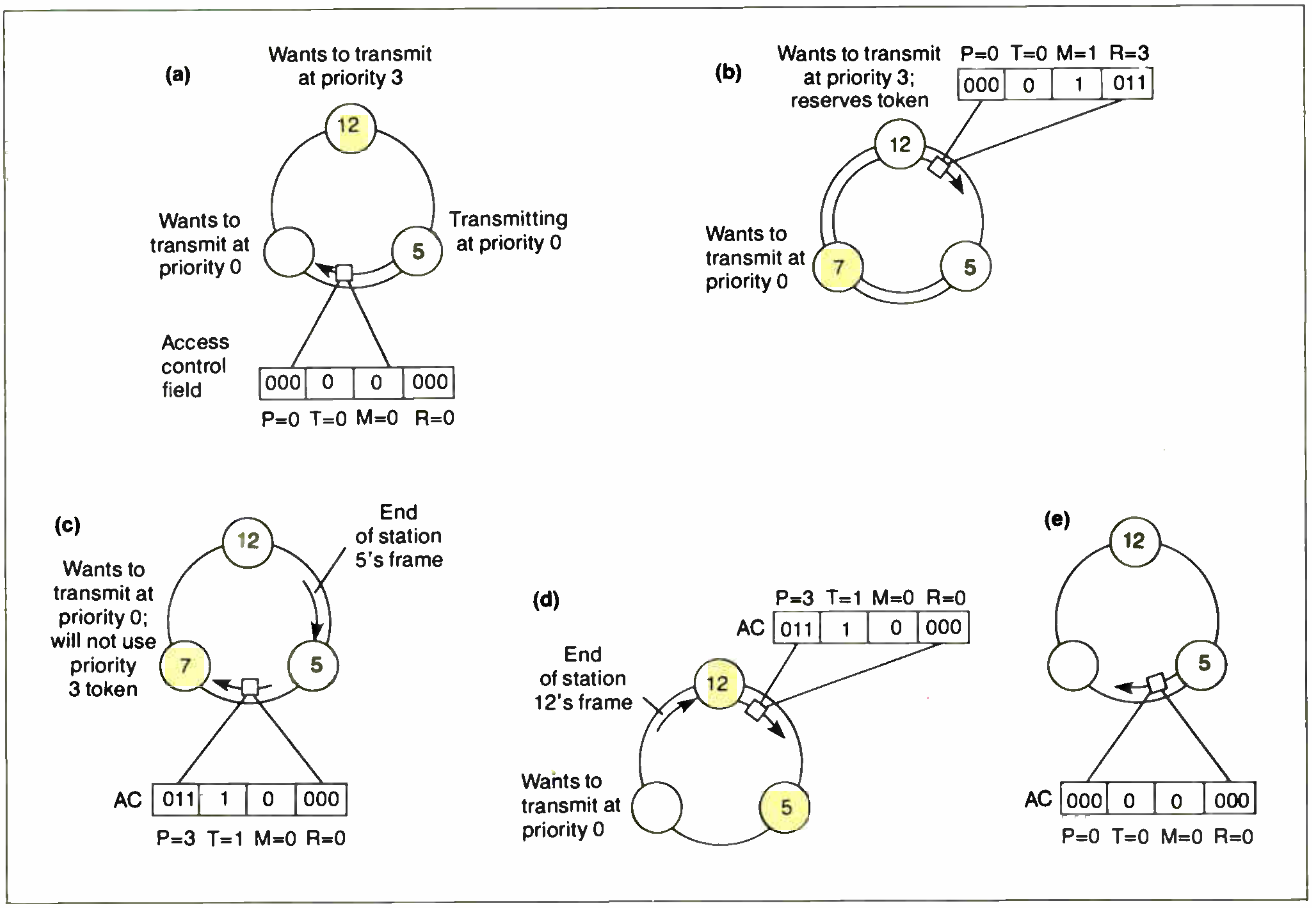


Figure 5: *Placing a reservation.* **(a)** *Station 5 is transmitting a frame to station 7 on the ring. Normally, station 7 would be the next node to get the token, even though station 12 had a higher-priority frame to transmit.* **(b)** *Station 12 sees that the reservation field of the frame is less than 3 and places a 3 there. The frame continues back to station 5, which absorbs the frame and emits a token.* **(c)** *The token emitted by station 5 had priority 3, so station 7 does not use it. The token continues on to station 12, which uses the token to transmit a frame.* **(d)** *When station 12 has finished transmitting, it releases a token, still at priority level 3.* **(e)** *Station 5 receives a token at priority level 3 and "remembers" that it was the one to raise the priority of the token. It therefore restores the priority to 0 so that station 7 will have a chance to transmit.*

Figure 6: *If, in figure 5, station 5 had placed a reservation for priority level 6 while station 12 was transmitting, station 12 would elevate the priority of the token, allow it to circulate, then restore the priority to 3. Station 5, in turn, would restore the priority of the token to 0 again.*

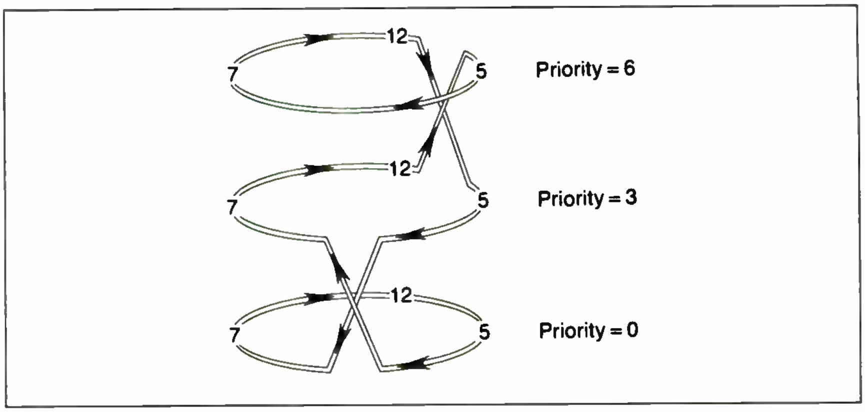


Figure 7: *The Token Ring can reconfigure itself to bypass shorts or breaks in a cable. In this diagram, the ring continues to function despite a cable break between MAU 3 and MAU 4.*

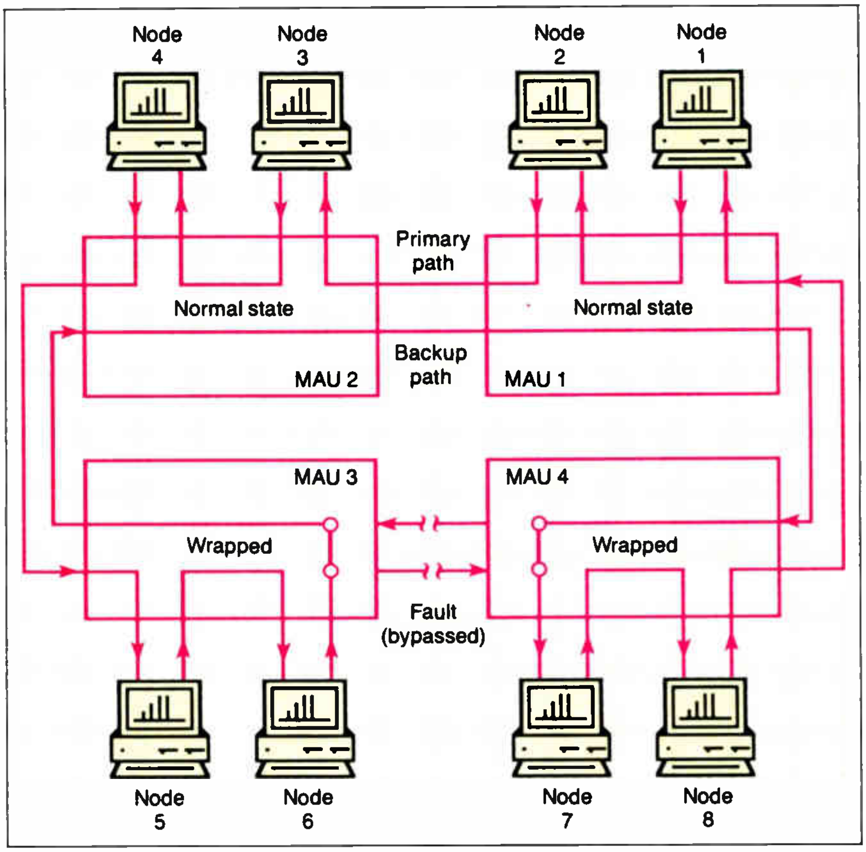
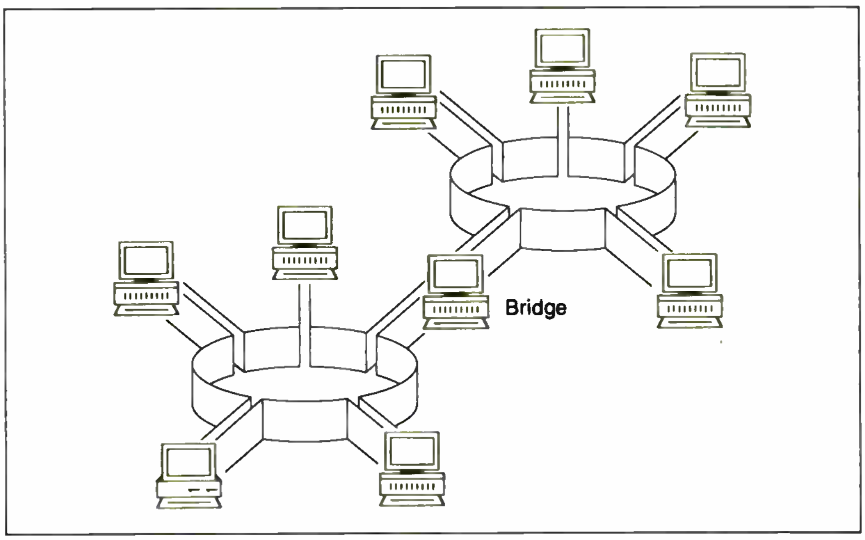


Figure 8: *A Token Ring bridge, a node that is on two rings at the same time and can pass frames from one ring to the other. (Figure courtesy of IBM Corp.)*



bypass a run of cable that has been completely destroyed. Look at figure 7 and notice the backup path. When two or more MAUs are connected in a ring, this path goes unused, because the ring goes in one end of each MAU and out the other.

But suppose that, for some reason, one of the cables connecting the MAUs into a ring fails. To get the ring up and running again, all you need to do is to remove the failed cable from both MAUs, allowing the backup path, which runs through all the MAUs, to complete the loop. Voilà! The ring is up and running again. If the MAU is an "intelligent wiring center" (IBM doesn't make one, but Proteon and other vendors do), you may not even need to remove the cable. The network management software is able to reroute the ring without any human intervention whatsoever.

Bridges and Backbones

A bridge is a node that is on two rings at the same time and is able to pass frames from one ring to the other. Figure 8 shows a simple bridge. Figure 9 shows multiple rings bridged to a backbone ring. In large installations, a backbone ring connects many rings to each other. It consists of a series of bridges, each connecting a local ring to the backbone.

NetBIOS and the Token Ring

Originally, the IBM NetBIOS (see my article "Understanding NetBIOS" on page 301) had to handle many of the same functions that the Token Ring provides. The firmware present on most Token Ring adapters (the LLC sublayer) orders packets and ensures their delivery. Therefore, the NetBIOS API (Application Program Interface) is provided by a NetBIOS emulator.

Despite the extra layer of interface, the Token Ring card usually performs better than the original IBM PC Network.

Token Ring Chip Sets

As of this writing, three chip sets implement the Token Ring architecture. The two produced by IBM and Ungermann-Bass are proprietary and not available to the general public. The third, the Texas Instruments TMS380, is available to all who wish to build an interface to the Token Ring.

The TMS380 chip set consists of five parts. The two Ring Interface chips (TMS38051/52) contain the analog components to interface to the ring. The Protocol Handler (TMS38020/21) manages the bit-level ring protocols.

The Communications Processor (TMS38010) contains a 16-bit microprocessor and 2.75K bytes of RAM; it executes firmware (co-developed by Texas Instruments and IBM) from a ROM in the Protocol Handler. The System Interface (TMS38030) connects the whole package to a Motorola or an Intel microprocessor bus.

We can expect the chip set to shrink to two chips soon, and to a single chip eventually. IBM uses its proprietary chip set on the PC and PS/2 Token Ring cards, but it uses the Texas Instruments chip set on the Token Ring adapter for the RT. This is a good indication that the two implementations are compatible.

As this article went to press, the IEEE 802.5 committee was finalizing the text of the standard for the 16-Mbps Token Ring, and IBM released new dual-speed (4-/16-Mbps) Token Ring adapters. In-

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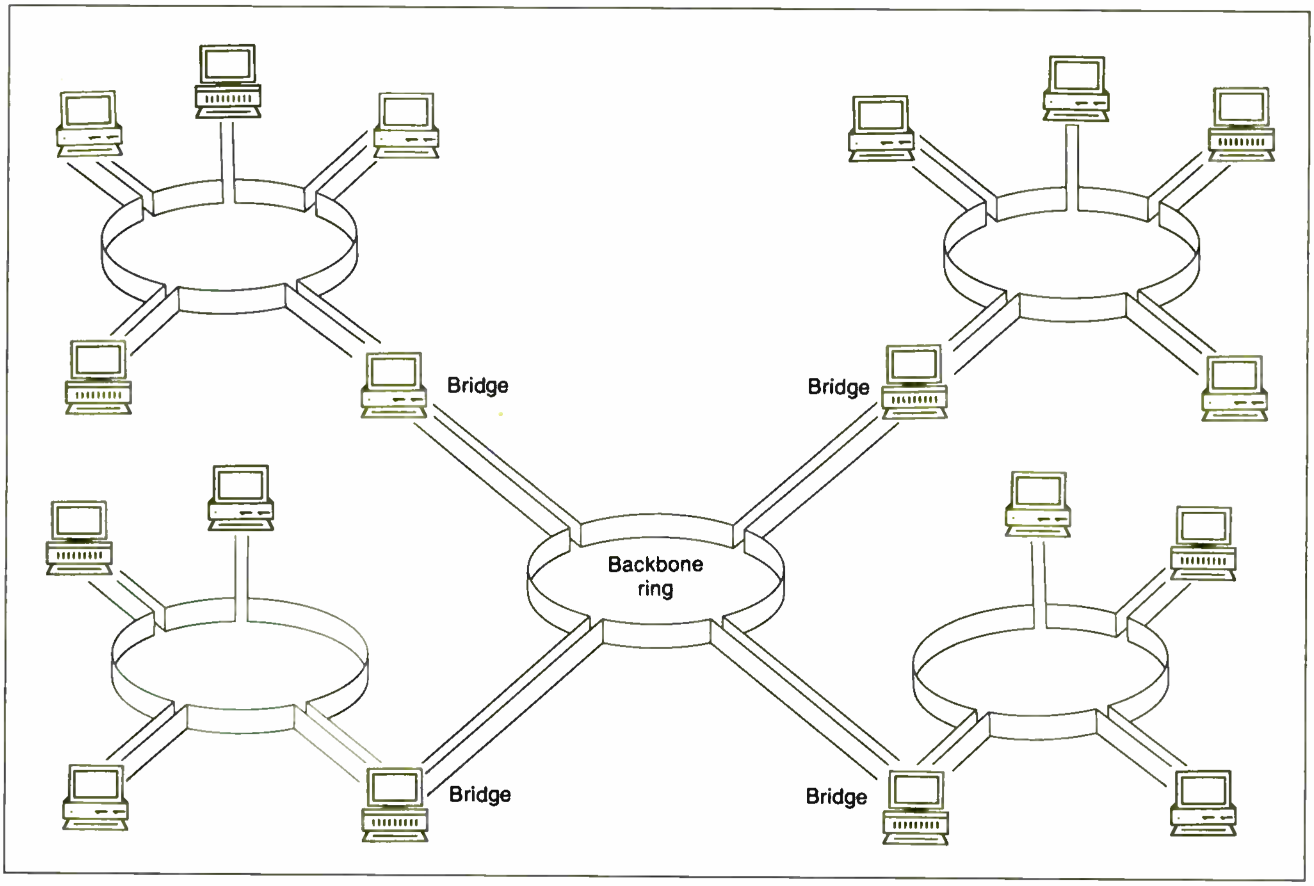

Figure 9: *A backbone ring consists of a series of bridges in a ring, each connecting a peripheral ring to the backbone.*

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corporated in the new boards is Early Token Release, which lets more than one frame (but only one free token) occupy the ring at one time. A proposal that may be adopted soon describes dual rings that rotate in opposite directions and merge to form a single ring if a cable fails. This feature is supported by Proteon but not by IBM.

An Animated Demonstration

This article has covered much of what there is to know about the Token Ring. For those readers who want to learn more or who want a graphical explanation, I've saved a fun and interesting surprise for last. The marketing folk at IBM's Research Triangle Park facility have developed a freely redistributable animated presentation on the Token Ring that will run on any IBM PC with a CGA.

First, download the file TOKNDEMO.ARC from the BIX listings file area "FROMBYTE88." (Warning: It's almost 180K bytes long.) Use PKXARC to unpack it onto a formatted floppy disk. Make the floppy disk the logged drive and type AUTOEXEC. You'll see a wonderful interactive demonstration of tokens running around rings, changing into frames with messages, shifting priorities, and vaporizing mysteriously. (Watch out for the mischievous starship *Enterprise*! The demonstration software uses a special technique to produce up to 20 simultaneous colors on an IBM CGA and isn't guaranteed to work with all EGA or VGA implementations. However, you should still be able to follow the demonstration (perhaps sans some of the brilliant colors) on almost any compatible system. Have fun! ■

Many thanks to Leon Adams and Leslie Price of Texas Instruments for providing vital materials for this article. Thanks also to IBM for use of diagrams and the Token Ring interactive demonstration.

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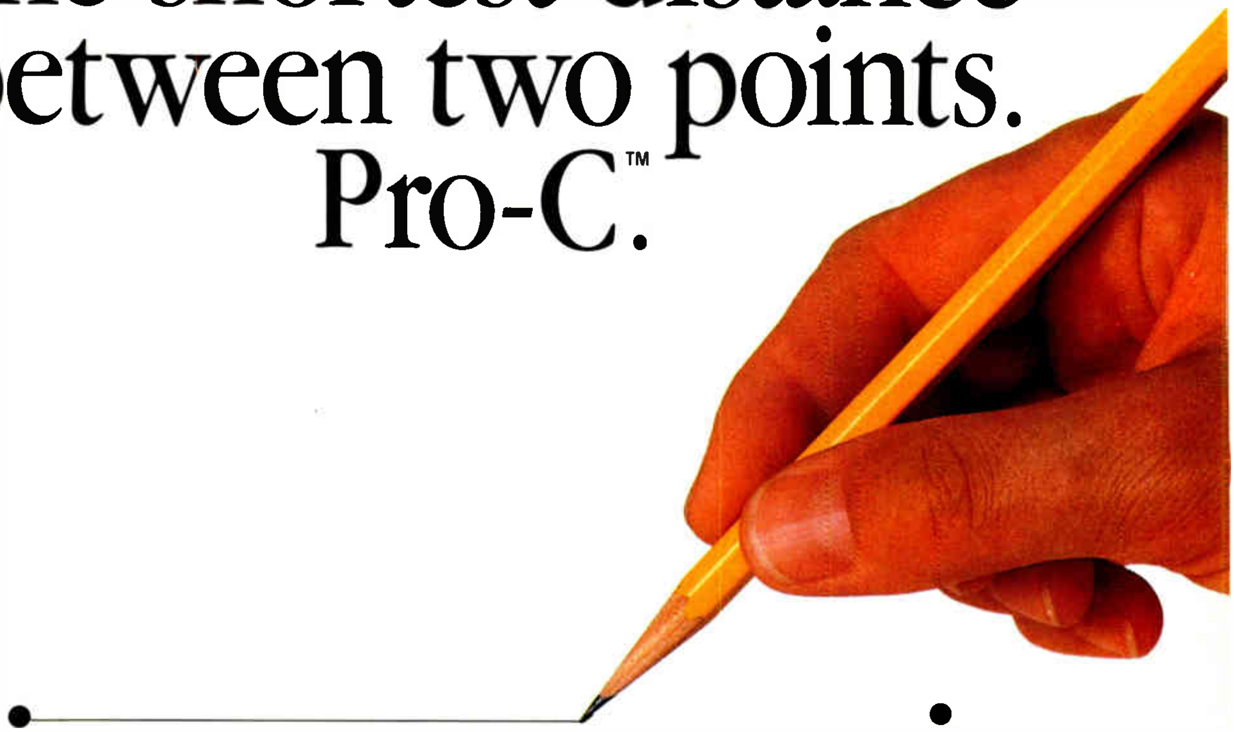

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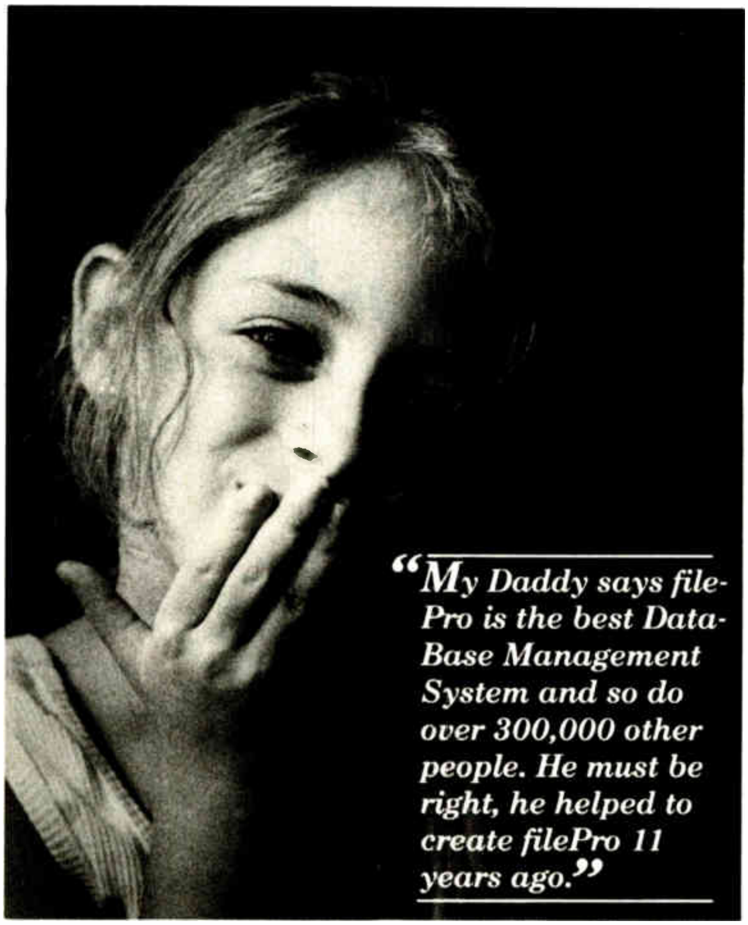

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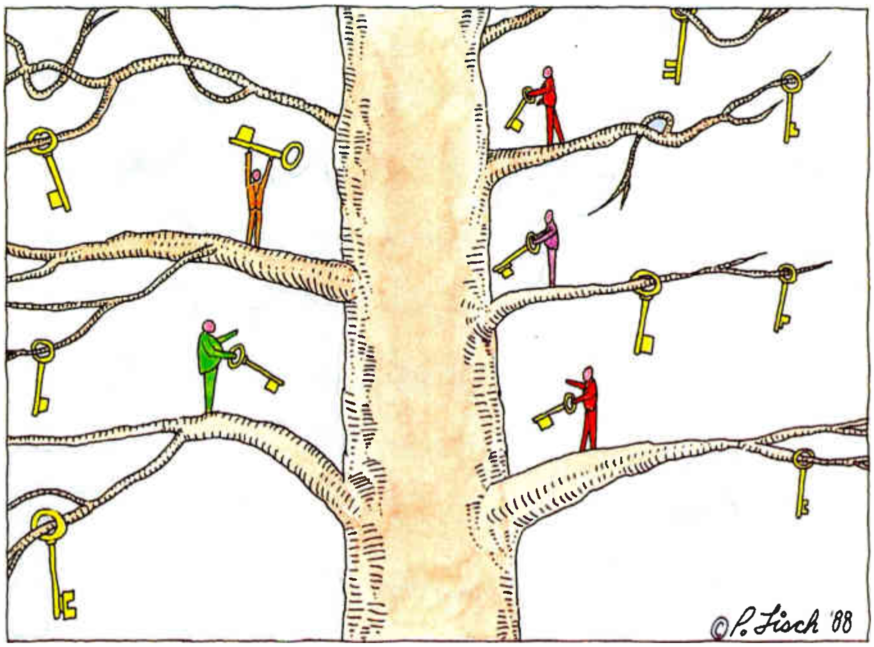
TREES 'N KEYS, Part 1

Keyed file systems can help unlock the data you've got stored in humongous databases

We have stepped into the era of big disks; I mean *big* disks. Not 2½ years ago, a full-height 10-megabyte hard disk drive was a respectable piece of hardware. Nowadays, you'd be lucky to find one in a flea market. A 20-megabyte half-height drive is now the *minimum* mass storage device a serious purchaser of microcomputers will settle for; and even so, the 20-megabyte hard disk drives are fast fading behind hedges of 40- and 80-megabyte drives. A better-than-100-megabyte hard disk drive is no longer something you hear about, it's something you've got your eye on for when the price comes down to within arm's reach of your budget. Then there's the gluttonous promise of optical storage.

This portends not only thousands of files stored in the space that once held only 360K bytes, but also the proliferation of large files—files holding megabytes' worth of information. Of course, as wonderful as it is to have the capacity for such giant databases, the very size of the files makes retrieving information from them that much tougher (read: takes longer).

Disk drive manufacturers can help some: They can reduce seek time, provide caching on the disk, and so on. Adding more buffers to your operating-system's file management handling can help, too, but there's a limit to what all this caching and buffering can do. You can stretch that limit considerably if you work on the structure of your data, not just how you retrieve it.



Keyed Files

I'll start the discussion of keyed file systems (KFSes) with an analogy: a drawer full of manila folders—the kinds with the raised tabs. Each folder holds several pages' worth of information on a customer. When you open the drawer, you're faced with an orderly arrangement of alphabetized customer names. So, when your boss swoops into your office unannounced for the latest lowdown on a given account, you can be in and out of the drawer with the goods in a matter of seconds.

In this analogy, the drawer is the database, consisting of two parts: The tabs represent the key file, and the papers within each folder represent the data file. The information on a given tab is referred to as a *key* (hence the term *key file*), a unique pointer to the information (the papers) associated with that key. The primary function of a KFS is similar to that of the drawer example: You give the database a key, and the program returns the information associated with that key.

Figure 1 graphically represents a simple KFS. Each entry in the key file is composed of a key and a data pointer. The data pointer indicates an offset into the data file where the record attached to the given key is located. So, in this example, we can see that Henry Carls lives at 100 South Park Ave.

Applications of KFSes are often similar to the uses of a filing cabinet: A database of sales history records might be keyed by client name or salesperson; a school enrollment database might have a data file of student information keyed by social security numbers; a general-ledger database might contain transactions keyed by ledger account numbers.

Of course, a KFS has some advantages over a filing cabinet; otherwise, we'd all pick manila folders over microcomputers when it came time to build a database. The two most critical assets are speed

continued

ILLUSTRATION: PAUL FISCH © 1989

(you want to locate a customer's data from a list of 10,000 names in seconds rather than minutes) and the ability to handle *large* databases: Hundreds of thousands of records should not strain the KFS. I'll address the issue of speed first; the issue of database size gets taken care of in the process.

Trees

Based on the premise that the most important job of a KFS is locating keys, a good bet is that the KFS will spend the lion's share of its time handling searches in the key file. I'm assuming that the data pointer associated with a key is contiguous with the key, so once the key is found, retrieving that data requires only one disk access. Drawing from the analogy of a sudden request from the boss, the KFS will have no foreknowledge of which key a user might request.

This means that you have to be careful about choosing the means by which the key file is maintained. Storing keys in a hodgepodge won't work at all, since searching for a key would require, on the average, that the system examine half the keys. You might try storing the keys as a huge, sorted, one-dimensional array, but that means that every time you add a new key, the system has to shift piles of keys around to make a "hole" at the proper place in the list for the new entry (a process known as *insertion sorting*). A singly linked or doubly linked sorted list (described in next month's column) solves the insertion problem, but then you have to come up with some mechanism to guarantee that the program won't have to perform a disk access every time a key is examined (looking for a key in a 5000-entry file would take an average of 2500 seeks).

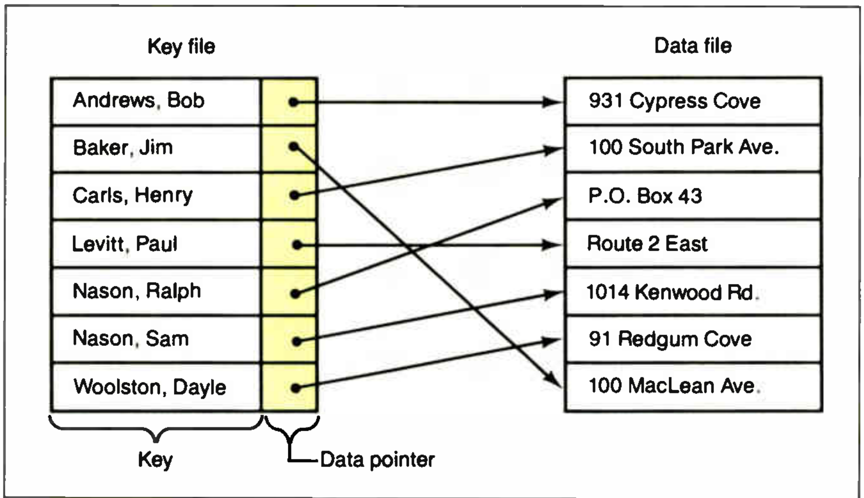


Figure 1: *A super-simple KFS. The key file holds keys and attached data pointers. Each data pointer is an offset into the data file where the associated data is located.*

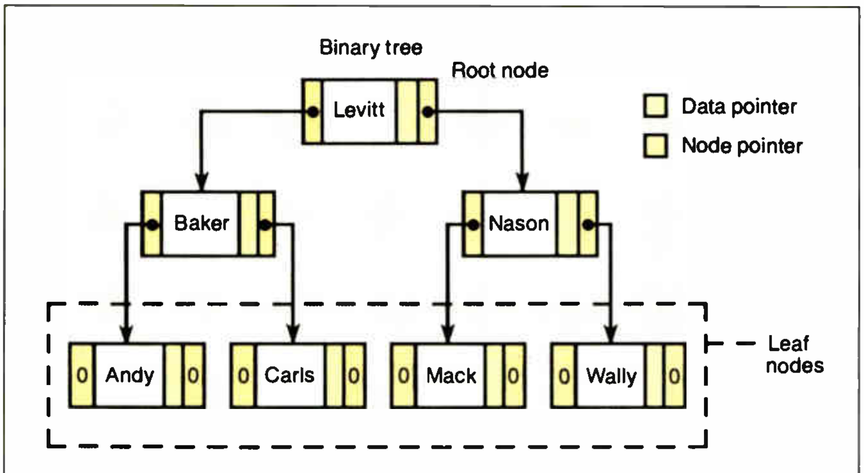


Figure 2: *A binary tree. The search for a particular key begins on the root node. Key-node pointers, flanking the key and its associated data pointer, point "down" the tree to other key nodes.*

The key files used by the system that I present here are stored using a B-tree data structure. The B-tree is often confused with the binary tree, but actually the B-tree is a step up in sophistication. All the algorithms I'll use for managing the B-trees have corresponding algorithms in binary trees. I picked the B-tree structure because of its elegance and because it provides speed when used with a large database. Many professional database packages use variants of the B-tree data structure; Btrieve (SoftCraft, Austin, Texas) and db_File (Raima Corp., Bellevue, Washington) come immediately to mind.

Examine the binary tree shown in figure 2. Notice that each entry in the file contains a key field and a data pointer, as in figure 1. Now, however, I've flanked each key and data pointer with two *key-node pointers*. Each unit—consisting of a key, data pointer, and left and right node pointers—is referred to as a *node*.

Moving from any node through its left node pointer, you go "down" the tree to nodes with keys that are lexicographically less; following the right node pointer, you move to nodes with keys greater than the current key. (Note: For the remainder of this article, I'll simply say "less" or "greater" when comparing one key to another. The system I present here stores keys based on string comparisons, but you can easily modify it to store keys based on numerical comparisons.)

Figure 3 shows a B-tree key file. Now each node holds multiple keys—four, in this example. As in the binary-tree example, the pointer to the left of a key points to nodes with lesser keys, and the pointer to the right of a key points to nodes with greater keys.

Let's say that you want to search a file of 100 entries in a binary tree for a specific key. By beginning at the root and determining whether your search item is less or greater than the key in the root node, you can eliminate half of the tree (unless you're lucky and the sought-after key is in the root). You've eliminated 50 keys from a search of 100 keys. Moving down a level and examining the next node again eliminates half: 25 keys remain for the routine to sift through. The third search reduces the number to 12, and the process continues. If your desired key lies on the bottommost level,

continued

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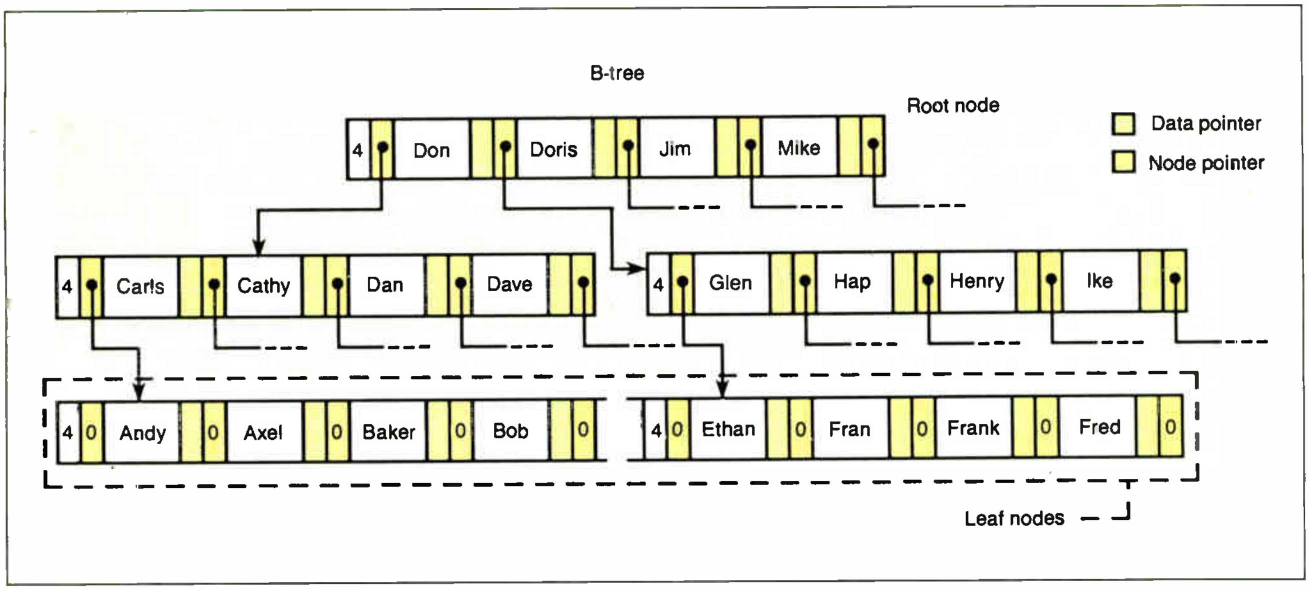

Figure 3: *A B-tree of order 4. Now, each node holds multiple keys. (Note the dashed-line key pointers leading to nodes not shown.)*

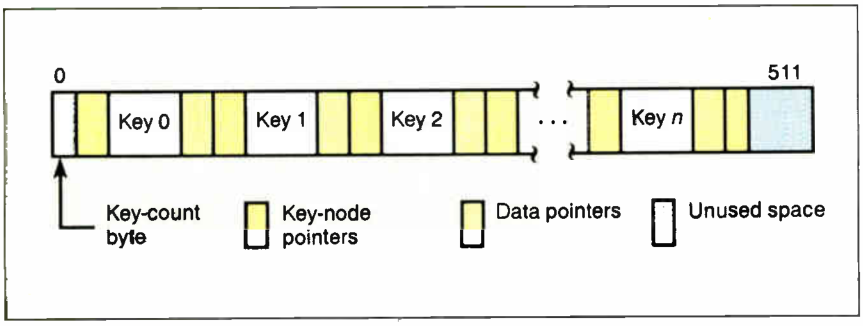

Figure 4: *Format of a B-tree node. The node's length is deliberately set to 512 bytes, the usual size of a physical disk sector. The unused space at the right end of the node varies depending on key length (constant for a given key file) and the number of keys on the node.*

Table 1: *The first sector of the key file is reserved by the KFS software; it holds descriptive information about the file (e.g., how many keys are currently in it, and the key length). This information is held in the first 10 bytes of the sector. You might want to expand this system to hold such information as the date the file was created, when it was last updated, or the name of its associated data file (if any).*

No. of bytes	Variable name	Description
1	KFTYPE	Type of key file; "K" = standard file (i.e., a data file is attached); "O" = key-only file (i.e., no data file is attached).
3	NOKEYSL/NOKEYSH	Number of keys in the file.
2	KAVSEC	First record on available list.
2	NXKYSC	Next free key sector.
1	KEYLEN	Key length.
1	MAXKS	Maximum keys per sector.

you will have examined a total of six nodes, the worst-case search of a balanced binary tree of this size.

Now store the same 100 keys in a B-tree structure with 4 keys per node (a B-tree of order 4). Again, begin the search by examining the root node; this divides the keys into five equal-size partitions. The first search reduces the number of keys you'll have to examine in the next step to 20. Dropping to the appropriate node down on the next level and searching it reduces the search by a factor of 5 a second time. Now you have narrowed the search to 4 keys. At the third level, you'll locate your target. The worst-case search examines only three nodes for a B-tree of order 4 with 100 keys stored in the tree. (Again, in this example, I've put the target key on a leaf node.)

You can see that a B-tree gains an even greater advantage when you align the nodes to disk sectors and fill the node with keys. (This is how my B-tree system works; a key node and a key sector refer to the same thing, and a single disk-read operation pulls an entire node into memory.) For a large file of 10,000 keys, a balanced binary tree requires a worst case of 14 seeks to find a key, while a B-tree of order 4 needs only 7 seeks, and a B-tree of order 10 needs only 5. (For more statistics, a 1,000,000-key file stored in binary-tree fashion requires 20 seeks maximum, a B-tree of order 4 takes 10, and a B-tree of order 10 takes only 7. I'm assuming all nodes are full in these examples.)

continued

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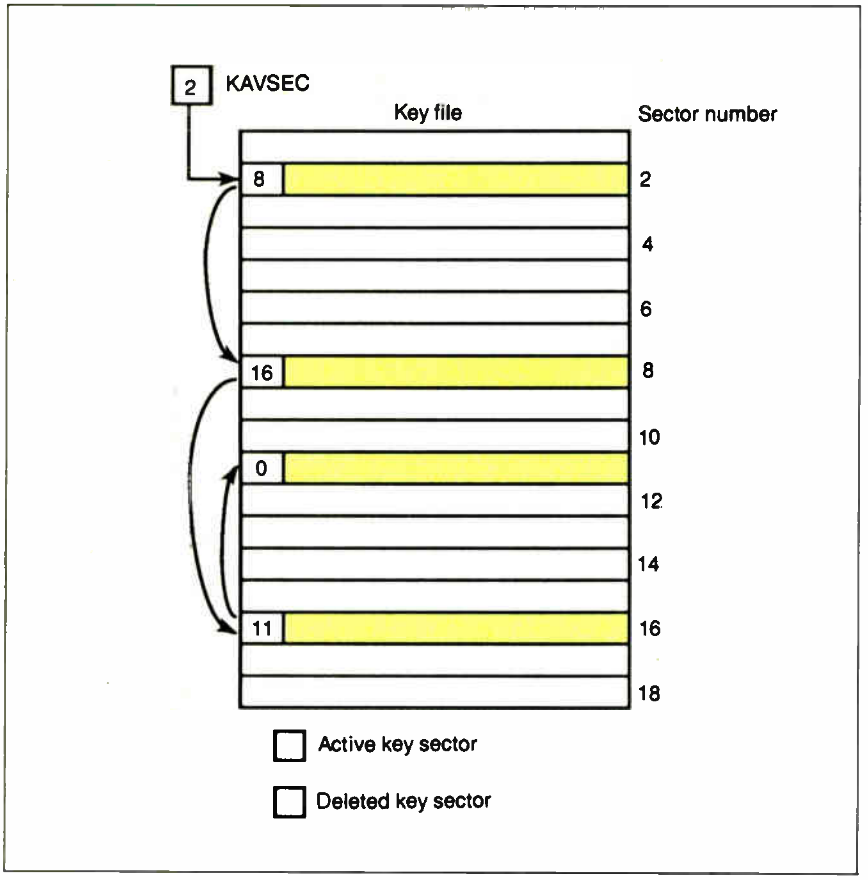

Figure 5: *When all keys are deleted from a key node, that node is placed on a singly linked list of available nodes, the available list. The variable* KAVSEC *points to the first sector of this list. The next time a new key node is needed, the software picks the lead node off the available list—8, in this case—instead of extending the file by using sector 19.*

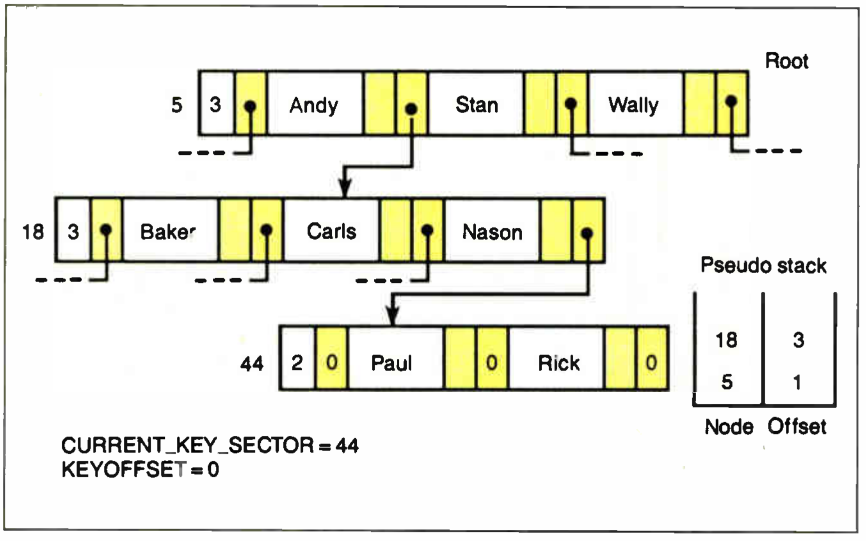

Figure 6: SEEK_KEY *searches for the key PAUL in this example. As the routine moves down the tree, it records its trail on the pseudo stack.* SEEK_KEY *leaves* CURRENT_KEY_SECTOR *set to the target node and* KEYOFFSET *set to the key number within the node.*

The Structure of the Structure

The structure of a key node for my B-tree system is shown in figure 4. The first byte of each node indicates the current number of keys in that node. This field is followed by the key and data-pointer substructure that is bracketed by key-node pointers. In a key file, all keys will be kept to a fixed length by either padding or truncating (alphanumeric keys are usually padded on the right with blanks or nulls). Each key-node pointer is a 16-bit quantity indicating a sector number. I'll talk later about the data-file structure; for now, all you need to know is that the data pointer is a 24-bit quantity that references a record in a data file.

As keys are added to and removed from the node, the key-count byte is incremented and decremented. The node itself has a fixed size of 512 bytes (the size of a typical MS-DOS disk sector). Since keys can be from 1 to 64 bytes, there will usually be some unused bytes near the end of the node. (I arrived at the 64-byte maximum through my own experience. This accommodates nearly every application of keyed files you can come up with. As usual, the source code is available, so if you don't like that maximum, you can change it.) The advantages of the B-tree scheme make it worthwhile to tolerate such wasted data space.

When it opens a key file, the KFS management software must know some details about the B-tree before it can perform any functions with the file. Since searches always begin at the root, it has to know which sector the root node is on. It has to know how many bytes long the keys are, and what the next available sector number is so that new nodes can be added. All this information is stored in sector 0 (see table 1).

Finally, the system has to be able to delete keys (I'll go into that algorithm next month). So it's possible that all keys could be deleted from a given sector. When this happens, that sector is placed on an *available list*—a chain of records free for use, as shown in figure 5. Use of the available list stabilizes the size of the file as keys are added and removed.

Having defined the structure of the B-tree, I'll describe how to use it, beginning with the routine for locating a key.

Finding That Key

As you've seen in the examples, the search process begins at the root. The real workhorse is SCANKEY (its pseudocode is in listing 1). SCANKEY manipulates an imaginary roving marker (composed of the pair CURRENT_KEY_SECTOR

continued

Formal B-Trees

The initial formulation of B-tree structures was made by R. Bayer and E. McCreight in 1972 (see reference 1). Well-known computer scientist Donald Knuth has a good discussion of B-trees in *The Art of Computer Programming, Volume III: Sorting and Searching* (see reference 2), where he gives a formal description and suggests some variations.

If you want to get rigorous, a B-tree of order n satisfies these properties:

- Every node in the tree has $<= n$ sons.
- Every node, except for the root and leaf nodes, has $>= n/2$ sons.
- The root node has at least two sons unless the root is a leaf.
- All the leaf nodes are at the same level, and they have no nonempty key-node pointers.
- A node with i sons contains $i-1$ keys.

From these properties, you can derive the formula for the retrieval performance of a B-tree. Namely, for a B-tree of order n filled with K keys, the height h of the tree has the upper bound given by the following:

$$h <= 1 + \log_{(n/2)+1} ((K+1)/2)$$

Some alterations to the fundamental B-tree scheme provide optimizations that could prove useful in specific applications. For example, if your database is used only for retrieval (e.g., an on-line dictionary file), a quick and easy way to create a B-treelike keyed file system is to follow these steps:

1. Create a hodgepodge key and data file (see figure 1 in the main text).
2. Sort the keys (keeping data pointers attached) and store them to disk so that there is a fixed number of key/data-pointer pairs per key file sector (except, perhaps, for the last sector). These sectors become the leaf nodes.
3. Scan through the key sectors, copying from each one the last (i.e., greatest) key (do not erase the key as you copy it). As you copy each key, attach the sector number from which it came. The new list of keys and pointers (it's already sorted) will become your next-level keys. Append this list to the key file in the same manner as described in step 2.
4. Repeat step 3, creating new levels on each pass. Each level will have fewer keys than the preceding level; continue until you end up with a number of keys small enough to fit on a single sector. That sector becomes the root.

You now have a keyed file structure much like a B-tree, except that each key is associated with one pointer. At every level but the leaf nodes, a key's pointer indicates the subtree holding all keys smaller than or equal to that key. At the leaves, the pointers are data pointers.

Also, notice that some keys are replicated at each level and that *all* the keys appear at the leaves. If you tack additional pointers onto leaf nodes so that each points to its left and right siblings, then accessing keys in ascending or descending order becomes a snap. The additional space consumed by nonleaf keys would certainly be tolerable in large-file applications, where sequential access is critical.

---

and KEYOFFSET); you give SCANKEY a key node and a target key, and it returns with the marker set to the target's location on the node (if the target key was found) or *where the target key would be if it had been on the node.*

It should be easy for you to follow the pseudocode for the SEEK_KEY routine in listing 2. First, of course, SEEK_KEY has to verify that there are any keys in the file. If not, the routine exits immediately with a "key not found" error. Otherwise, SEEK_KEY sets the current key node to the root node and begins the process of repeatedly calling SCANKEY until that routine either returns a "key found" condition or encounters a leaf node. If SEEK_KEY hits a leaf node, there is no more tree to search, and the routine exits with a "key not found" error.

Notice that, as SEEK_KEY moves down into the tree in search of its target, it blazes its trail on what I refer to as a *pseudo stack* (using the PUSH( ) function). This pseudo stack operates just like a processor push-down stack (first in, first out)—you can push and pop its entries—but an element on the pseudo stack is a key-node/key-offset pair. So, when SEEK_KEY completes, you can trace its trail through the tree by examining the pseudo stack's contents (see figure 6). You'll see the reasons for maintaining this stack in upcoming routines. Now that you know how to find a key, you need to get something into the tree so that you can have keys to look for.

Adding Keys

The CREATE_KEY routine (see listing 3) begins by making sure there are keys in the tree. If not, CREATE_KEY calls GET_NEW_KEY_SECTOR, which returns a new, empty key node. This node will become the tree's root. If the file does have keys in it, CREATE_KEY calls SEEK_KEY to verify that the key you're trying to add to the file is not already in the B-tree. Notice that SEEK_KEY performs two functions: If it finds the key, then CREATE_KEY exits with a "key already exists" error; if it doesn't find the key, it at least has created the pseudo stack and has set the roving marker to reflect the path and position of the key if it had been in the file. In other words, SEEK_KEY returns telling CREATE_KEY either "the key is in the file right *here*" or "here's where the key should be."

Assuming the call to SEEK_KEY fails, CREATE_KEY gets the green light and attaches the data associated with the key to the node. It does this by moving the target key into a holding area called the FLOATING_KEY buffer. Once CREATE_KEY has built the data record and written it to the data file, it records the pointer to that record in its proper place in the FLOATING_KEY buffer. (The routine is building a "key packet," consisting of a key, a data pointer, and left and right key-node pointers, in the FLOATING_KEY buffer, and it is preparing to tuck that packet into the appropriate position in the tree file.)

To perform the insertion, CREATE_KEY copies the contents of the CURRENT_KEY_SECTOR into another holding area called the WORKING_KEY buffer. CREATE_KEY then makes a "hole" for the new key by shoving all the keys one notch to the right, starting with the key position given by KEYOFFSET. Next, the routine copies the contents of the FLOATING_KEY buffer into the hole and increments the node's key count by 1.

Now, if life were easy, you could write the updated node back out to disk and go home. But inserting the new key may have made the node too large to fit in a single sector; CREATE_KEY checks the newly incremented key count to determine whether the node can fit. Fortunately, I've defined the WORKING_KEY buffer to be larger than a standard sector—larger, in fact, by the margin of an additional key and its attendant pointers. If the node does overrun the sector size, then CREATE_KEY must split the node.

To split a node, locate the central key on the node, copy that key into the FLOATING_KEY buffer, write all the keys to the left of the central key to one node (you can use the original node), and write all the keys to the right of the central key onto another, newly created node. Next, set the left and right node pointers of the key in the FLOATING_KEY buffer to point to the left and right halves of the split node.

And what about the key and key-node pointers that you copied into the FLOATING_KEY buffer? That key becomes the parent of the two halves of the node that you split. This is how a B-tree grows. If the node that was split in the preceding paragaph is the only node of the tree, then the contents of the FLOATING_KEY buffer become the tree's new root. Otherwise, you have to insert the contents of the FLOATING_KEY buffer into the parent of the original node.

Once again, the contents of the pseudo stack determine where you insert the

continued

Listing 1: *In this pseudocode listing,* SCANKEY *searches the current key node for the target key* (CURRENT_KEY)*. The routine leaves* KEYOFFSET *set to the key's location if it's found, or to where the key would be if it were on the node.*

```
{ This routine scans the key node -- represented by the array
{ KEY_NODE[] -- for a match with the target key, CURRENT_KEY.
{ KEY_NODE[] is loaded by GET(CURRENT_KEY_SECTOR) and written
{ to disk by PUT(CURRENT_KEY_SECTOR).
{ KEYOFFSET indicates a key position (0 for leftmost, 1 for the
{ next to the right, etc...) and not a byte offset.
SCANKEY:
  KEYOFFSET := 0;  IFLAG := 0;
   WHILE KEYOFFSET < NUMBER_KEYS
    BEGIN
     IF key at KEY_NODE[KEYOFFSET] = CURRENT_KEY then RETURN;
       IF key at KEY_NODE[KEYOFFSET] > CURRENT_KEY
        BEGIN
          IFLAG := 1;
          RETURN;
        END
       KEYOFFSET := KEYOFFSET + 1;
    END
   IFLAG :=1;
 RETURN
```

Listing 2: *The pseudocode for* SEEK_KEY.

```
{ This routine searches for a key. If the key is found,
{ CURRENT_KEY_SECTOR holds the key node that key is on,
{ KEYOFFSET points to the key, and IFLAG is set to 0.
{ Otherwise, IFLAG is set to 1, and
{ CURRENT_KEY_SECTOR and KEYOFFSET show where the key
{ *would* have been.
{ NOTE: GET() and PUT() read and write key sectors to
{ and from the disk file.
SEEK_KEY:
  IF number of keys in file = 0 then RETURN file empty error;
  Clear Pseudo stack;
  CURRENT_KEY_SECTOR := Root;
  REPEAT
    GET( CURRENT_KEY_SECTOR );
    CALL SCANKEY;
    IF key found RETURN;
    { If the key node pointer is empty, the search has
    { encountered a leaf.
    IF KEY_POINTER[KEYOFFSET] = 0
      RETURN key not found error;
    { Push pseudo stack.
    PUSH( CURRENT_KEY_SECTOR,KEYOFFSET );
    { Search down the subtree.
    CURRENT_KEY_SECTOR := KEY_POINTER[KEYOFFSET];
  END REPEAT
```

key. You can see in listing 3 that CREATE_KEY attempts to pop the pseudo stack and, if successful, returns within itself to do the insert. This process can repeat as many times as there are levels in the tree. Each time it repeats, it works its way toward the root, splitting nodes and moving the central key up a level. Always, as the tree grows, the keys' relationships are preserved. (Figure 7 shows the process of adding a key to a B-tree.)

Finally, CREATE_KEY must terminate with the pseudo stack and internal pointers set to the location of the newly created

Listing 3: *The pseudocode for* CREATE_KEY. *This routine adds a new key to a B-tree file.*

```
{ Add a new key to the key file.
CREATE_KEY:
  SFLAG = 0;
  IF number of keys in file = 0
    BEGIN
      GET_NEW_KEY_SECTOR;
      Root := new key node;
      Load CURRENT_KEY value;
    END
  ELSE
    BEGIN
      CALL SEEK_KEY;
      IF key found
        RETURN key already exists error;
    END
  FLOATING_KEY := CURRENT_KEY;
  { ** Code to handle creating a new
  { ** data record goes here.
L1:
  Move KEY_NODE[] to WORKING_KEY buffer;
  Move all keys -- in WORKING_KEY buffer
        -- starting at KEYOFFSET 1 key position to the
        right;
  Move FLOATING_KEY into WORKING_KEY buffer at location
       given by KEYOFFSET;
  Increment WORKING_KEY buffer's keycount;
  IF WORKING_KEY buffer's keycount > maximum
                                   keys per key sector
    BEGIN
    { Note: keycount refers to the number of keys in
    { WORKING_KEY_BUFFER.
      FLOATING_KEY := WORKING_KEY[keycount/2];
      FLOATING_KEY's left key pointer :=
      CURRENT_KEY_SECTOR;
      Move leftmost keycount/2 keys from WORKING_KEY
        buffer to KEY_NODE[];
      PUT(CURRENT_KEY_SECTOR);
      GET a new key node;
      CURRENT_KEY_SECTOR := new key node;
      FLOATING_KEY's right key pointer :=
                       CURRENT_KEY_SECTOR;
      IF keycount is ODD
         i:=keycount/2
      ELSE { keycount is EVEN }
         i:=keycount/2 - 1;
      Move rightmost i keys from WORKING_KEY buffer
         to KEY_NODE[];
      PUT(CURRENT_KEY_SECTOR);
      POP (CURRENT_KEY_SECTOR,KEYOFFSET);
      IF POP() failed
        BEGIN
          GET a new key node;
          ROOT := new key node;
        END
      GO TO L1;
    END
  ELSE
    BEGIN
      PUT(CURRENT_KEY_SECTOR);
      IF SFLAG = 1
        CALL SEEK_KEY;
      IFLAG=0;
      RETURN no error;
    END;
```

key. (This is particularly important in the routine I'll describe next, SEEK_NEXT_KEY, which must know the location of the current key in order to find the subsequent key.) There is no problem if the routine hasn't split any nodes in the process of inserting the new key. But if nodes have split, there is the probability that new nodes have been created. Then the list of key-node/offset pairs on the pseudo stack would no longer have legitimate directions for locating the recently inserted key in the tree.

So, CREATE_KEY sets the variable SFLAG whenever there has been a split. Before CREATE_KEY exits, it checks SFLAG. If SFLAG is set, CREATE_KEY calls SEEK_KEY with the original key, blazing a new trail into the tree and leaving the pseudo stack, CURRENT_KEY_SECTOR, and KEYOFFSET set with correct values.

Who's Next?

Suppose you have created a KFS for your accounts payable system, and you want to print the transactions out in ascending-date order. You need a function that, given that you've just accessed a specific key, allows you to move to the next greater key in the tree (the *inorder successor*, in technical jargon). See listing 4.

First, keep in mind what the previous operations on the B-tree might have been. If a SEEK_KEY has taken place, then the pseudo stack holds the trail you've fol-

continued

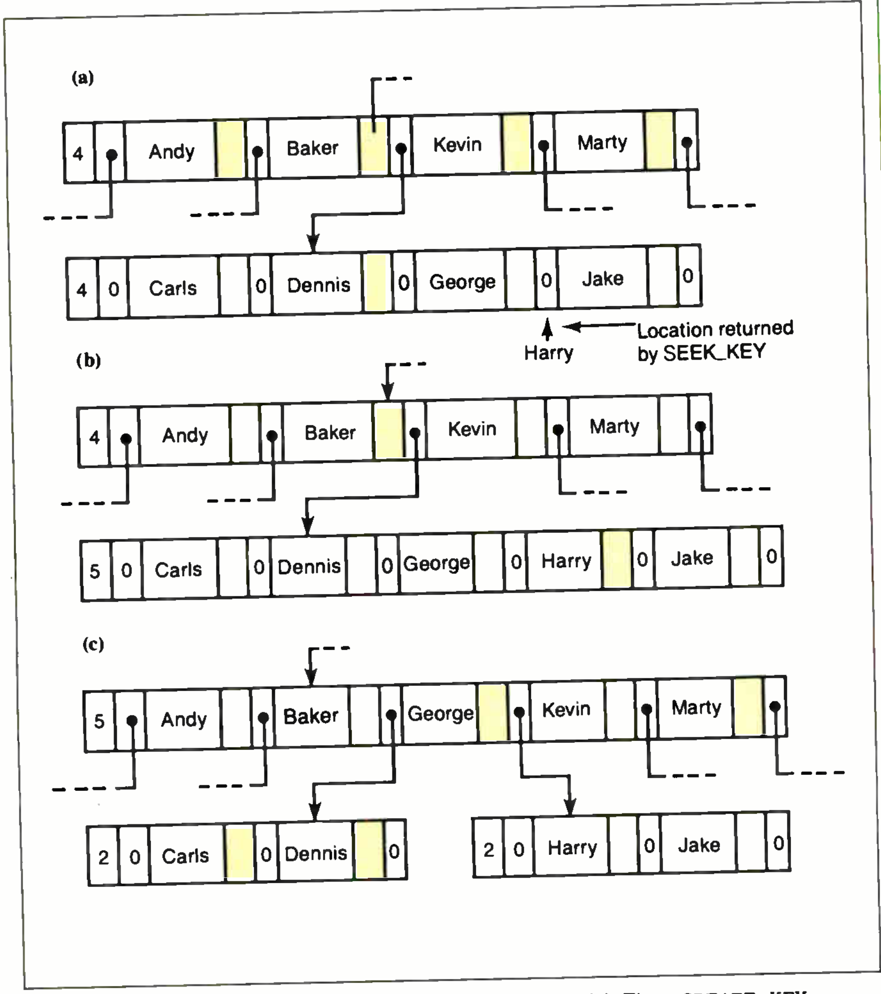

Figure 7: *Inserting key HARRY into an order-4 B-tree.* **(a)** *First,* CREATE_KEY *locates where HARRY should go in the tree by calling* SEEK_KEY. **(b)** *The target key node is expanded, and HARRY is written in—but now the node has grown beyond the maximum number of keys allowed per node.* **(c)** *GEORGE, the middle key on the node, is moved up to the parent node, and the leaf node splits. Notice that now the parent node has more than the maximum number of keys allowed. It, too, will split, and GEORGE will move up the tree to the next parent or—if no parent exists—will become the root.*

lowed into the tree, and CURRENT_KEY_SECTOR and KEYOFFSET indicate the location of the current key. In SEEK_KEY, you can see that if IFLAG is set, the last call to SEEK_KEY has failed but KEYOFFSET shows where the key would have been. The choices then become

- If IFLAG is set, clear it. KEYOFFSET is pointing to the key you want. However, if KEYOFFSET points to the right of the last key on the node, you must pop back to the parent node and repeat the process.
- If IFLAG is clear, simply move to the next key on the node if the node is a leaf (key-node pointers on a leaf node are empty, so the node cannot be a parent). If, as in the above case, the current key is the last on the node, you must pop back to the parent, set IFLAG, and try again. (All this popping is why it's important for CREATE_KEY to keep the pseudo stack intact; otherwise, calling SEEK_NEXT_KEY immediately after CREATE_KEY would produce unpredictable results.) If the node is not a leaf, move to the next key pointer on the node. Follow that pointer to the child node, and continue following the leftmost key pointers until you encounter a leaf. The first node on that leaf is the inorder successor. Once again, as SEEK_NEXT_KEY delves into the tree on its search, it records its trail on the pseudo stack.

One special case occurs when SEEK_NEXT_KEY's attempt to pop the pseudo stack fails: The stack is empty. What's happened? Simply that the current key is the greatest (last) key in the B-tree, and the call to SEEK_NEXT_KEY has fallen off the end. The routine handles this by rewinding the file and returning an "end-of-file" error. (The term *rewinding* is handed down from the days when tape drives were the primary storage device for computers; it refers to the act of setting the pseudo stack and roving marker to the logical beginning of the file.) The very short pseudocode routine for rewinding the file appears in listing 5.

Listing 4: *Pseudocode for* SEEK_NEXT_KEY.

```
{ This routine searches for the current key's inorder
{ successor.  If it hits the end of file, it rewinds
{ the key file and returns an error.
SEEK_NEXT_KEY:
 IF number of keys in file = 0 then RETURN file empty error;
 IF file is rewound
   BEGIN
     CURRENT_KEY_SECTOR := Root;
     IFLAG := 1;
     GOTO L1;
   END
 GET(CURRENT_KEY_SECTOR);
 REPEAT
   IF IFLAG NOT = 0
     BEGIN
       IF KEYOFFSET NOT = number of keys on node
         BEGIN
           IFLAG = 0;
           RETURN;
         END
       IF Pseudo stack is empty
         BEGIN
           REWINDKEY;
           RETURN end of file error;
         END
       POP(CURRENT_KEY_SECTOR,KEYOFFSET);
       GET(CURRENT_KEY_SECTOR);
     END
   ELSE

   { The following code executes if this file's
   { keypointer currently points to a key.
   { This means you have to advance to that key's
   { right keypointer and search that subtree --
   { if it exists -- for the "lowest and leftmost" key.
   { KEYOFFSET is interpreted here to indicate a key
   { node pointer on KEY_NODE[]: 0 for leftmost, 1 for
   { next to the right, etc....
     BEGIN
       KEYOFFSET := KEYOFFSET + 1; IFLAG = 1;
       WHILE key node pointer at KEYOFFSET NOT = 0
         BEGIN
           TEMP := key node pointer at KEYOFFSET;
           PUSH(CURRENT_KEY_SECTOR,KEYOFFSET);
           CURRENT_KEY_SECTOR:=TEMP;
       L2: KEYOFFSET := 0;
           GET(CURRENT_KEY_SECTOR);
         END
     END
END REPEAT
```

Listing 5: *Pseudocode routine for rewinding the key file.*

```
{ Rewind a key file.
{ This sets the roving pointer given by CURRENT_KEY_SECTOR
{ and KEYOFFSET to the file's logical start.
REWINDKEY:
  CURRENT_KEY_SECTOR := 0;
  KEYOFFSET := 0;
  Clear Pseudo stack;
  RETURN;
```

Next Month

I'll wind up my presentation of the key file handling routines with a description of the deletion algorithm and a discussion of the data-file side of things. ■

Author's note: *The source code for the B-tree system will be available as of the final part of this three-part series.*

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TMS2532A	4096 x 8	(450ns) 21V	4.49
TMS2564	8192 x 8	(450ns) 25V	6.95
TMS2716	2048 x 8	(450ns) 3 Voltage	6.95
1702A	256 x 8	(1μs)	4.95
2708	1024 x 8	(450ns)	6.95
2716	2048 x 8	(450ns) 25V	3.75
2716-1	2048 x 8	(350ns) 25V	4.25
27C16	2048 x 8	(450ns) 25V (CMOS)	4.25
2732	4096 x 8	(450ns) 25V	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
27C32	4096 x 8	(450ns) 25V (CMOS)	4.95
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.59
2764A-25	8192 x 8	(250ns) 12.5V	3.69
2764-45	8192 x 8	(450ns) 21V	3.39
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Part No.			Price
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2817A	2048 x 8	(350ns) 5V Read/Write	7.95
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318019-03	12.95
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*No specs available
**Note: 82S100PLA U17 (C-64)

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2N3904	.12	1N751	.15	C106B1	.49

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74HCT10	.17	74HCT240	.69
74HCT32	.19	74HCT244	.59
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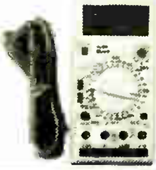

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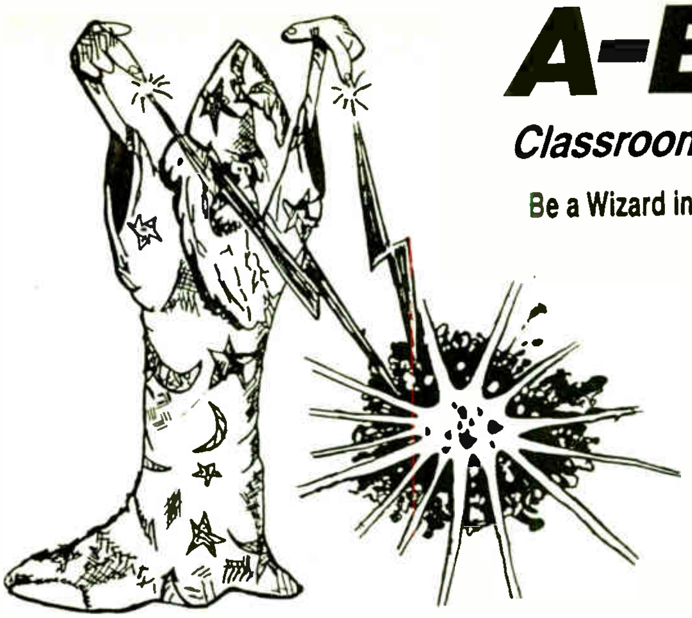

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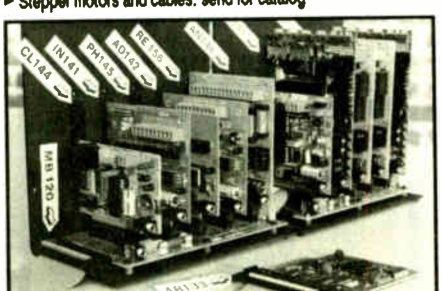

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Tandy Color Computers Fits ROM slot, Multipak or Y-Cable	AR-138: $49

A-BUS Cable: Necessary to connect any parallel adapter to one A-BUS card or to first motherboard. 50 pin, 3 ft. **CA-163: $24**
Special Cable for two A-BUS cards **CA-162: $34**

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Serial Processor: same as above plus built in BASIC for off-line monitoring, logging, decision making, etc. **SP-127: $189**
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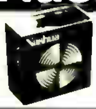

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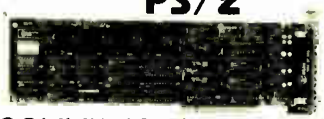

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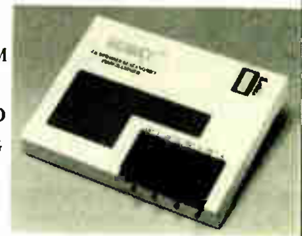

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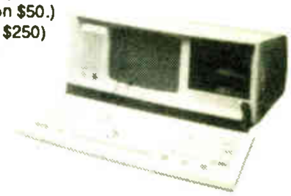

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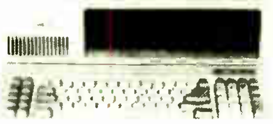

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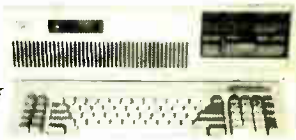

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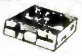

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The **Voice Master PC Digitizer** is a full 8-bit PCM sampler board. Fits in any available slot. Up to 15,000 samples per second. Input pre-amp has automatic gain control and 4.5 Khz low pass filter. Includes a quality headset microphone. Software included for recording and editing sound files for playback through **Speech Thing**. Also includes a real-time spectrum display and oscilloscope display as well as assembly language source listings for writing your own drivers. **BONUS:** Voice recognition program included which is callable via an interrupt vector. Demonstration program written in GWBASIC. **VOICE MASTER PC DIGITIZER—$89.95.**

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WITH TWO SEPARATE INPUTS (SERIAL AND PARALLEL) AND TWO SEPARATE OUTPUTS (SERIAL AND PARALLEL) CAN BE USED LIKE STANDARD BUFFER WITH ANY INPUT TO ANY OUTPUT BUT ALSO YOU CAN CONNECT 2 COMPUTERS TO 1 PRINTER OR 1 COMPUTER TO 2 PRINTERS, OR 2 COMPUTERS AND 2 PRINTERS AND MORE = 1 COMPUTER TO 3 PRINTERS OR 3 COMPUTERS TO 1 PRINTER
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DCB A-64K $ 195 DCB-B-256K $ 255 (*)

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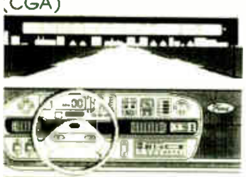
GAMES

ARCADE GAMES (106) Has Kong, 3-D Pacman, Bricks, Pango. (Requires color.)
BASIC GAMES (107) Pac-man, Lunar Lander, Startrek, Meteor, Breakout, and others.
CARD GAMES (109) Canasta, hearts, draw poker & bridge.
STRIKER (110) Defender-like game. "Top Gun" in space.
FLIGHTMARE (112) Futuristic fighter pilot game. (Requires color graphics adapter.)
SLEUTH (117) Who done it?
DND (119) Like Dungeon and Dragons.
ROUND 42 (120) Better than Space Invaders. 42 levels.
GAMES IN BASIC (124) Lander, biorhythms, desert, Phoenix, Star Wars, others.
QUEST (152) Role playing adventure fantasy game. (Requires CGA.)
SPACE WAR (158) Dogfight in outer space, using phasers, photon torpedoes, etc.
BRIDGE PAL (171) Complete game of contract bridge, with tutorial.
FENIX (193) Just like the famous arcade game.
PINBALL GAMES (197) Pinball, Rain, Twilight Zone, Wizard, etc.
KID-GAMES (GAM8) Animals math, clock game, alphabet, etc.
CHESS (GAM9) Incredible. 2D and 3D. Many levels. Play back moves, store games.

EGA RISK (GAM11) World domination in great color. Includes EGA Asteroids.
PC PRO-GOLF (GAM27-28) Great graphics. Complete 18 hole, 72 par course. (CGA)
PEARL HARBOR (GAM32) Shoot down Jap Zeros before they destroy U.S. Fleet. (CGA)
ULTIMA 21 DELUXE (GAM34) Best Blackjack game around. Includes Video Poker.
FORD SIMULATOR (GAM37) Great driving simulation. (CGA)



MUSIC

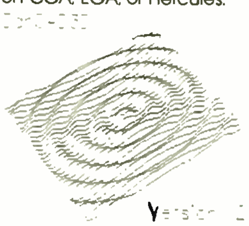
PIANOMAN 3.2 (301) Turn your keyboard into a piano.
PC-MUSICIAN (302) Compose, save, and play music.
CHRISTMAS SONGS (311) Play your favorites on a PC.

WORD PROCESSING

PC-WRITE 2.71 (401-402) (2 disks) Latest version of this popular program w/spelling checker.
PC-TYPE+ (421-423) (3 disks) Excellent. Includes mail merge, 100,000 word spelling checker. Interfaces with PC-File+, PC-Style.
MAXI-MAX (432) 59 macros to use with Word Perfect 4.2 or later. 11 templates for forms, border designs, etc.

GRAPHICS

KEYDRAW CAD SYSTEM (1001, 1002, 1065) (3 disks) Popular. Also uses mouse. (Requires color graphics - CGA.)
DANCAD 3-D (1051, 1052) (2 disks) Create 3-D graphics. Rotate, magnify, etc. Runs on CGA, EGA, or Hercules.



SIDEWAYS (1007) Prints text sideways. Useful for spreadsheets.
SIMCGA/HGCIBM (1027, 1062) (2 disks) Use with Hercules graphics card/ compatibles to run programs requiring CGA on your monochrome PC.
IMAGE 3-D (1048) Create and edit 3-D objects. Move, scale, rotate and tip image.
FINGERPAINT (1050) Use keyboard or mouse to draw. Like MacPaint. (Requires CGA or EGA.)
FANTASY (1057) Create flowing graphic images with mouse or keyboard. (CGA)
FLOWCHARTING (1078-1079) Complete system for flowcharts, organizational, electrical, etc., with symbols.

RELIGION

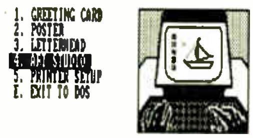
THE BIBLE (3301-3306) (6 disks) Old Testament, King James version.
THE BIBLE (3307-3308) (2 disks) New Testament, King James version.
WORD WORKER (3309-3310) (2 disks) Bible search program. New Testament, King James version.
BIBLEMEN (3330) Excellent Bible quiz program.

BASIC

PC-PROFESSOR (1401) BASIC tutorial. Good.
BASIC PROGRAM GENERATOR (1402) The menu driven way to write programs.
B-WINDOW (1407) Give windowing capabilities to your Basic program.

UTILITIES

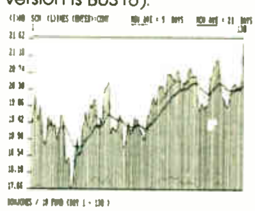
HOMEBASE (2608, 2612, 2613) Complete desktop organizer. Great!
LIGHTNING PRESS (2718) Printshop clone. Includes graphics for many uses.



PROFESSIONAL MASTERKEY (2805) Like Norton's. Retrieve deleted files. A lifesaver.
BAKER'S DOZEN (2821) 13 utilities from Buttonware.
AUTOMENU (3003) Make PC menu driven. Incl. passwords.
SCREEN (3006) Save your monitor from screen burn-in.
DOT MATRIX FONTS (3061-3062) (2 disks) Print your text in different fonts. Works with most printers.

ACCOUNTING/FINANCE

MARKET CGA (BUS17) Performs sophisticated analysis on stocks, funds, etc. (EGA version is BUS16).



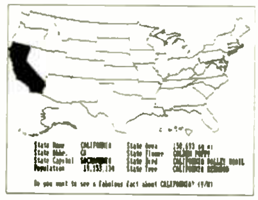
BILLPOWER+ (BUS40) Bill clients for time and materials, advances, retainers, etc. Computes taxes, past due interest, etc. Has full G/L.
CPA LEDGER (706-708) (3 disks) Complete general ledger for corporations, partnerships or sole proprietors.
PERSONAL FINANCE MANAGER (715) Household budget manager. Keep track of checking, savings, investments.
PAYROLL USA (725-726) Up to 2,000 employees in any state. dBaseIII and Lotus compatible. Complete P/R system.
EXPRESS CHECK (786) Check acount with running balance, monthly reports, etc. Prints checks.
FINANCE MANAGER II (774-775) (2 disks) For personal or small business financial management.

SPREADSHEETS

AS-EASY-AS (505) Great. Includes screen help menus. Utilizes function keys. A Lotus clone that reads Lotus files.
PC-CALC+ (512-514) (3 disks) Jim Button's famous Lotus clone.

EDUCATION

FUNNELS AND BUCKETS (201) A fun way to learn math.
MATHPAK (202) Tutorial with lessons in higher math.
PC-TOUCH (204) Learn typing.
BASIC TUTORIAL (208) Learn programming with BASIC.
BEGINNING SPANISH (211) Tutorial.
SPANISH II (232) Sequel.
BIBLEQ (214) Learn the Bible with this Q-A tutorial.
FACTS 50 (239) Geography lessons for U.S. Nice graphics.



APPLICATIONS

FORM LETTERS (1907) Commonly used form letters and business applications.
EZ-FORMS (1908) Make forms to meet different needs.
MANAGER'S PLANNER (1920) Daily planner. Prints out.
HOME INVENTORY (1966) Track all your possessions.
BIORHYTHM (1990) Display the 3 biological cycles: physical, emotional, intellectual.
FAMILY HISTORY (2203-2204) (2 disks) Create files and genealogical reports.
DR DATA LABEL (2327) Powerful mailing list program. Customize labels to size.
LOTTO PROPHET (2364) Best Lotto program we've seen.
CITY DESK (2513) Simple desktop publisher.

SPREADSHEET TEMPLATES

LOTUS MACROS (601) Save hours of work. (Req. Lotus)
LOTUS SPREADSHEET TEMPLATES (602) Ready-made. (Requires Lotus 1-2-3)
GOAL-SEEKER V3.5 (624) Achieve objectives by changing spreadsheet variables and seeing result. (Requires Lotus.)
LOTUS TUTORIAL (630) Learn Lotus (requires Lotus).

DOS

DOS TUTORIAL (1301) Teaches you to use DOS.
STILL RIVER SHELL (1304) Run DOS commands from a menu. Makes DOS easy.
BATCH FILE TUTORIAL (1305) Utilize batch file processing.
MORE DOS TIPS (1318, 1323) (2 disks) More about DOS.
HELP DOS (1326) On line DOS help with menus. Includes DOS dictionary of terms and a hints menu.

TELECOMMUNICATIONS

Q-MODEM 3.1 (1101, 1102, 1144) (3 disks) Powerful but easy to use. Fast.
RBBS V16.1A (1107-1109, 1150) (4 disks) Multi-user BBS.
PROCOM 2.42 (1112-1113) (2 disks) Hacker's delight. Redial capability. Latest version.

SECURITY/HACKING

UNPROTECT PROTECTED PROGRAMS (1202) Make backups of protected software.
UNPROTECT II (1203-1204) (2 disks) Ways to backup commercial software.
UNPROTECT III (1205) Unprotect Softguard protection.
UNPROTECT IV (1206) More programs you can unprotect.

ADULTS ONLY

ADULTS ONLY (2901) Animated. Req. CGA.
MAXINE (2902) Incredible. (CGA)
STRIP POKER (2903) Pick opponent (CGA)
BAD-BAD (2904) Adventure game.
ASTRO-(BLEEP) (2905) Arcade game (CGA)
X-RATED COLOR SHOW (2915) Beautiful girls. (CGA)
X-RATED PRINTSHOP (2909) Graphics for Printshop.

DATABASE PROGRAMS

PC-FILE + 2.0 (801, 805, 837) (3 disks) Rated better than dBase III+ by Consumer Rpts.
PC-GRAPH (802) Create graphics from PC FILE.
FILE EXPRESS 4.0 (803-804) Powerful system. Allows 32,000 records. Sorts up to 10 key fields.
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This card has 1 serial port and 1 parallel port. It can be expanded to 1.5MB memory. This card has **extended memory** only. (This is not EMS or EEMS.)

You can attach a **monochrome monitor** to the card as well as hook up a **lightpen**.

Also includes utility software: drive emulator, printer spooler, utility to control calendar/clock.

Uses 64K or 265 K chips.
0-K memory on board.

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HIGH POWERED 3-D GRAPHICS FOR YOUR IBM PC
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Includes: Board, manual and driver software
Features:
- 9 color planes, 672x480 pixels.
- 20 & 30 operation modes, 4096 colors.
- Also emulates IBM CGA card.
- On-board processors—Intel 80188 and NEC 7220.
- 75 high-level graphics commands in firmware.
- Character-like commands generated by I/O statements in high level language used to control graphics operation.

Compatible with Auto-CAD.
(Note: Card uses 2—8 bit slots.)

$350.00

HITACHI DOT MATRIX
LIQUID CRYSTAL DISPLAY

• 16 characters x 1 line • 5v power required • C-MOS/TTL compatible signal level • Built-in RAM for display data storage • Multiple instruction set (based on 13 commands) • Built-in C-MOS LCD driver & controller • Easy "Microprocessor" interface • Low power consumption • 5x10 dot matrix formation with cursor, alphanumerics & special symbols • 98 ASCII character generator (plus 64 katakana) • 8 programmable characters • ribbon cable connector already prewired

Physical size 3-1/8"L x 1-3/8"W x 1/4"D

5 for $25

NEC FLOPPY DRIVES

½ Ht. 360K 5¼" DS/DD **$65.00**

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LCD DISPLAY

WOW WOW

480 dot x 128 dot graphic and alphanumeric display.

Easy "Microprocessor" interface.
Documentation included.

Approx. size: 10"Wx4"Hx.05"D

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Great source of optical and electro-mechanical parts and systems including the basis for an infrared communications system.
Contains f1.4 - 12 to 72 mm (6x) zoom lens with auto focusing capability. DC motor driven or manual zoom and focus systems with precision gear reduction units, mechanical clutches, and high quality DC motors. DC rotary actuator controlled iris diaphram unit.
Option Available: Infrared distance measuring system (focusing unit) with control electronics $10.00.

$19.00

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DC300 XIDEX **$10.00** (2 pc. minimum)

DC1000 No label **$5.00** (4 pc. minimum)

FULCRUM TRACK BALL

- *Stationary Mouse*
- *PC Magazine Editors First Choice for CAD Use*

New Menu Key
-Do Lotus123
Wordperfect or your own menus

$89

EPSON QX-10 MOTHERBOARD

w/your choice: ASCII Keyboard (Enclosed) or HASCII (bare)

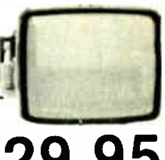
$69.95

Will work with any IBM compatible disk drive • CPU μPD780AC-1 (Z80A compatible, 4 MHz) • Memory-RAM 256K on board, C-MOS RAM 2K, EPROM 2/4/8K (for IPL) Clock C-MOS real-time clock interface. Serial and Parallel DMA 7 channels Interrupt levels 15, Counter/timer 6 channels Card slots 5 Compatible with any TTL monitor Weight 10 lbs with enclosed keyboard, 8 lbs with bare keyboard

ADAPTEC 4000A SCSI Controller $60.00

I/O for the ST412-506 Interface using MFM encoding

ZENITH 7" DIAGONAL SCREEN MONITOR



Model DJ7NK2
HIGH RESOLUTION AMBER

- Flat faceplate
- 900 lines at center
- 650 lines at corners
- Operates from 12VDC at 1.4 amp
- Vertical input is 47 to 63 Hz
- Horizontal frequency: 15 Khz (adjustable)

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22 MHZ TYPICAL BANDWIDTH

$29.95 4 for $99

For split video (TTL inputs) operation. Not composite video.

POWER SUPPLY BLOWOUT! $12.00

YOUR CHOICE! Minimum 2 per Order

Please check dimensions. These are open frame supplies.

188 Watt Switching Power Supply.

On/off switch in the front. Built in filter for easy power cord plug-in. Open frame, L-bracket type. Two 4-pin power plugs for floppy and/or hard disk drives.

Output: +5.05V @ 22A, +12.02V @ 4A, -12V @ .5A, +12.59 Reg. @ 1.5A D.C.

Dimensions: 13½L X 5½W X 2¾H

Compower 130 Watt supply. *Unit is open framed.*

Output: +5V @ 5A, +12V @ 5A, -12V @ .5A
Dimensions: 8½L x 4¾W x 2½H

Power Systems — 180 Watt supply. *Unit is open framed with 2 four pin power connectors built onto the unit.*

Output: +5V @ 20A, +12V @ 4A, -12V @ 5A
Dimensions: 9¼L x 4⅞W x 2½H

THE RETURN OF THE SPY IN THE SKY

NEC UPD791D — (CHARGE COUPLED DEVICE)
4096 ELEMENT — LINEAR IMAGE SENSOR

The charge coupled device is soldered to a pre-amplifier board. (We sold out of the A/D board that accompanied the unit . . . They went fast!) Since this is an analog device, the circuitry to provide timing signals and convert analog outputs to digital MUST BE SUPPLIED BY THE PURCHASER to interface to a microprocessor based system.

Timing requirements could be determined from a NEC manual on the 791D or from the schematic on the A/D board. PLEASE NOTE: We have the A/D board schematic, but unfortunately, we do NOT have the NEC manual. Designed for page scanning applications including facsimile. (Optical character recognition and other imaging applications which require high resolution and high sensitivity)

$39.95

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NEC 5261
(Same as 5260)

10 Milliwatt (Max Output)—5 Mw (minimum)

Tube is in cylindrical housing 15" long. Emits Red beam. -Class IIIb Laser-Random Polarization-Non-polarized Laser-Mode: TEMoo-Beam diam. at 1/e2.83mm-Beam divergence: .96mrad-Operating Voltage: 2350V±100-Starting Voltage: <10KV-Operating Current: 6.5 mA

VGA Color Graphics Package

Possible Display Modes VGA Graphics:

800x560x16 colors 320x200x256 colors
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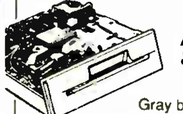

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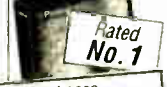

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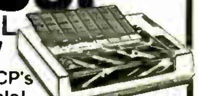

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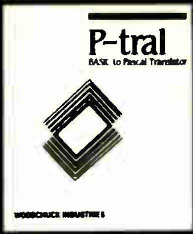

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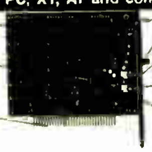

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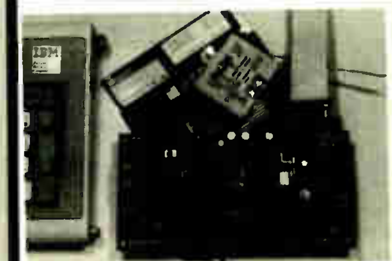

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22	50V	.05
33	50V	.05
47	50V	.05
100	50V	.05
220	50V	.05
.001µf	50V	.05
.005	50V	.05
.01	50V	.07
.05	50V	.07
.1	12V	.10
.1	50V	.12

ELECTROLYTIC

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1µf	50V	.14
4.7	50V	.11
10	50V	.11
47	35V	.13
100	16V	.15
100	50V	.23
220	35V	.20
470	25V	.30
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10	16V	.14
10	50V	.16
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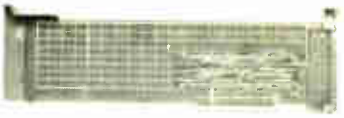

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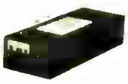

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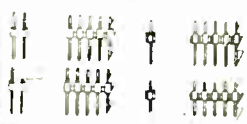

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RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
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RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
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FOR ORDERING INSTRUCTIONS, SEE D SUBMINIATURE CONNECTORS BELOW

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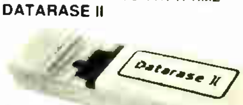

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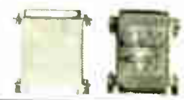

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	FEMALE	DBxxSR	.55	.75	--	.85	2.49	--
WIREWRAP	MALE	DBxxPWW	1.69	2.56	--	3.89	5.60	--
	FEMALE	DBxxSWW	2.76	4.27	--	6.84	9.95	--
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	--	2.25	4.25	--
	FEMALE	IDBxxS	1.45	2.05	--	2.35	4.49	--
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ZIF SOCKETS	ZIFxx	--	4.95	4.95	--	5.95	--	5.95	6.95	9.95
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FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

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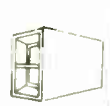

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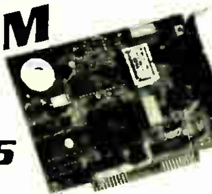

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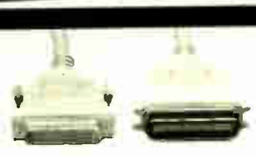

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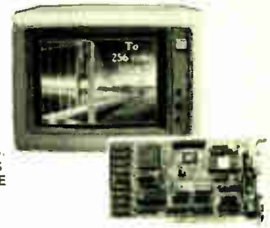

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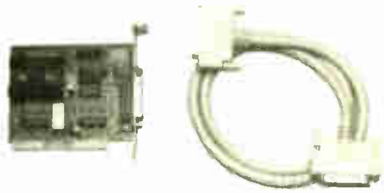

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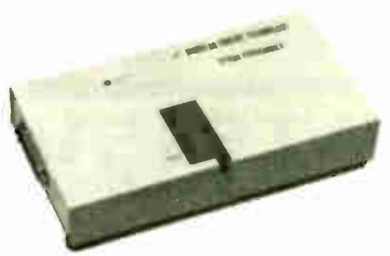

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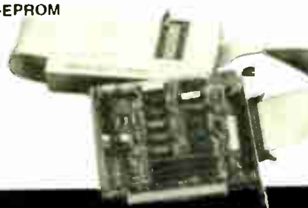

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This message is brought to you by:

the MICROCOMPUTER MARKETING COUNCIL of the Direct Marketing Association, Inc.
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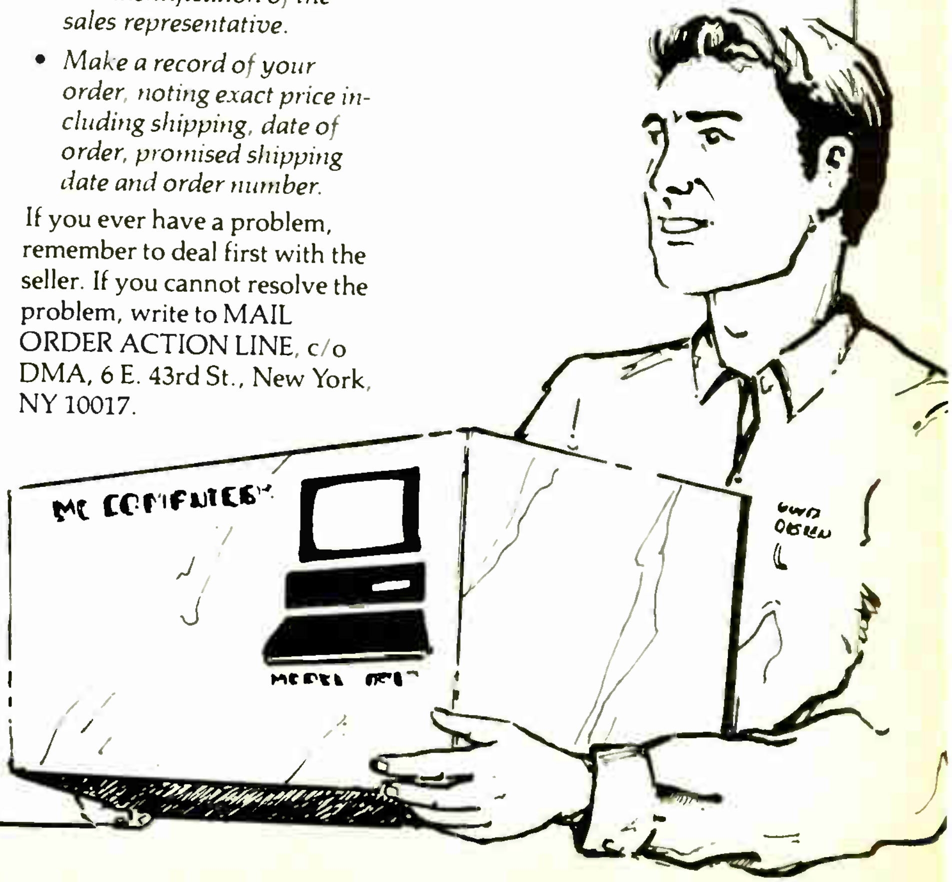

Editorial Index by Company

Index of companies covered in articles, columns, or news stories in this issue
Each reference is to the first page of the article or section in which the company name appears

COMING UP IN BYTE

PRODUCTS IN PERSPECTIVE:

In the **front of the book** will be Microbytes, What's New, and Short Takes. Next month's Short Takes will include products for computer security, programmer's tools, a writer's utility package, the Apple IIC+, and more.

Our **First Impression** will take a look at the most recent incarnation of Borland's Paradox database for the IBM PC.

February's **Product Focus** will deal with six of the latest generation of C compilers, which represent the most recent advances by software houses to address the needs of serious programmers.

System reviews will consider the newest Zenith and Ogivar 80386 portable computers, as well as Tandy's Model 5000 80386.

Hardware reviews will start out with a look at five new floppy disk drives and controllers for both the IBM PC and the Macintosh.
Another review looks at four midsize SCSI hard disk drives for the Mac.

In **software reviews**, we have a group review of three assemblers: MASM, Turbo Assembler, and OPTASM. We'll also review a new C programming toolkit for both the Mac and the Microsoft Windows environment on the PC, called XVT. **Application reviews** will include consideration of two of Ashton-Tate's latest, the long-awaited dBASE IV and Full Impact.

IN DEPTH:

Personal workstations is the subject of our February In-Depth section. It will begin with Nick Baran providing a working definition of just what a personal workstation is. Speaking directly to that point, Stan Diehl and Steve Apiki have performed a bit of garage-shop magic in a piece about the ultimate upgrade. Other articles will feature the ins and outs of performance measurement, a comparison of RISC chips, the state of the art in workstation graphics, how well the Mac II and 80386 machines function as workstations, a survey of the current crop, and more.

FEATURES:

We'll look at how microcomputers are being used in **sequencing DNA**. Dick Pountain explores a new storage medium, **digital paper**. Roy Kimbrell has contributed a series of **C programs**. Charles Hart has also contributed a series of programs to accompany his interesting piece on **Turbo windowing**.
In our Hands On section of the Features department, Brett Glass focuses his hardware lens on **disk drive interfaces**, while Rick Grehan continues the January theme by presenting part 2 of his **B-tree project**.

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1) If you are a new subscriber or have lost your I.D. card, circle #1 on the Reader Service Card; **attach mailer label**. We will immediately send your personal TIPS subscriber card.

GET PREPARED

2) Write your Subscriber Number, as printed on your Subscriber I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: (413) 442-2668 and wait for voice commands.

ENTER YOUR SUBSCRIBER AND ISSUE NUMBERS

5) When TIPS says: "Enter Subscriber Number"
(Enter by pushing the numbers and symbols [# or * enclosed in the boxes] on telephone pad ignoring blank boxes)
Enter ☐☐☐☐☐☐☐☐☐☐ # #

6) When TIPS says "Enter magazine code & issue code"
Enter 1 # 1 9 # #

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. ☐☐☐ # #	6. ☐☐☐ # #	10. ☐☐☐ # #	14. ☐☐☐ # #
2. ☐☐☐ # #	7. ☐☐☐ # #	11. ☐☐☐ # #	15. ☐☐☐ # #
3. ☐☐☐ # #	8. ☐☐☐ # #	12. ☐☐☐ # #	16. ☐☐☐ # #
4. ☐☐☐ # #	9. ☐☐☐ # #	13. ☐☐☐ # #	17. ☐☐☐ # #
5. ☐☐☐ # #			

END SESSION

8) End session by entering * * 9 1 # #

9) Hang up after hearing final message
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