SETTING THE STANDARDS
15
YEARS

# BYTE

JULY 1990

A McGRAW-HILL PUBLICATION

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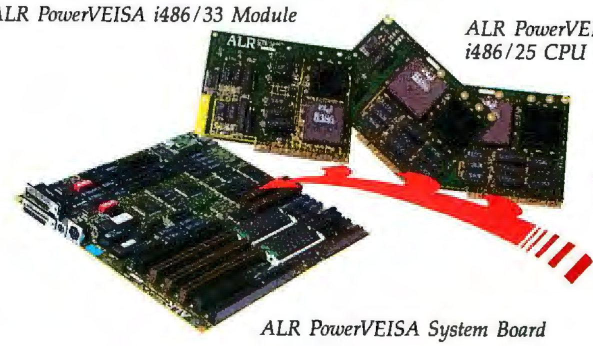


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BYTE

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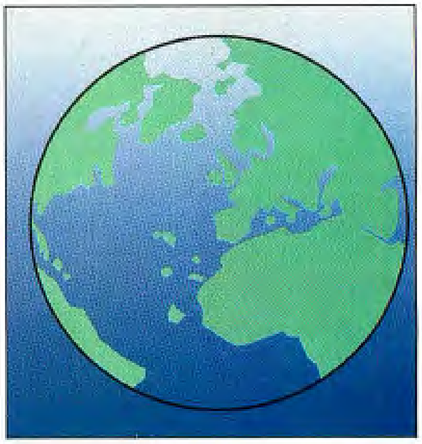

# GROWTH, CHANGE, AND 3-D INTERFACES

*A new source of European computer information, and a "virtual environment" expert*

This month we throw the spotlight on our London-based senior editor, Colin Barker, who works on our international coverage. (BYTE's International section is sent out to almost 130,000 readers worldwide.) He will also help make sure that the rest of us are aware of the exciting things happening around the world.

Before coming to BYTE, Colin was the editor of *DEC Computing*, the leading British magazine focusing on products from DEC. Before that he spent some time as editor of *Which Computer?*, one of the leading British microcomputer magazines.

Colin is based in McGraw-Hill's new offices in Wimbledon. And, although he is officially based in the U.K., Colin will be spending a good amount of time hopping around Europe, digging out the most important news and developments. He can be reached at BYTE/McGraw-Hill, Wimbledon Bridge House, 1 Hartfield Rd., Wimbledon, London SW19 3RU, UK.

**Virtual Environments**

On another topic, we are pleased to have an article in this month's State of the Art section by Scott S. Fisher, the foremost authority on virtual environments (see "Living in a Virtual World" on page 215). Virtual environments provide you with a way to enter three-dimensional space in your computer and interact with it, "one on one."

From 1978 to 1982, Scott was a member of the Architecture Machine Group at MIT, where he helped develop the Aspen Movie Map surrogate-travel videodisk project and several stereoscopic display systems for teleconferencing and telepresence applications. His current research focuses mainly on stereoscopic imaging technologies, interactive display environments, and developing media technology to represent "first-person" sensory experience.

As director of the Virtual Environment Workstation Project at NASA's Ames Research Center, Scott's objective is to develop a multisensory "virtual environment" workstation to be used in space station teleoperation, telepresence, and automation activities. As we look for more creative, efficient, and realistic ways of establishing interfaces between us and our machines, the virtual environment provides an alternative to the 2-D space of a flat screen. ■

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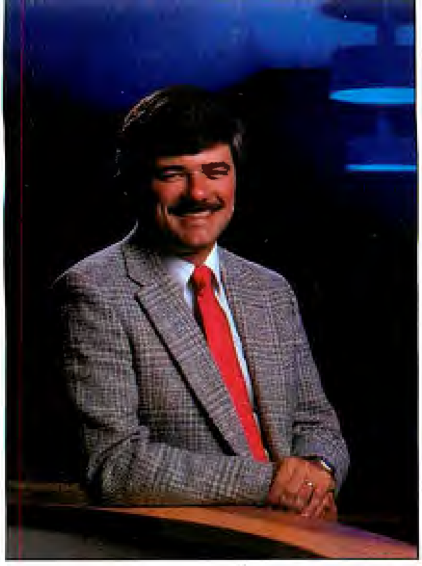

EDITORIAL ■ Fred Langa

# THE SOFTWARE STORY OF THE YEAR

## Windows 3.0 is a landmark product that will have a profound effect on everything

In last month's cover story, BYTE senior editor (and Windows expert) Jon Udell introduced Windows 3.0, explaining what it is and how it fits into the spectrum that starts at vanilla DOS and ends with 32-bit OS/2. There is much more Windows coverage this month, focusing on applications; and we're planning additional special coverage in August. Why all the fuss?

Because of this: We expect end users and corporations to flock to Windows by the millions. The ripple effects of those millions of copies of Windows will, in turn, be felt in almost every corner of the desktop computing world.

Jon has been using prerelease versions of Windows 3.0 since last year, and based on that extensive experience, he's come up with a staggering list of the implications of Windows. Here are a few highlights from his notes:

**286 Systems:** Windows 3.0, not OS/2, is the solution for the installed and still-growing 286 base. Windows delivers to 286 machines the three key benefits that it was originally thought OS/2 would provide: large memory, multitasking, and intertask protection. Windows 3.0's cooperative multitasking and memory management rescue the faster 286 machines from obsolescence and make them—for many home and business uses—a reasonable and very inexpensive choice.

**386 Systems:** Although Windows 3.0 is a 16-bit product, it's going to sell a lot of 32-bit hardware. A 386 running Windows, equipped with a Super VGA board like the Video Seven VGA (640 by 480 by 256 pixels) and a slew of Windows 3.0 applications, is arguably the most cost-effective and versatile desktop machine you can buy today. Windows 3.0 inherits the rich library of existing Windows software, all of which runs much better thanks to Windows' ability to run itself and its applications in extended memory. This makes the 386 very attractive relative to a Mac II: functionally comparable and considerably cheaper.

**Macintosh:** Windows 3.0 may actually boost sales of Mac systems and software because Apple will almost certainly have to lower prices to compete against increasingly Mac-like, inexpensive DOS/Windows boxes. Lower prices mean that more people will be able to afford Macs.

**Memory:** As people get used to multitasking and to more powerful applications, adding that extra 2 or 4 megabytes of RAM really starts to make sense. The relationship between added RAM and added productivity will become much more linear for lots of folks.

**Networks:** Windows 3.0 includes excellent support for a variety of networks, including LAN Manager, Novell NetWare, 3Com, and Vines. Smaller fry, like LANtastic and Grapevine, will almost certainly join the party as well. With good drivers, Windows is better than OS/2 or Unix at hiding much of the complexity of using a network—and, unlike the Mac, Windows encompasses many hardware sources. Expect the combination of Windows and a network to become an overwhelming standard in many corporate settings.

**Graphics:** Windows 3.0 removes previous limitations on memory and color management, and it also provides single-driver simplicity (no more having to juggle a pile of separate application-specific drivers). Expect Super VGA and powerful graphics accelerators/coprocessors to proliferate.

**Software:** Windows will finally allow DOS systems to perform well in previous Mac strongholds like desktop publishing, presentation graphics, and image processing; watch for developments there. In fact, demand for all Windows 3.0 applications will be intense; that, in turn, will fuel demand for more and better software development tools.

Watch for additional growth in DOS extender products. Windows 3.0 is itself a DOS extender; that is, while relying on underlying DOS services, it gives applications access to extended memory. Windows will become the premier DOS extender, but it won't kill the other ones.

The forthcoming DPMI (DOS Protected Mode Interface) specification provides hooks so that DOS-extended programs built with the Phar Lap Software, Rational Systems, or Ergo Computing toolkits can run and multitask under Windows 3.0. If this comes to pass, 32-bit applications like AutoCAD 386, built with Phar Lap tools, will theoretically be able to run in 32-bit mode using a flat memory model, yet they'll be able to coexist with Windows 3.0.

In the DBMS arena, Windows is a great platform for the client half of distributed applications. Windows will be a front end to NetWare, OS/2, Unix, and mainframe database servers. Tools like SQLWindows (for the interface development) will be hot, as will Windows implementations of network protocols like TCP/IP for bridging DOS/Windows machines across a variety of network architectures.

Windows 3.0 is a landmark product whose effects we'll all be living with for years to come. Things just got a whole lot more interesting.

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

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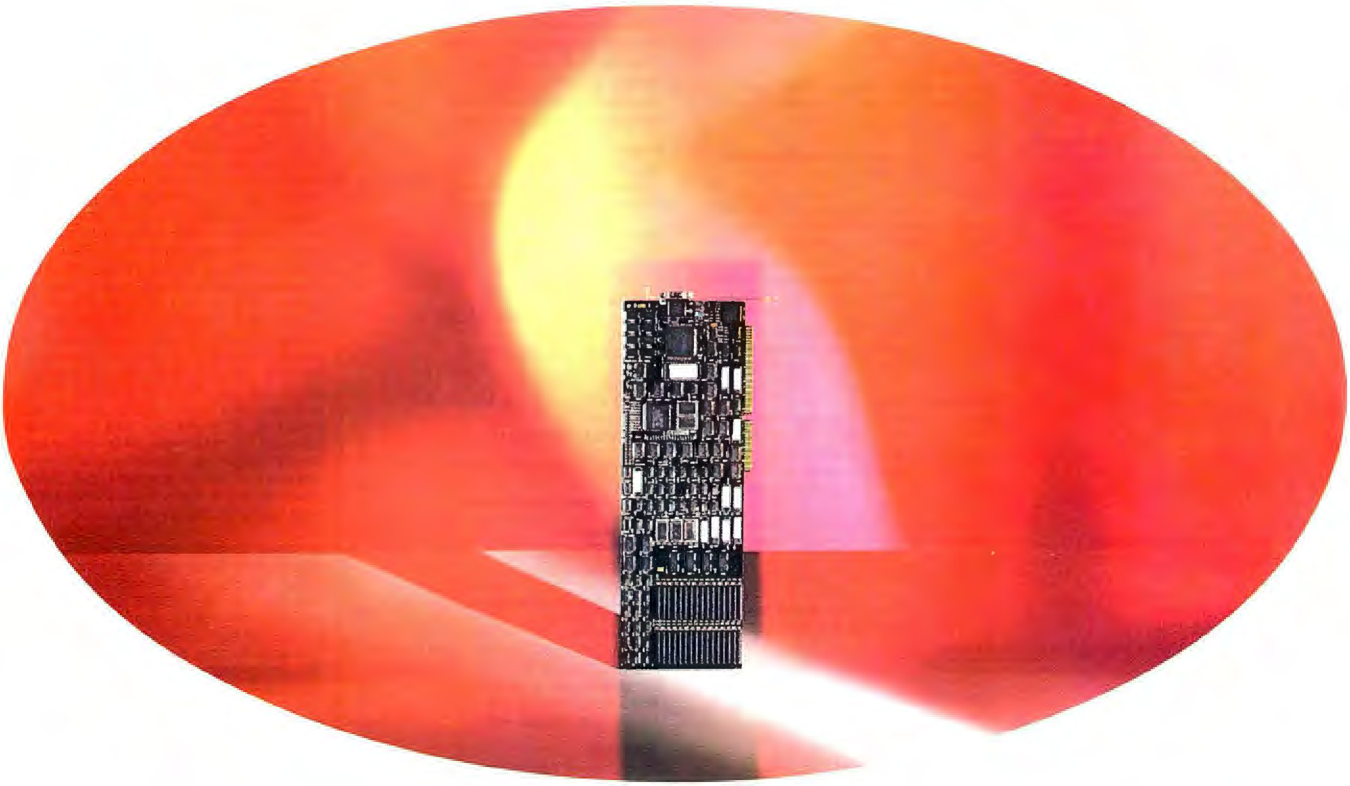

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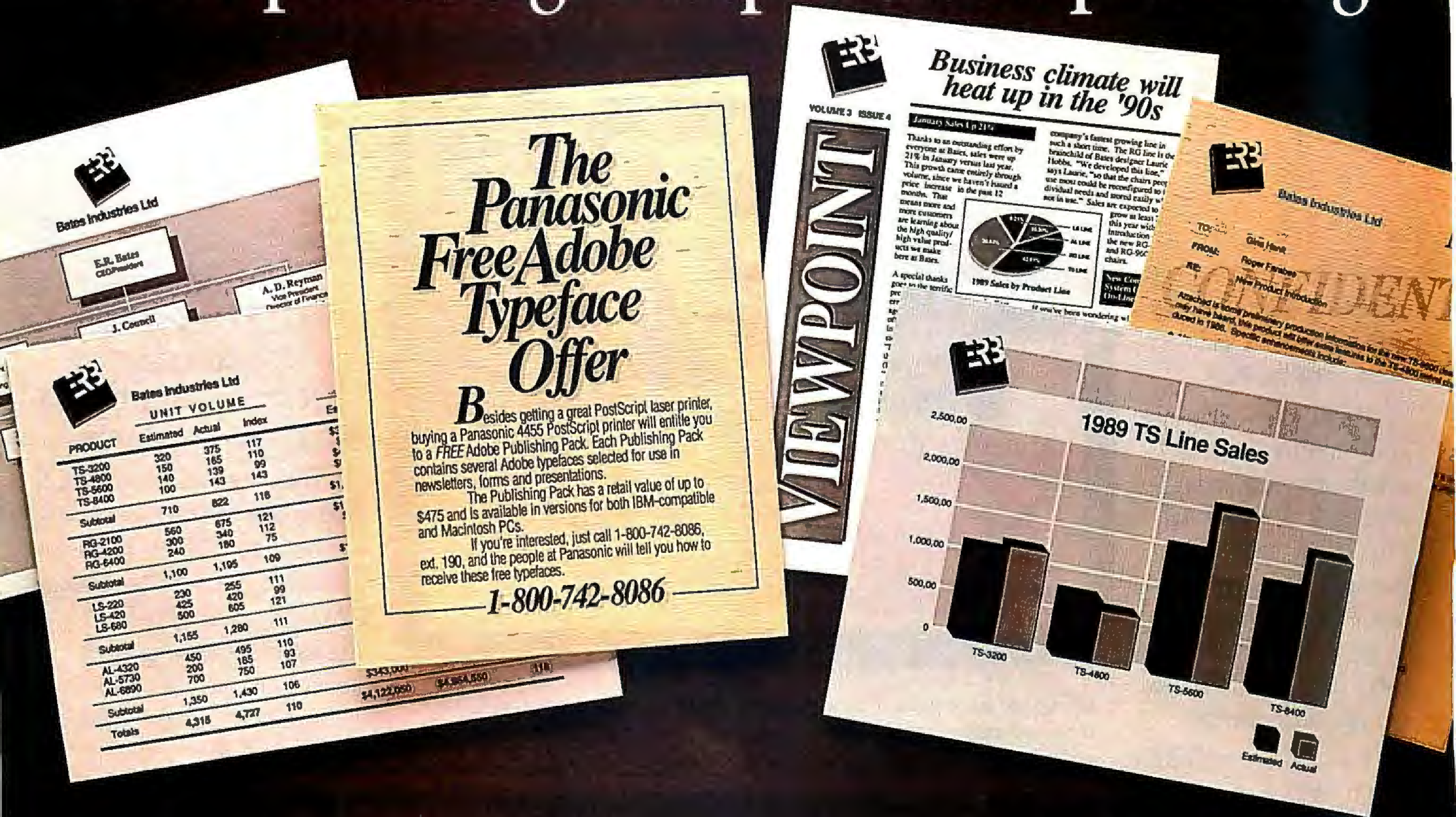


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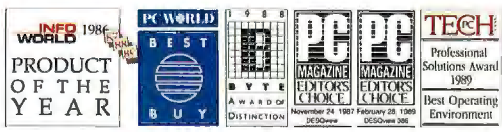


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*Research news and industry developments shaping the world of desktop computing*
*Edited by D. Barker*

## Microsoft Puts New Spin on Windows, OS/2

Remember when OS/2 was going to kick DOS right off the desktop—sometime during the early 1990s? Well, that tune has been changing lately, particularly with the interest given Windows 3.0, and even Microsoft isn't singing it anymore.

In a recent interview with BYTE, Microsoft's Steve Ballmer, vice president of systems software, said that the company is "trying to kick off a new perception of OS/2." He christened OS/2 with a new nickname: Windows Plus. That designation is a far cry from what we used to hear, which was, in effect, that Windows was "OS/2 Minus."

The new OS/2 and the new Windows will have the same user interface, Ballmer said, but OS/2 will have better security features, better memory protection, and the ability to function as a LAN peer rather than just a client.

What Ballmer and other Microsoft officials have been suggesting is that Microsoft (and, presumably, IBM) is increasingly viewing Windows as the primary graphical environment for individual PC clients, while OS/2, running at the server level, will provide a more robust superset of Windows' capabilities for large networked applications. Applications software houses are adopting this approach, too, with even holdout Lotus Development committing to a Windows-compatible 1-2-3.

This change can be traced to two new capabilities for OS/2 that were officially announced recently. Microsoft said that at some point in the future, perhaps late this year, OS/2 will be able to run Windows programs directly. In other words, you won't have to run Windows applications under OS/2's DOS compatibility box. With this capability, any Windows application would be able to run directly under OS/2 just like a regular OS/2 program. In practice, OS/2's new capabilities would mean that Windows applications could swap data with other Windows or Presentation Manager (PM) applications through OS/2 Dynamic Data Exchange channels or the clipboard, thus eliminating migration penalties between the operating systems for end users and facilitating networked applications involving programs written for both environments.

Microsoft says that this capability will be available in a future edition of OS/2 version 2. Ballmer says that it could appear in the version that will show up by the end of this year, but the company does not want to commit to that date.

The second and related capability is a new Software Migration Kit that could greatly simplify for developers the task of porting Windows applications to OS/2. Using a concept similar to Micrografx's Mirrors—in fact, parts of the technology, though not the code itself, were licensed from Micrografx—this kit provides a set of libraries that developers can link into Windows applications to map their Windows calls into PM calls. Microsoft hopes that using this kit will slow performance down by no more than 10 percent.

Some industry observers have complained that Microsoft has failed to differentiate Windows from OS/2 in a manner understandable to users. Ballmer's comments changed that situation in an unexpected way: For the first time, instead of hearing OS/2 touted as an end-user operating system (which, of course, it can still be) or that the user's CPU and memory configuration should determine which operating system to install, Microsoft appears to be easing into a client/server model at the operating-system level. Software companies that develop DOS applications are adopting that approach, too.

This positioning will help OS/2-based LAN Manager and SQL Server, but the biggest beneficiary will be the corporate computer manager with an installed base of hundreds or thousands of 286-based machines: Now, the pressure to convert from DOS to OS/2 on every desktop has lessened considerably.

*—Rich Malloy*

*continued*

### NANOBYTES

Now that the legendary **new Windows** has arrived, where is it going next? Some people at **Microsoft** hope to **squeeze it into ROM** and have computer makers pop the chips onto their motherboards. The company has put DOS into ROM (and Digital Research has done the same with DR DOS). There's "no magic" involved in getting the graphical environment into ROM, according to Rich Abel, Microsoft's group project manager for Windows. But considering the amount of RAM that Windows 3.0 requires, somebody might want to put in a call to Blackstone.

Not every big software company is doing the omniplatform thing. **Borland** president **Philippe Kahn** says that the company will develop languages and applications for DOS, Windows, and OS/2 but has **no plans to design new Macintosh or Unix packages**. The company wants to write software that is used by people, not by other machines, he says. "Our goal at Borland is to deal on the client side [of the client/server model]: user tools and development tools."

**Smallness** has been such a theme in Microsoft CEO **Bill Gates**'s public comments lately that you'd never know he heads a software company that's anything but small. Gates told some users group representatives during a late-night session that he was unimpressed by a competitor's boast in an advertisement that it has 35 programmers working on a product. "**It takes a small team** to do it right," Gates said. "When we started Excel, we had five people working on it, including myself. We have seven people working on it today, and at the maximum we had 15 people working on the program. There's too much that needs to work together to have so many people spread out on a program."

## NANOBYTES

**ICI ImageData**, a British company that makes the substrate used in floppy disks, is working on a new type of optical media. ICI's 4-mm **LaserTape**, based on a technology developed jointly by Sony and Hitachi, uses a technique called *holographic tag recording* to put 1 trillion bytes of data in a single package just slightly bigger than a digital audio tape cartridge. A company official said that the compatible drives will be able to access any piece of data in an average of 28 seconds.

Computer users have been **hesitant to accept optical storage** devices because they represent a "totally new market," says Jim Jones, Hewlett-Packard marketing development manager for optical drives. "One percent of the world's data is stored on disk, 2 percent on tape, 5 percent on microfiche, and 95 percent on paper only," Jones says. It's that 95 percent that represents a "new opportunity," he says.

**Peripheral Land** (Fremont, CA) has designed a Macintosh RAM drive with its own 68020 processor acting as the disk drive controller. It runs about 500 times faster than a normal hard disk drive, allowing up to **1000 disk accesses per second** and 6-MBps data transfers, PLI says. But be prepared to dig deep into your pockets: An 8-MB RAM drive costs $6995; a 108-MB version costs $60,000. But for a network server where speed is critical, for example, this RAM drive could be cost-effective.

The new version (3.1) of Timbuktu from **Farallon Computing** (Emeryville, CA) lets a user at one Macintosh observe and control multiple Macs on a network simultaneously. This capability is actually a **form of groupware**. Using Timbuktu, multiple users can work on a document at the same time. Timbuktu also allows voice communications over the same phone line as the PhoneNet network. Farallon's Tom Reilly said the company's ambition is to fully integrate voice mail and E-mail over networks.

# Motorola's I/O-Driven Media Processor Built to Handle Color Graphics, Stereo Sound

If industry evangelists are right that images and sound will be a big part of computing, systems are going to need more power than what they have in their general-purpose CPUs. Motorola thinks it has the answer with its new 96002 FPU, a 32-bit chip designed to handle the furious calculations and frenzied data shuttling involved in generating colorful graphics and stereo sound. The new processor "is not so much a CPU as a chip to deal with real-time, continuous I/O," said Garth Hillman, applications manager for Motorola's digital signal processor operations (Austin, TX).

The 96002 is a successor to Motorola's 24-bit 56001 DSP (used in the NeXT Computer), but the designers have built in an FPU (conforming to the IEEE-754 standard) to deal with the calculations required by three-dimensional graphics and algorithms for realistic imaging. At the core of the 750,000-transistor chip are four devices: an ALU; a program-control unit; a dual-channel DMA controller, which can work on two data transfer tasks at the same time; and an address-generation unit.

These execution units and the 96002's six on-chip memories (three ROMs, three RAMs) are connected by eight 32-bit buses (five data, three address), with a bandwidth of 266 million bytes per second, Motorola says. With all these execution units, memories, and high-speed buses, Hillman said, the chip can process 10 operations in one instruction cycle.

Motorola has designed the 96002 to work as an "attached processor," Hillman said. It's meant to handle all the chores related to media processing instead of the host CPU (e.g., a 680x0 or 80x86). The chip has two 32-bit ports on opposing sides, by which the processor can directly send and receive commands to and from other processors. Using these two ports, a designer could string multiple 96002s in linear arrays or in symmetrical blocks, Hillman explained.

Because the chip can appear to generate images and sound simultaneously, Motorola says, it will be perfect for multimedia computing machines. However, the 96002 could also find a place in graphics engines, scientific imaging systems, color laser printers, and communications devices.

Motorola says that computers and boards using the new "Media Engine" will arrive later this year. The first company to introduce a 96002 product is Ariel (Highland Park, NJ), which offers an add-in board called the MM-96 for AT compatibles.

Motorola has started offering samples of the 96002. The first version has a clock speed of 33 MHz; a 40-MHz model is in the works. The price for a 33-MHz model is $750. Motorola says that price will tumble; Collins pointed out that the 56000 DSP came out in 1987 at $500 and now sells for $56.

Until now, building a system that can manipulate realistic graphics and CD-quality audio required multiple chips dedicated to those different media. Motorola has developed one device that can handle the billions of computations involved in audiovisual operations. The 96002's dual-bus approach represents "where DSP is going to head," said Ariel president Anthony Agnello. "People who write algorithms are insatiable for power."

*—D. Barker*

# Mac Developers Finally See System 7.0

Apple Computer promised to deliver System 7.0, its major revision of the Mac OS, during the summer of 1990. But the winter of 1991 is a more accurate projection. Apple finally distributed an alpha version with the System 7.0 development kit, on CD-ROM, to independent developers in May. Apparently realizing that software designers can make or break the new Mac OS, Apple officials used the Worldwide Developers Conference to convince them that System 7.0 will be worth their investment.

In addition to a totally revamped Finder shell (which, among other things, will actually find a file based on user-supplied search criteria), the new system software will support an interapplication communication (IAC) protocol. IAC will allow implementation of a publish/subscribe mechanism

*continued*

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## NANOBYTES

Rembrandt, who was sometimes too broke to buy new brushes, would have liked these guys. **Delta Tao Software** (Sunnyvale, CA) has come up with a 24-bit **color painting program** for the Macintosh that **costs only $99. Color MacCheese** offers full-color picture manipulation, regardless of screen depth; waterpaint-like blends and wash effects, like some of the higher-priced art packages; antialiasing on objects, so that their edges look less jagged (this feature requires 32-Bit QuickDraw); full support of color printing through Apple's LaserWriter 6.0 driver; and a help window that displays explanations of the tool icons or menu selections when you put the pointer near them. As for the name, a Delta Tao official said that the people there wanted to develop a "cheesy little color paint program."

**Apple Computer recently lowered the price of its Macintosh Portable** by $1000. A model with one floppy disk drive and 1 MB of memory retails for $4799; with a 40-MB hard disk drive, it costs $5499. According to marketing manager Dave Rothschild, the price cuts are Apple's response to new products designed to compete in the Mac "laptop" market, including the Outbound Laptop System from Outbound (formerly Wallaby), the Road E Kit from Macadam Computers, and the Stealth Laptop from Colby Systems. Response to the cut was generally determined by religious affiliation: Mac users said it was a good move, and users of IBM-type systems said it was still too expensive.

**Advanced Micro Devices** (Sunnyvale, CA) and **Vitesse Semiconductor** (Camarillo, CA) are working together on **high-speed circuits** for data communications. The gallium-arsenide chips will be part of "gigabit-speed connections between computers," an AMD official said. The initial joint product will be chips for electronic interfaces to optical systems, the companies said.

that can, for example, update information within an existing document when information changes on another linked document. The ability to use and recognize IAC events will be the hallmark of System 7.0 applications but will certainly require developers to rewrite their existing applications.

Some of the anticipated features of System 7.0 are not yet being released to developers; one of these is the AppleScript language, intended to allow users to customize their environment at a fairly high level. And a few features promised at last year's developers conference will not appear in System 7.0, including asynchronous SCSI protocols (perhaps Apple is waiting for the final implementation of SCSI-2) and the new Print Architecture. Apple personnel said that there wasn't time to implement these functions. "We had to decide what was of the most importance," one said.

Although Apple states that System 7.0 will run on any Mac with 2 MB of RAM and a hard disk drive, quick tests of the alpha version showed it to be unacceptably slow on any machine other than a Mac II. Apple could fix this speed problem before issuing the final software, however.

The question for developers then becomes whether or not it will be worth their time and money to revise their programs. Apple is trying hard to get them motivated, if not intimidated; one company official even said that "if you don't go the System 7.0 route, you'll be out of the Mac software business in a few years." Developers at the conference were generally positive, if somewhat confused.

Regardless of how many Mac software companies migrate to System 7.0, compatible programs will be delayed, because developers can't really get started until they have a beta version of the operating system to work with. Delays could be further extended because System 7.0 is very complex, involving memory management of multiple tasks and interprocess communications (IPC). One veteran Mac programmer, Yung Harvill, said he fears that users will be reluctant to upgrade to System 7.0 until their favorite applications run smoothly under it.

Many existing Macintosh software products will not be compatible with System 7.0, said Harvill, who developed Paracomp's Swivel 3D program and also worked on VPL Research's DataGlove. "A lot of older products fiddled with the high memory bits," he said, "and those won't run on System 7.0." Macintosh software vendors will have to establish "more formal relationships" with each other, Harvill said, since interprocess communications will require integration of programs from different vendors.

Nevertheless, Harvill said he looks forward to System 7.0. "The virtual memory and IPC features will really help us," he said.

—*Nick Baran and Larry Loeb*

## Standard Would Enable Expert Systems to Exchange Knowledge from Different Sources

Major high-technology vendors and users have banded together to formulate an open software standard for expert systems. The standard, which they expect will be used in new expert systems later this year, is designed to facilitate interoperability among knowledge-based programs that run on different hardware and operating-system platforms.

The Initiative for Managing Knowledge Assets was founded by DEC, Texas Instruments, Carnegie Group, Ford Motor Company, and US West. IMKA has just begun to develop the code that it says will be used to write a new generation of expert-system software.

Those new expert systems are expected to run on many major operating systems, including Unix, OS/2, and VAX/VMS, and on all types of machines, from mainframes to personal computers. The programs will not run on DOS-based machines, however.

The new software will allow expert systems residing in many facilities and on different computers to access and analyze data residing anywhere else in the organization, said David Fawcett, manager of expert systems at Ford. For example, Fawcett said, a design engineer using a CAD/CAM workstation equipped with an expert system based on the new standard will be able to import "knowledge" from a different type of computer located at a remote production facility, allowing the designer to access information on manufacturing specifications or even

*continued*

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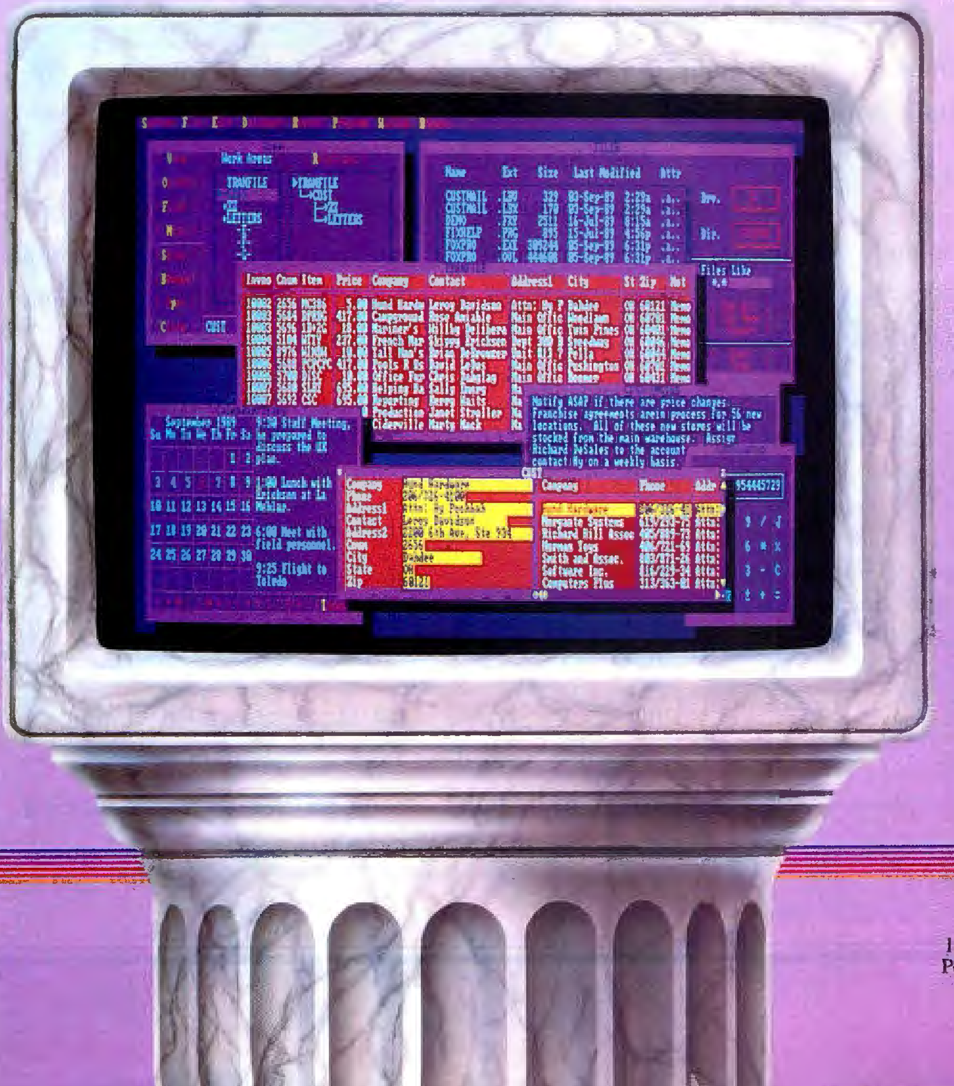

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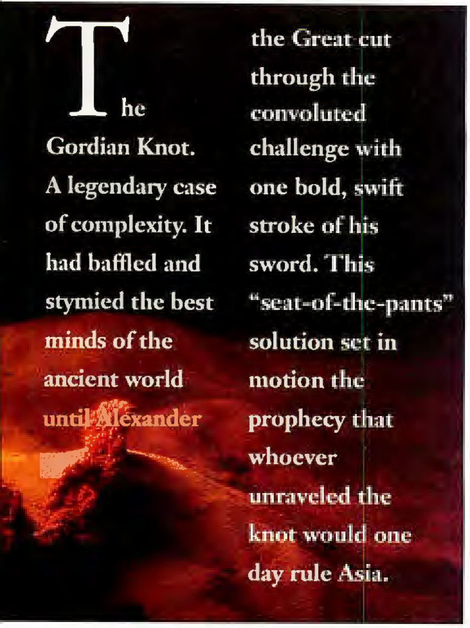

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## NANOBYTES

After tackling the nuclear-triggered geopolitical situation with Balance of Power, noted **game designer Chris Crawford** has taken on an even more complex subject: the earth's environment. **Balance of the Planet** is a simulation program meant to illustrate the interrelationship between humans, industry, and Mother Earth. You play the United Nations High Commissioner of the Environment. The game starts in 1990; you have until 2035 to straighten out the mess. Be prepared for bad results: Poor policies can contribute to starvation, flooding, and a host of other woes. The simulation is not easy; we know one technical editor who, in the course of a weekend, wiped out the world nearly half a dozen times before determining which industries to tax and which objectives to fund. The program is available for Macs or PCs; it's $49.95 from Accolade (San Jose, CA).

When it comes to user interfaces, there's **too much "breakfast cereal marketing,"** said departing Apple Products president **Jean-Louis Gassée** in a recent speech to Mac users. "We talk about windows and menus and magic-this and hyper-that. Soon we'll have the user interface equivalent of cola wars."

**DuPont Imaging Systems** (Newark, DE) has designed a hardware/software package that gives Macintosh users **access to Unix through the Mac interface** and file system. The new MacBlitz coprocessing board ($9995) uses a Clipper C300 RISC processor running at 50 MHz.

**WordPerfect** (Orem, UT) has just started beta-testing its word processor for OS/2 Presentation Manager and expects it on the shelves in November. The company will provide its OS/2 drivers for the hundreds of printers now supported by DOS editions of WordPerfect. The company says that it's committed to a **Windows version** but doesn't think it will be ready until 1991.

financial data that might affect the design.

The code for the new standard is being built using C and C++ and will employ an X Window System–based user interface on all platforms. The expert systems based on the standard will be compatible with Structured Query Language–based database systems, the developers say.

Ford and US West plan to start beta tests of software using the new code in the fourth quarter of this year. Testing of more-advanced software versions is scheduled to start in the fourth quarter of next year.

Cooperation between the companies is limited to the development of the new software code. Each partner will be allowed to use the code to produce and market its own knowledge-based expert systems. IMKA is looking for new recruits, including foreign firms, to contribute funding or technical expertise.

*—Rob Calem*

## Sharp Plans Better-Looking Color LCD This Year

Although Sharp and NEC are now selling portable computers with flat-panel color displays, both companies admit that the screens leave something to be desired. The color is washed out, and the viewing angle is restricted.

But that picture could change soon. Sharp Electronics (Mahwah, NJ) plans to have a color 10-inch LCD panel available to OEMs by the end of September. The color screen could appear in portables by early 1991. The new Sharp display uses the same active-matrix technology as the Macintosh Portable but adds 512 colors and VGA resolution.

Active-matrix color LCDs are now used in tiny TVs and have been heralded as the display technology of the future. But poor manufacturing yields have made panels larger than about 6 inches across unreliable and prohibitively expensive. The difficulties of making even a monochrome active-matrix panel accounted for much of the delay in the Macintosh Portable.

The new thin-film transistor (TFT) Sharp screen represents two innovations. First, each pixel is backed up with two transistors, so if one fails, another is there to take its place. Second, the company has a new manufacturing line that uses laser repair equipment; defective transistors can be fixed or removed before the display leaves the plant.

The Sharp TFT screen has a total of 921,600 pixels, or three for every point of a 640- by 480-pixel VGA array (one each for red, green, and blue). The quality difference between the TFT screen and the passive-matrix display in the Sharp Multi-Color 386 is striking: The TFT's colors are bright, rich, and solid, and the horizontal viewing angle is a wide 120 degrees.

The panel uses a lot of juice—about 12 watts, including hot-cathode backlighting—so for the time being, it's practical only for AC-powered machines. It also weighs 2⅕ pounds, or about half as much as some entire notebook computers.

Sharp estimates that its color LCD panels will cost five to 10 times as much as a conventional monochrome LCD. This could make for an expensive computer, but Sharp, which plans to use most of the displays itself, thinks that it can produce a model in the $10,000 range, or for about the same price as the Multi-Color 386.

*—Andy Reinhardt*

## First of Fatter Floppy Drives Finally Arriving

High-capacity floppy disk drives have been something of a Holy Grail in the personal computer business, but for end users the search could be winding down. Q/Cor (Norcross, GA), a Quadram spin-off, says that it has started shipping floppy disk drives that can pack 21 MB onto special 3½-inch media. The Stor/Mor drives are based on Brier Technology's Flextra subsystem, which uses a proprietary closed-loop servo tracking scheme to boost disk capacity. Flextra was announced more than a year ago and has been in testing since then.

Stor/Mor drives have an embedded SCSI controller and are shipped with an interface board for IBM PC compatibles. An external unit for ATs lists for $895, an internal for ATs is

*continued*


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## NANOBYTES

**MIPS Computer Systems** (Sunnyvale, CA) is designing a **new workstation**, currently called the RC6280, that will use the company's new R6000 RISC processor. This is subject to change, but the system will most likely come with 32 MB of main memory (expandable to 256 MB); address up to 4 gigabytes of virtual memory; use multiple VME buses; and have a 655-MB hard disk drive, a SCSI bus, and serial and Ethernet ports. The 66.7-MHz R6000 processor can achieve single-cycle execution time for almost all instructions, MIPS says.

**National Information Services** (Baltimore) is publishing *Consumer Reports* on **CD-ROM**. The "beginner's" collection dates back to January 1985; the advanced collection, which comes with more sophisticated search tools, dates back to January 1982. Annual subscriptions are priced at $445 and $695, respectively.

**Japan's Ministry of International Trade and Industry** will spend $46 million on its **Fifth Generation Computer Project** this year, and $9.8 million on its distributed data-processing environment of the future, according to *New Technology Week* (published by King Communications, Washington, DC). MITI will invest $100,000 in neural network research, the newsletter said.

**Xircom** (Woodland Hills, CA) has **cut the price** of its Pocket Ethernet Adapter by $100. The diminutive device, which works with IBM PC–compatible laptops, now sells for $595.

**Senior managers** at the nation's 1500 biggest companies **aren't happy** with the way their businesses are using computer technology, according to a survey conducted by **Beta Research** (Syosset, NY). Beta pollsters report that 52 percent of the senior managers polled said that their companies are not using computers and communications to their full potential.

$795, and an external unit for Micro Channel machines is $995. The special disks cost $25 each.

Flextra is one of several emerging technologies to cram greater amounts of data onto 3½-inch removable floppy disks. Most of the new drives are still months from reaching the market, but a 2.88-MB-capacity model made by Toshiba and resold in the U.S. by Pacific Rim Systems could become the next step up from 1.44 MB. Insite Peripherals says that it's redesigning its 20.9-MB Floptical drive (announced last year) for backward compatibility. The company's current I325 model will remain an evaluation unit only, and Insite's first commercial product will be a 1-inch-high drive slated for next year.

The Toshiba, Insite, and Brier systems all use new barium-ferrite disks manufactured by Maxell, Verbatim, and others. These disks have ultrafine metal particles and a smoother surface than conventional ferric-oxide disks, which lets them hold twice as much data per linear inch. In the Toshiba drive, which is compatible with existing 720K-byte and 1.44-MB disks, the media is formatted with the same number of tracks, but each track has twice as many sectors.

The Insite and Brier drives achieve their higher capacity by greatly increasing the number of tracks on the disk. Since the head can be positioned very precisely, the tracks can be narrower and closer together. To encode track information, however, requires that the mass-produced barium-ferrite disks be specially formatted at the factory. As a result, the disks are more costly, and neither drive can read from or write to existing floppy disks.

Brier's "twin-tiered tracking" involves storing data on two levels of the disk media. The bottom layer contains magnetic servo information that defines the location of the tracks, while the top layer holds data.

Flextra disks have an unformatted capacity of 25 MB, or 21.4 MB after formatting. The servo tracks now written onto the disks are dense enough to support capacities of 50 or even 100 MB unformatted, Brier says, but getting to the higher levels will involve further technology refinements and new metal-powder disk media. Brier plans to announce a 43.2-MB-capacity model "within the year."

*—Andy Reinhardt*

## Little Guys: Bill Gates Has Good News for You

Small application programs and small software companies to develop them—that's a wave of the future, according to Microsoft chairman Bill Gates. Gates told the National Apple Users Group conference recently that he bases his forecast on what he sees as a move away from large, multifeatured application programs, like Word and Excel, to small, special-purpose programs that can work together.

"Because things are fairly self-contained today, with simply cutting and pasting, you can have only these large applications. You can't have these nifty little tools that you pull in to manipulate a little bit of data and then move that data onto another application," Gates said. "With an architecture of small- to medium-size applications to attach to larger applications, we allow small software companies to provide specialized packages that will appeal to special audiences that the larger companies like ours cannot address."

The technology that will spur these new programs and small companies is the Dynamic Data Exchange channel in Windows and OS/2, which allows applications to easily exchange information, Gates said.

*—David Reed*

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# LETTERS

*and Ask BYTE*

### Tales from the Archives

While "Saving Space" by Steven J. Vaughan-Nichols (March) is quite informative, I would like to make a few comments. Vaughan-Nichols says that "none of [the archiving programs] bothers to determine whether sufficient space exists. . . before starting." This is true but misleading. It is impossible to predict just how much space will be required for working files. The designer must walk the thin line between the possibility of the program running out of space and that of alerting the user that there is insufficient space when, in fact, there is enough.

It is possible to check the fit as the program proceeds, or to break the job into two or more smaller pieces. But these approaches also have problems—namely, slower compression time, and loss of an unerase utility to recover the previous archive.

Vaughan-Nichols mentions that he has never been able to create a self-extracting archive using LHarc 1.13. I have been using that version for about eight months and have never had a problem with it. Not only does it produce archives that are typically within a few percentage points either way of the size of PKzip archives, but its self-extraction code adds only about 1300 bytes to the size of an archive. It also does not require another file in the same directory—as PKzip 1.01 does, contrary to its documentation. LHarc cannot create a self-extracting archive if there is not enough memory, while PKzip's self-extracting archives work on machines with any memory size. Due to the convenience of LHarc's self-extraction feature, I am currently using it for all my self-extracting archives.

I use PKzip for almost all other archiving because of its significant speed advantage over LHarc. I also use PKzip in its quick compression mode to back up data files and source code, since it is fast, compresses relatively well, and allows multiple file specifications. Another advantage of PKzip is that it detects when it is running on a 386 and uses 386 instructions for a significant performance improvement.

One final point. Zoo is not the only archiving program available on more than one system. I use LHarc and ARC on a

Saving Space

*Data compression can add years to the life of your hard disk for a lot less than the price of a new drive*

*Steven J. Vaughan-Nichols*

Unix machine, and I have heard of a Unix version of PKzip.

Stephen M. Dunn
*Brampton, Ontario, Canada*

### The Coke Standard

You should have told Charles E. Green (Ask BYTE, March) that the computer industry is hard at work searching for alternatives to confusing technology.

Sharp observers, for example, will have noticed the subtle shift toward the adoption of familiar objects as reference standards. Witness the clever use of Coca-Cola cans to define precise height, a move introduced simultaneously in the March BYTE by Flytech Technology (page 96) and Northgate Computers (following page 40). The latter even went so far as to announce that it had broken the full-can height barrier ("standing not even as tall as America's favorite diet cola"). No doubt benchmarks will soon codify this brave lead. Figures such as "1.678 cans," "4.238 cans$^2$," or even (is it too much to hope for?) "0.0795 cans per second" will soon become commonplace.

It is disturbing to see that full standardization still eludes us, as the two innovators cannot agree on whether the calibration standard should be Diet Coke or regular Coke. But an important first step has been taken, and I think it should be applauded.

Peter Bolton
*New Smyrna Beach, FL*

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### Succession Crisis Revisited

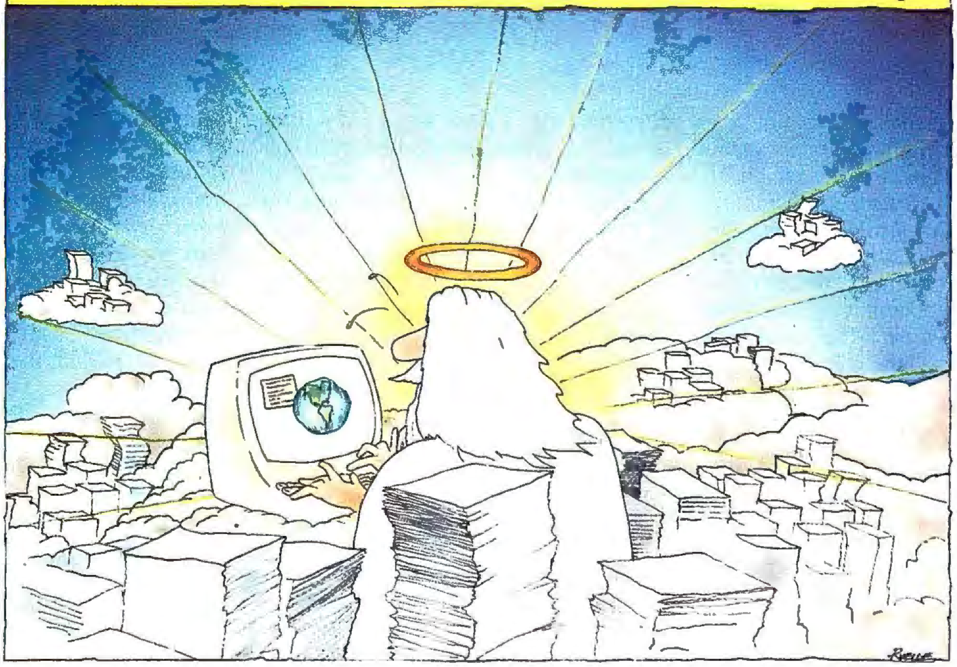
I found Bob Ryan's "The Succession Crisis" (March) both informative and useful to those who are considering Unix and OS/2 as an alternative to DOS. I believe that Ryan's advice to postpone the Unix versus OS/2 choice until they both offer the range of applications found under DOS is well taken by those who can afford to wait.

For those who must make the move in the near future, the situation is different. I'd like to point out some of the findings of a comparison between Unix and OS/2 that Andrew S. Tanenbaum makes in his book *Structured Computer Organization* (Prentice-Hall, 1990):

- Unix supports multiple users; OS/2 supports one.
- Unix is portable; OS/2 was designed specifically for the 286.
- Unix has a linear memory model; OS/2 has a segmented memory model.
- Unix supports virtual memory via paging; OS/2 supports it via segmentation.
- Unix allows multiple links to a file; OS/2 does not.
- Unix allows a collection of disks to be mounted on a single tree; OS/2 does not.
- Unix processes make system calls by trapping to the kernel; OS/2 processes make system calls by procedure calls through call gates.
- Unix has only a single level of access—the file system; OS/2 also has I/O subsystems.
- Unix has neither threads nor sessions; OS/2 has both.

*continued*

# Great Moments in C-Programmer History



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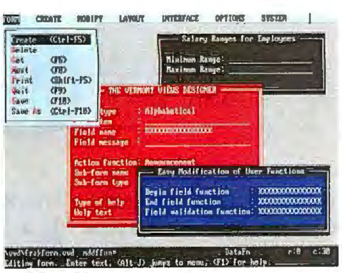

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Tanenbaum says that an even more important factor is the widespread availability of Unix source code, which allows Unix system developers to rapidly respond to technological changes. The source code for OS/2, on the other hand, is a guarded secret held by IBM and Microsoft. As an example, Tanenbaum points out that when RISC machines were introduced, Unix was the unanimous choice of all the RISC vendors.

Unix is over 20 years old, and it has a rich tradition and culture associated with it. A rich tradition and culture for OS/2 has yet to be established.

Rodney Adams
*Cambridge, MA*

## Multimedia Wars

I think Don Crabb has misled readers and given bad advice in "A Mac Mélange" (March). The Macintosh is a reasonable platform for multimedia, provided you have unlimited funds. It is expensive to provide the Mac with the functionality that the Amiga has right out of the box. The Amiga was designed as a multimedia (and multitasking) machine, and if Crabb does not take it seriously, the people who are using it for digitized images, sound, music, full-motion video, and animation do.

My advice to Crabb's readers is this: If you are interested in multimedia, by all means look at the Mac first. Then buy an Amiga.

Dana S. West
*Columbus, OH*

## East Europeans Seek Correspondents

I am a 36-year-old electronics engineer. I work mostly on projects based on the Intel 8048, 8051, and 8096 single-chip microcontrollers for use in measurement and control. I would like to find someone with whom I can exchange letters on programming hints and hobby applications of these devices.

Lubomir Matystak
*Polni 581*
*742 83 Klimkovice*
*Czechoslovakia*

I have been a reader of BYTE for several years, and I profit greatly from your articles on both hardware and software. I develop information-retrieval software under MS-DOS, OS/2, and Unix, and I try to capture the actual trends in software engineering with the help of your magazine.

The changes here in East Germany have given me greater opportunities for sharing information with the international community. This is why I am writing to you. I'd like to find a colleague to correspond with.

I am 43 years old. My wife is a teacher of Russian and English, and we have a 12-year-old daughter. In addition to my professional interests, I enjoy the cultural events that Dresden and Saxonia are known for (especially the concerts of the Staatskappelle and the exhibitions of the Semper Gallery). My wife and I are interested in English and American literature.

Dr. Peter Naumann
*Rosenbergstrasse 21*
*Dresden 8021*
*East Germany*

## Thanks for the Unix Benchmarks

I read Ben Smith's "The BYTE Unix Benchmarks" (March) with great pleasure. Someday, perhaps, BYTE will routinely publish Unix-based performance figures.

In principle, all BYTE benchmarks might be run simultaneously on one Unix system. The total real time would be longer because of multitasking overhead, but the per-process user and system CPU times should be the same as for successive, serial benchmark runs.

The new BYTE shell-script approach should yield portability. However, there are pitfalls in the form of unknown but systematic errors in user time to search the PATH for the script's executables. Below is the data for the old BYTE Sieve of Eratosthenes benchmark program, coded with *times* (*S*) system calls and run under shell timing (using The Santa Cruz Operation's Unix 3.2 running on an IBM AT with an Intel Inboard). It ran 10 iterations to a maximum of 8191 (1899 primes). The average user time in seconds (variation) of six trials on a quiet multiuser system is as follows:

| | System call | Time command |
|---|---|---|
| C shell built-in time | 0.508 (0.04) | 0.5 (0) |
| timex sieve | 0.602 (0.16) | 0.611 (0.16) |
| /usr/bin/timex ./sieve | 0.468 (0.01) | 0.472 (0.01) |

These results do not invalidate the BYTE shell-script approach for between-platform comparison, provided that all commands are invoked by a fully qualified path.

John Michael Williams
*Senior Software Engineer*
*Dazix, Inc.*
*Redwood City, CA*

*The time utility is not started until all paths and variables have been established and the test is ready to run. In the benchmark tests that return the number of loops (instead of a time), the timing routine is internal to the test itself and is not started until all the internal variables have been set for the specific test. Future tests for BYTE benchmarks will follow this later scheme, since there is no upper limit on performance that can be evaluated this way.*

*We do, in fact, run some tests concurrently, but with as much control as possible. The system-load test incrementally increases the number of concurrent copies of itself that are running. This is a good indicator of how a system will perform under a variety of process loads. The danger of running benchmarks when the system is in multiuser mode is that there are an unknown number of demon processes associated with being at the multiuser level.*

*Although it is impossible to have absolutely all the variables dependent on the benchmarks, we think that it is important to try to reach that goal to cross-evaluate divergent Unix versions on the spectrum of Unix hardware. That doesn't mean that benchmarks are invalid when run in other than our standard way (e.g., single-user, no windowing, and full optimization). Our tests can be used for evaluating a single machine under different conditions. In this way, they become a tool for fine-tuning performance.*

—Ben Smith

## Don't Tell All

I am appalled at Hugh Kenner's review of that wonderful true mystery by Clifford Stoll, *The Cuckoo's Egg* (Print Queue, March). This wasn't a review; it was a retelling of the whole story. How dare he "tell it all" and ruin the excitement of reading it and wondering, "What next? What next?"

B. M. Hutchison
*Pendleton, OR*

## ASK BYTE

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## CD-ROMs and Printers

What does it take to install a CD-ROM drive in an XT or AT clone? Is a SCSI controller card necessary? Do different ROM drive manufacturers have different requirements?

If you have a color printer, what is the best way to dump screen images for CGA, EGA, or VGA?

Al Sardello
*Boulder, CO*

*continued*

# Here's what they say about Zortech C++

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Richard Hale Shaw, PC Magazine, p.38, March 13, 1990

"' Zortech has done a commendable job with C++ 2.0 and I recommend it highly...The debugger is impressive...Get the Developers version...it's worth the money."

Bruce Eckel, Micro Cornucopia, pp. 8-17, March 1990

" Zortech C++ is one of the best MS-DOS products I've had the luck to use.....I can highly recommend the Zortech 2.0 release."

Scott Robert Ladd, Dr. Dobbs Journal, pp. 64-73, January 1990

*"We have devoted virtually a full issue to evaluation of C Compilers. . . . it's an easy choice. We pick ZORTECH."*

J. D. Hilderbrand, Editor, Computer Language, p. 7, May 1990

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*CD-ROM drives normally come with their own controller (usually an 8-bit, XT-compatible card) and device driver software. To install one, you plug in the card, connect the drive, and install the drivers. That's it. The drives that we've seen here at BYTE have had controllers that are basically SCSI with some modification. Don't plan on daisy chaining hard disk drives or tape drives off the controller, although you should be able to chain multiple CD-ROM drives from the same manufacturer. To be sure, check with the manufacturer before you buy.*

*Printing color is just as easy. Normal screen printing support on the PC is simply a BIOS call to a function that reads the screen and copies the contents to an ASCII printer. The GRAPHICS.COM program that comes with DOS lets you dump a monochrome graphic to an Epson-compatible printer. You probably knew that; otherwise, you wouldn't have asked about color screen dumps.*

*Poke around on a local BBS. There are lots of public domain screen dumping programs—you just have to find one that supports both your particular printer and the screen type you have. VGA shouldn't be any problem, but without knowing what kind of printer you have, I can't give you any specific names to look for.*

*There are commercial alternatives. One choice might be Inset, from Inset Systems (71 Commerce Rd., Brookfield, CT 06804, (203) 775-5866). It's a TSR screen capture/image manipulation package that supports lots of screen modes and lots of different printers. It's probably more than you need, but it's a handy piece of software to have around anyway.*—H. E.

### Desperately Seeking

Please help me to find ESP Software Systems. Does its product, Command Plus, still exist?

A. R. Kidson
*Bromley, Kent, UK*

*Command Plus still exists. You can contact ESP Software Systems at 6120 Bristol Pkwy., Cover City, CA 90230, (213) 645-3095.*—H. E.

### The Dream Machine

I would like to buy a computer with the following components:

- a 386 running at 25 MHz with 4 megabytes of RAM
- a 32K-byte cache and controller
- an 80-MB Control Data Corp. (CDC) or Priam hard disk drive
- a Perstor PS180-16FN hard/floppy disk drive controller
- a 512K-byte Super VGA card with 1024- by 768-pixel resolution and 256 colors
- a 3½-inch 1.44-MB floppy disk drive
- a 5¼-inch 1.2-MB floppy disk drive
- an 80387 math coprocessor
- an 8514 IBM monitor
- a Northgate Omnikey keyboard
- an Epson LQ-510 printer
- a mouse

Can all this work in one machine?

Also, which interleave ratio for the hard/floppy disk drive controller is correct—1-to-1, 2-to-1, or 3-to-1? What specification on the hard disk drive is the best—run length limited (RLL), modified frequency modulation (MFM), ESDI, or SCSI?

My ultimate goal is to use CAD software to design bathrooms and kitchens, to take a space and fit it with the optimum equipment. I want to do more than just draw squares and circles. Is there any CAD software available that will help me do this?

Tom Callaghan
*Aliquippa, PA*

*Since you have a specific application in mind, here's a good rule of thumb: Pick the software you like first, then pick the computer to run it on. That way, you're sure to have all the right hardware—not too much or too little. That said, the system you're proposing should more than do the trick. However, a few things about your choices are worth pointing out.*

*The Perstor controller is designed to work with either MFM or RLL disks only. With the Perstor's data compression, you can expect to get 132 MB out of a 72-MB CDC Wren 86, or 81 MB out of a 44-MB Priam ID45H drive. You specified the 8514 monitor, which is designed for the 8514/A graphics card. Either bag the Super VGA and take the 8514/A, or use any good multifrequency monitor with your Super VGA. The 8514 is a good choice, as it's a well-known standard and is likely to be supported by most CAD software. You might also reconsider the mouse. Most serious CAD software supports graphics tablets, which are considerably more precise and often easier to use than mice. Don't buy either until you've picked out your software. Also, make sure that you have enough serial ports to connect the mouse/tablet and the plotter that you'll eventually need.*

*As for software, you can hardly go wrong with the big names in CAD. As an alternative, track down some of the field-specific drawing packages. You might find architects in your area who have specific experience in using interior design software. Take them to lunch and pick their brains.*

*To determine the best interleave, you generally try different interleave factors until you get the best system performance, or use utility software like Gibson's SpinRite to try the combinations for you.*—H. E.

### Good Things in Small Packages

I am interested in a small, durable, reliable, inexpensive hand-held computer that patients can carry with them during the day. This computer would be preprogrammed to ask the patient a series of questions that he or she could answer with numerical responses. All the hand-held computer would need for input is a numeric keypad. The computer screen would need to be able to display about 30 alphabetical characters in a single-line display. Additionally, I would need to be able to upload programs into the hand-held computer, as well as download patient responses into an IBM compatible. It would be nice if the memory capacity of the hand-held computer was around 64K bytes.

I have read about the Casio BOSS and the Sharp Wizard, and they sound interesting. Could you advise me about the pros and cons of these or similar units?

Daniel J. Cox, Ph.D.
*Professor, Department of Behavioral Medicine and Psychiatry*
*University of Virginia*
*Charlottesville, VA*

*Small, reliable, cheap, and with a big display? It's a good thing that you're not picky. One thing I was not clear on, though: You want to upload programs, and I assume that you mean PC programs. Unfortunately, the Wizard isn't PC-compatible, and it's programmed solely through ROM cartridges. For your application, that would seem to be a "con."*

*Casio's BOSS might work for you. It has a 32-column by 6-row display and can transfer data to or from both Macintoshes and PCs. To program the BOSS, you'd need to get some detailed information from Casio. Contact the BOSS Products Division at (201) 361-5400, ext. 135 or 132.*

*A few other possibilities: The Psion Organiser is another non-DOS machine that is fairly rugged and reasonably inexpensive. The Poqet computer and Atari*

*continued*


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| Lahey F77L-EM/32 (w/ OS/386) | 1090 | 979 |
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| Lattice C 386 (w/ extension) | 895 | 715 |
| Novell C Network Compiler/386 | 995 | 799 |
| Paradox/386 | 895 | 629 |
| PC-lint 386 | 239 | 189 |
| Phar Lap 386 ASM/LINK | 495 | 435 |
| WATCOM C 8.0/386 Prof. | 1295 | 1099 |
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### ASSEMBLY LANGUAGE

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| MS Macro Assembler | 150 | 105 |
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| Sourcer w/ Pre-Processor | 140 | 125 |
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| Visible Computer: 80286 | 100 | 89 |

### BASIC COMPILERS

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| MS BASIC Prof. Devel. System | 495 | 349 |
| Power Basic | 110 | 99 |
| QuickBASIC | 99 | 69 |
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### BASIC LIBS/UTILITIES

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| DiaLogic | 95 | 85 |
| GraphPak | 79 | 70 |
| GraphPak Professional | 149 | 125 |
| P.D.Q. | 129 | 115 |
| ProBas | 135 | 125 |
| ProBas Toolkit | 99 | 94 |
| ProMath | 99 | 94 |
| QBase and Quickscreen | 149 | 125 |
| QuickComm | 149 | 135 |
| QuickMenu | 59 | 55 |
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### C COMPILERS

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| C Network Compiler | 695 | 559 |
| Lattice C 6.0 | 250 | 189 |
| Microsoft C 6.0 | 495 | 329 |
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| MS QuickC w/ QuickAssembler | 199 | 139 |
| Top Speed C | 199 | 179 |
| DOS Professional | 399 | 359 |
| OS/2 Professional | 495 | 445 |
| Turbo C 2.0 | 100 | 69 |
| WATCOM C 8.0 Professional | 495 | 419 |
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### C++

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| Zortech C++ Debugger | 150 | 129 |
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### C-COMMUNICATIONS

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| C Asynch Manager 3.0 | 189 | 139 |
| Essential Communications | 329 | 299 |
| Greenleaf Comm. Library | 299 | 249 |
| Greenleaf ViewComm | CALL | CALL |
| SilverComm C Async Library | 249 | 209 |
| View-232 | 189 | 149 |

### C-FILE MANAGEMENT

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| AccSys for dBASE or Paradox | 395 | 335 |
| w/ source | 795 | 675 |
| Btrieve | 245 | 185 |
| Btrieve for DOS 3.1 Networks | 595 | 449 |
| C-Index Plus | 195 | 175 |
| C-ISAM | 225 | 209 |
| Codebase IV | 295 | 219 |
| CQL w/ PASS | 395 | 349 |
| c-tree | 395 | 315 |
| dBC III | 250 | 229 |
| dBC III Plus | 500 | 439 |
| db_FILE Bundle | 295 | 249 |
| Essential B-Tree w/ source | 198 | 149 |
| FairCom Toolbox - Prof. Edition | 1095 | 789 |
| FairCom Toolbox - Special | 695 | 509 |
| Informix Products | CALL | CALL |
| Xtrieve PLUS | 595 | 459 |

### C-GENERAL LIBRARIES

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|---|---|---|
| C TOOLS PLUS/6.0 | 149 | 109 |
| C Utility Library | 249 | 199 |
| Greenleaf Functions | 229 | 209 |
| Greenleaf SuperFunctions | 299 | 239 |
| Power Search | 149 | 109 |
| Turbo C TOOLS/2.0 | 149 | 109 |

### C SCREENS

| | LIST | OURS |
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| Hi-Screen XL | 149 | 129 |
| Panel Plus | 495 | 395 |
| Vermont Views | 395 | CALL |
| Vitamin C | 225 | 169 |
| VC Screen | 149 | 115 |

### C-UTILITIES/OTHER

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| C-Terp | 300 | 219 |
| Code Runner | 149 | 135 |
| Heap Expander | 80 | 70 |
| PC-lint | 139 | 109 |
| PCYACC Professional | 495 | 469 |
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| OPTDEBUG | 150 | 129 |
| Periscope I/512K | 495 | 429 |
| Periscope II | 175 | 125 |
| Periscope II-x | 145 | 105 |
| Periscope IV/16, 25 MHz | CALL | CALL |
| Pfix86plus | 295 | 259 |
| Sherlock | 195 | 175 |
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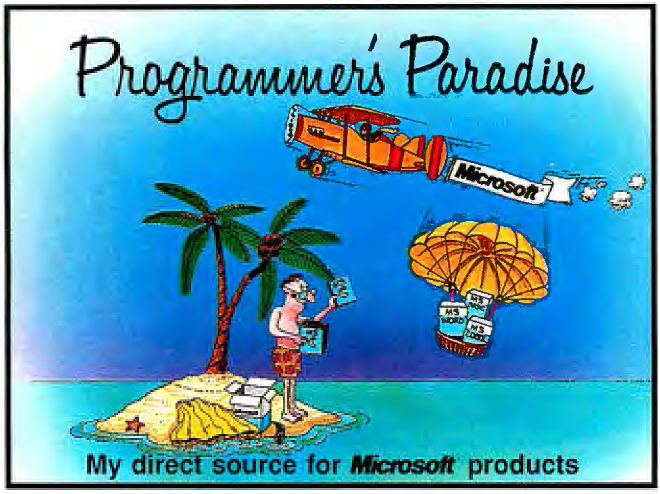


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| Mathematica for Sun | CALL | CALL |
| NeuralWorks Professional II | 4095 | CALL |
| Panel Plus (Sun 3) | 1595 | 1355 |
| WordPerfect for Sun | 495 | CALL |

## Programmer's Policies

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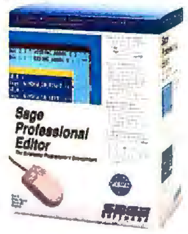
**Return Policy**
30 days. Due to copyright laws, we cannot take back software with the disk seal broken unless authorized by the manufacturer. Returned product must include R.A. number.

## *Sage Professional Editor*

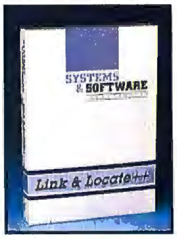



The Sage Professional Editor is the world's best programming editor, designed to create the applications of the 90's. It has an advanced windowed user interface, integrated mouse support, on-line help, menu-driven commands and is highly configurable. Turnkey emulations for Vi, Brief, EMACS/Epsilon and WordStar get you up and running fast. The virtual memory system gives you the ability to edit huge files (up to 100 MEG) in as many as 256 windows--over two billion lines. MS-DOS, OS/2 and Dual Mode versions are all included on both 3.5 and 5.25 inch diskettes.

| | List: $295 | Ours: $249 |
|---|---|---|
| w/ Mouse | List: $395 | Ours: $335 |

SAGE SOFTWARE

## *Link & Locate ++ V6.0*




SYSTEMS & SOFTWARE

Link & Locate ++ is a firmware development package for development on IBM-PC hosts for Intel 8086/87/ 186/286 microprocessors. Its features include: accepts object files as input produced by the Microsoft C Compiler and the Microsoft Macro Assembler; generates cross reference listing among input object files and library files; maintains object libraries; incremental linking with type checking of symbols; accepts debugging records in Microsoft OMF (CodeView compatible or Intel OMF); full control of placement of segments and groups anywhere in the physical memory. Works with Microsoft C 5.1 and Microsoft C 6.0. Requires 640K memory and a hard disk.

***List: $395 Ours: $329***

## *Lahey F77L-EM/32*

This is a fast and powerful 32-bit FORTRAN compiler that lets users write and port programs up to 4 GigaBytes on 80386's. F77L-EM/32 was the winner of PC Magazine's 1988 Technical Excellence Award for Compilers/ Languages. Version 3.0 includes: Weitek support for faster processing, easier mainframe porting with DO WHILE and DO END DO statements, Video Graphics, Editor, Full 77 Standard, VAX and IBM VS mainframe extensions, fast compilation, excellent diagnostics, and a powerful debugger. Another outstanding product from the FORTRAN experts. New OS/386: Includes Virtual Memory Support, DESQview Support, and free Unlimited Runtimes.

***List: $895 Ours: $719***

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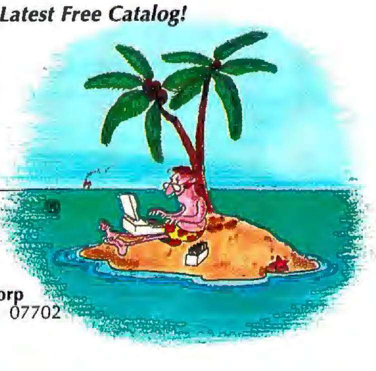

**A Division of Voyager Software Corp**
1163 Shrewsbury Ave., Shrewsbury, NJ 07702

*Portfolio are DOS compatibles. The Poqet isn't exactly cheap, and while both are well built, they may not stand up to serious abuse.*

*Should you decide to go all out, there is a class of machines specifically designed for data collection. They're not cheap, either, but they're small, reliable, and built to beat the band. National Datacomputer's DC 3.0 is the only DOS-compatible one of these that I know of. It comes standard with 128K bytes of RAM (expandable to 960K bytes), a backlit 26-column by 10-row LCD, a full numeric keypad and a small QWERTY keyboard, a serial port, and a built-in modem. And if that's not enough, the whole thing runs for hours and hours on four AA batteries.*

*It's not really running DOS, but a reasonable facsimile. You program it on a regular DOS machine and then upload the software into it. Later, you simply reconnect the PC to retrieve your data. If $2000 to $3000 (depending on configuration) doesn't scare you off, contact National Datacomputer (Middlesex Technology Center, 900 Middlesex Tpk., Building 5, Billerica, MA 01821, (508) 663-7677).*—H. E.

**Memory Serves**

I recently purchased a 386SX with 2 megabytes of memory. With DOS 4.01, I have access to EMM.SYS, which enables me to use some of the extended memory to handle many of my Symphony 2.0 files (which are too large for the 640K-byte DOS limit). I can do essentially the same thing using QEMM.SYS as the expanded memory manager, and I have figured out how to install FASTOPEN and buffers in the expanded memory.

There are various other things that I have read about doing in expanded or extended memory, but I need some help from experts. Can you recommend a good, small book on the subject? Do you intend to have any articles soon on what users can do with 1.4 MB of extended or expanded memory? Is it possible to use some of the 384K bytes immediately above the 640K bytes that DOS normally uses?

Milton Feldman
*Beaverton, OR*

*You can find a good overview of EMS in "Expanding the Limits" (March BYTE). Also, you might try* Microsoft Systems Journal. *It has done a number of articles on EMS; in particular, its September 1989 issue contains the source code for an EMS library. You can contact* MSJ's *circulation department at P.O. Box 1903, Marion, OH 44305, (800) 669-1002. Also, look for a copy of* Extending DOS, *available from Addison-Wesley.*

*As for actually using expanded memory, you should look to the very company that supplies QEMM.SYS—Quarterdeck. Its DESQview system makes good use of EMS. In fact, since you're running a 386SX, you're actually using extended memory to mimic expanded memory. DESQview can run a portion of itself in extended memory, leaving more room in conventional memory for multiple applications.*

*You can use the memory above DOS and below the 1-MB memory for RAM disks or disk caching. There are plenty of public domain packages available; check any of the shareware mail-order houses or cruise the BBS circuit (BIX is a good place to start).*—R. G.

**You Ask a Lot of Questions...**

I want to develop serious programs for my own use as well as to release into the public domain market as shareware. However, I am sure that any experienced programmer would turn livid upon viewing my spaghetti-like code. Could you recommend a good book on structured programming?

In addition, I need a book on fast, efficient, and frequently used algorithms such as sorting and searching. Also, I would appreciate it if you could give me the titles of some general books on the following topics: data compression algorithms, image- and sound-processing algorithms, encryption algorithms and general computer security, implementing an interpreter, and algorithms for implementing games such as chess on computers.

Finally, I want to implement the classic game of Life on my computer. The definition of the game calls for an infinite matrix of cells, an obviously impossible requirement. Hence, the resulting corner and edge cells can have only three and five neighboring cells, respectively, as compared to eight for all the others, which contradicts the definition of the game. How do I handle this dilemma?

Stephen J. Scheck
*Jamul, CA*

*For structured programming, try* Programming Structures, Vol. 1: Machines and Programs *by Jan Hext (Prentice-Hall, 1990).*

*For frequently used sorting and searching algorithms, there is Donald E. Knuth's classic* The Art of Computer Programming, Vol. 3: Sorting and Searching *(Addison-Wesley, 1973) and G. H. Gonnet's* Handbook of Algorithms *(Addison-Wesley, 1983).*

*For data compression, seek out* Data Compression Methods and Theory *by James A. Storer (Computer Science Press, 1988).*

*For image and sound processing, look for* Two-Dimensional Signal and Image Processing *by Jae S. Lim (Prentice-Hall, 1990). Also, locate* Computer Composer's Toolbox *by Phil Winsor (Windcrest, a division of TAB books, 1990).*

*For data encryption, see the bibliography in "Cloak and Data" (June BYTE).*

*For interpreters, look for* Programming Language Translation: A Practical Approach *by Patrick D. Terry (Addison-Wesley, 1986). Also look for Herb Schildt's* Born to Code in C *(Osborne/McGraw-Hill, 1989).*

*Finally, as for boundary conditions on the game of Life, I have seen numerous treatments. A public domain version that I've used gives players the option of either treating cells beyond the boundaries as dead, or simply not counting those imaginary cells when determining a border cell's next life cycle.*—R. G.

## FIXES

- Contrary to the features table in "Multiuser Databases: The SQL" (May, page 139), Oracle does not offer stored procedures, and Ingres does not offer binary large object data types.
- DTK Computer reports that its latest BIOS does indeed work with OS/2 1.1 and 1.2. The BIOS version used by Mark J. Minasi (OS/2 Notebook, April) apparently was not up to date.
- The correct telephone number for Jameco Electronics, mentioned in "The Heart and Soul of a PC Compatible" (April), is (415) 592-8097. Also in that article, the correct dimensions of the Atronics International ATI-386/B motherboard are 8½ by 12 inches. The ATI board does indeed have a connector for an external battery, as well. ATI says that it has upgraded its BIOS for faster caching; the upgrade is free to customers with the older BIOS.
- In "Not Quite As Simple As 1-2-3" (September 1989), the speed comparison between Lotus 1-2-3 releases 3.0 and 2.1 should read, "Lotus 3.0 is 59 percent as fast as 2.1 on a 386-based system and 52 percent as fast on a 286-based system."
- The acronym LCD in the review of the NEC ProSpeed CSX ("Color Hits the Streets," April) refers to a liquid crystal display. ■

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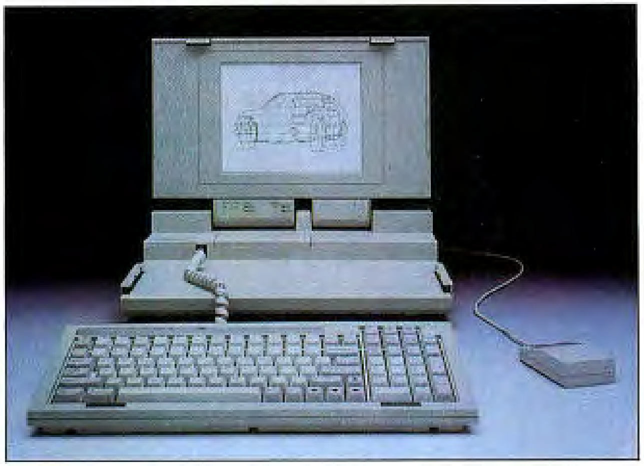


*The Altima Two is a 16-MHz 286 laptop with VGA resolution and a removable full-size 101-key keyboard.*

## A No-Compromise 15-Pound Laptop

The Altima Two is a 16-MHz 286-based laptop that includes VGA paper-white graphics on a backlit LCD, internal hard and floppy disk drives, an internal 2400-bps modem, and a full-size 101-key detachable keyboard. The system measures 15⁷⁄₁₀ by 11⅘ by 3⁹⁄₁₀ inches and weighs 15 pounds.

The Altima Two also includes 1 MB of RAM (expandable to 5 MB), a two-button mouse, DOS 4.01, a half-length 8-bit expansion slot, an AC adapter, and a carrying case. The drives are a 3½-inch 1.44-MB internal floppy disk drive and a 40-MB 25-ms internal hard disk drive. Interfaces include a VGA monitor port, a parallel port, a serial port, and an external keyboard port.

An external 4-pound, 2½-hour battery is optional.

**Price:** $4499; battery, $199.

**Contact:** Altima Systems, Inc., 1390 Willow Pass Rd., Suite 1050, Concord, CA 94520, (800) 356-9990 or (415) 356-5600.

**Inquiry 1139.**

## DTK Joins the Laptop Brigade

DTK, a company that has specialized in motherboards, has announced its first complete system, a 386SX laptop. Features include VGA graphics on a paper-white backlit LCD screen and a detachable keyboard.

Standard hardware includes 1 MB of RAM (expandable to 5 MB), an internal battery that lasts 15 minutes, a serial port, a parallel port, a 3½-inch 1.44-MB floppy disk drive, an AC adapter, and a power-saver feature. You can upgrade with a three-quarter-length 16-bit expansion slot and an 80387SX coprocessor socket. Bundled software includes DOS 3.3 and LapLink. The BIOS is DTK's own. The 386SX weighs 10½ pounds and measures 11⁹⁄₁₀ by 4 by 12⁹⁄₁₀ inches.

A system option package includes a 2400-bps internal modem (occupying a separate modem slot), an internal 40-MB 28-ms hard disk drive, an external battery pack that extends power to 3 hours and weighs about 3 pounds, and a carrying case. An optional Expansion Station, enclosed in a minitower case, can accommodate two 5¼-inch half-height drives, one 5¼-inch full-height drive, and three full-length 16-bit expansion cards.

**Price:** Under $3000; system option package, $500; Expansion Station, $295.

**Contact:** DTK Computer, Inc., 15711 East Valley Blvd., City of Industry, CA 91744, (818) 333-7533.

**Inquiry 1140.**

## Fortron Unveils Complete SX for $1495

The NetSet 386SX is one of the few 16-MHz 386SX systems that costs less than $1500. After you include the high-capacity 5¼- or 3½-inch floppy disk drive and a video card, you still have two open 16-bit slots and two open half-height 5¼-inch drive bays. The system has one parallel and two serial ports, 1 MB of RAM (expandable to 8 MB), and a 150-W power supply.

Standard equipment on the basic system includes a VGA card and a 101-key keyboard but no monitor. You can specify the monochrome system with a monochrome video card, a 12-inch monitor, and a 40-MB 28-ms hard disk drive. You can also opt for a 14-inch color VGA monitor and a 40-MB hard disk drive. DOS 3.3 or 4.01 is an option.

**Price:** Basic system, $1295; monochrome system, $1390; VGA system, $2050; DOS, $105.

**Contact:** Fortron/Source, 6818-G Patterson Pass Rd., Livermore, CA 94550, (800) 821-9771 or (415) 373-1008.

**Inquiry 1141.**

## NEC's ProSpeed 386SX Designed to Communicate

NEC's ProSpeed 386SX laptop features a proprietary expansion slot for a line of communications cards. The proprietary Laptop Expansion Slot, the LTX, houses optional cards for local area networking, several types of synchronous terminal emulation, and a modem. The ProSpeed 386SX laptop also includes one non-LTX proprietary slot for memory and another for a modem or fax modem.

Standard features include a backlit VGA display, an 82-key keyboard, 1 MB of RAM (expandable to 9 MB), a 3½-inch 1.44-MB floppy disk drive, and your choice of an internal 40-MB (29 ms) or 100-MB (25 ms) hard disk drive. Standard interfaces include one serial port, one parallel port, a floppy disk drive expansion port, an RGB video output port, an external keyboard port, an RJ-11 modem port, and a DC power port.

LTX cards are available for Ethernet, Token Ring (4 Mbps), ARCnet, 3270 emulation, 5250 emulation, send-and-receive faxing, additional serial ports, SCSI devices, and memory. The laptop measures 12 by 14⁹⁄₁₀ by 3⅖ inches and weighs 14 pounds.

**Price:** With 40-MB hard disk drive, $5799; with 100-MB hard disk drive, $6599; battery cartridge, $199.

**Contact:** NEC Technologies, Inc., 1255 Michael Dr., Wood Dale, IL 60191, (800) 826-2255 or (708) 860-9500.

**Inquiry 1142.**

## Hewlett-Packard Shows Mac Printers, One with Color

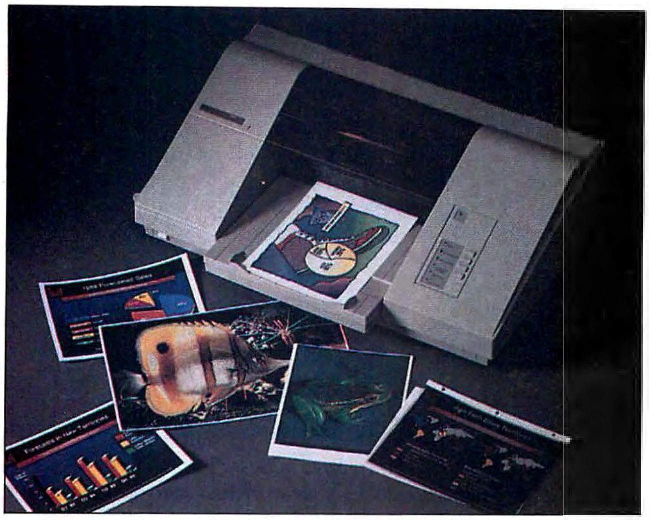
Hewlett-Packard has introduced a color printer for Macs on an AppleTalk network and added an AppleTalk interface to its DeskWriter.

On or off AppleTalk, the HP PaintWriter XL prints a page of color graphics in about 1½ minutes. It uses all QuickDraw-compatible software and lets your Mac II print on letter- and tabloid-size (11- by 17-inch) paper from a palette of up to 16.7 million colors. Your Mac Plus, SE, or Portable can print from a palette of up to eight colors. The PaintWriter XL also features background printing with a spooling capability and has scalable outline fonts, including CS Times, CS Triumvirate, CS Courier, and CS Symbol.

The PaintWriter XL can print in portrait and landscape orientations and has an automatic sheet feeder that will handle up to 200 paper pages or 70 sheets of overhead-transparency film. The PaintWriter measures 9 by 29½ by 17⅓ inches.

The enhanced DeskWriter is a thermal ink-jet printer with a print resolution of 300 dpi. It measures 17³⁄₁₀ by 8 by 14⅘ inches.

**Price:** $2995; DeskWriter, $1195.
**Contact:** Hewlett-Packard, Company Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.
**Inquiry 1143.**



*HP's PaintWriter XL is designed for your Mac, and it functions on an AppleTalk network.*

## 20-pound Device Projects VGA and Mac Color Images

The MagniView 800 VGA multisync data projector lets you project up to eight shades of simulated color from any VGA or Mac-compatible video source, according to the manufacturer. And because it's equipped with a 250-W lamp, a fan, and a projection lens, you don't need a separate overhead projector.

The maximum graphics resolution is 640 by 480 pixels; the maximum text resolution is 720 by 400 pixels. Controls on the front of the 13- by 17½- by 6-inch unit let you adjust color, contrast, synchronization, and positioning and let you clear the screen and reverse the video.

**Price:** $1895; Macintosh interface, $20.
**Contact:** Dukane Corp., 2900 Dukane Dr., St. Charles, IL 60174, (708) 584-2300.
**Inquiry 1146.**

## Panasonic Offers 8514/A and VGA Color Monitor

The PanaSync C1381 is an inexpensive 14-inch color monitor with a resolution of 1024 by 768 pixels.

It automatically adjusts to the signal frequencies of 8514/A, VGA, CGA, and Macintosh graphics (you need an optional adapter for a Mac). The dot pitch is 0.28.

**Price:** $699; Macintosh adapter cable, $43.
**Contact:** Panasonic Communications and Systems Co., Two Panasonic Way, Secaucus, NJ 07094, (800) 742-8086 or (201) 348-7000.
**Inquiry 1145.**

## This 3½-inch Floppy Disk Drive Holds 21 MB

Using specially made floppy disks, the Stor/Mor drive stores as much data as a 21-MB hard disk drive, its manufacturer says. It holds up to 21 MB of formatted data on what looks like a standard 3½-inch floppy disk. The drive's average access time is 35 ms.

The Stor/Mor system uses a closed-loop servo tracking mechanism, as opposed to the open-loop stepper motor found in conventional disk drives. The floppy disk contains two strata: a top layer where data is stored, and an underlying layer of unerasable magnetic rings used to position the head. To further boost capacity, the Stor/Mor uses multizone recording, in which the outer tracks contain more sectors than those nearer the center.

There are three Stor/Mor models. One internal drive is a 5¼-inch half-height drive that comes complete with a SCSI adapter, software utilities, and cabling. An external unit (which measures 5½ by 8¾ by 2¼ inches including an internal fan) is packaged with a SCSI adapter and a separate 3- by 3- by 4½-inch 12-W power supply. A third unit, for PS/2 systems, is an internal subsystem that includes a Micro Channel SCSI adapter.

**Price:** Internal, $795; external, $895; Micro Channel, $995; each disk, $25.
**Contact:** Q/Cor, One Meca Way, Norcross, GA 30093, (800) 548-3420 or (404) 923-6666.
**Inquiry 1144.**

*continued*

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*ITT PowerSystems' VIP PowerSave 500 is a backup power supply with software for saving your work and automatically shutting down your system.*

## Backup Power Supply Fits in a Slot

The VIP PowerSave 500 is a backup power supply on an extra-wide 8-bit board with accompanying software for your DOS system.

You install PowerSave in a single slot when adjacent to a short board. On-board nickel-cadmium batteries are included, as is battery-backed-up RAM that contains real-time software for operation.

PowerSave provides a power capacity of 200 W: 200 VA for up to 90 seconds or 50 VA for up to 15 minutes; it then automatically shuts your system down and saves your work. The company claims that if there's a 2-second power outage, you won't notice it. If power goes out for 2 to 20 seconds, PowerSave performs a complete system backup that lasts up to 30 seconds and lets you continue work after the backup is complete.

Finally, if the power goes out for more than 20 seconds—even if you power down the system yourself—PowerSave performs the complete system backup and shuts down your system. When AC power returns, or when you return to power up your system, your application is restored.

**Price:** $329.

**Contact:** ITT PowerSystems Corp., 3400 East Britannia Dr., Suite 122, Tucson, AZ 85706, (602) 889-7600.

**Inquiry 1149.**

## Make Your Mac a Signal Processor

The NB-DSP2300 digital-signal-processing accelerator board from National Instruments, which features the Texas Instruments TMS320C30 floating-point DSP, enables your Mac II to process signals in real time. Coupled with the company's NB-A2100, a 16-bit audio A/D converter board, the DSP board gives the Mac II audio-processing capabilities for applications such as speech recognition, vibration analysis, and other acoustical research.

When used with National Instruments LabView2 software, the company says, the boards rival stand-alone signal analyzers that are three times the price.

The DSP board and the 16-bit audio board let you process sounds at a rate of up to 33 MFLOPS. They sample analog input from two different channels at several software-programmable rates, including 44.1 kHz (the rate of compact disk players) and 32 and 48 kHz (the rates used in digital audio tape recorders).

**Price:** NB-DSP2300, $4995; NB-A2100 board, $1595; LabView2 software, $1995.

**Contact:** National Instruments, 6504 Bridge Point Pkwy., Austin, TX 78730, (800) 433-3488 or (512) 794-0100.

**Inquiry 1150.**

## Shift Your SQL Queries into High Gear

The dBASE Query Accelerator speeds up SQL database queries by as much as 100 times. The accelerator consists of a SCSI disk drive controller and a database coprocessor. SCSI drives attach to the board with a ribbon cable. When the CPU issues a database query to the disk drive, the request is intercepted by an Advanced Micro Devices RISC processor on the card and is processed locally before answers are returned to the CPU.

The benefit of this approach, ADS says, is that communication between the drive and the coprocessor occurs at fast SCSI disk transfer speeds and only the final query results are returned to the CPU across the slower AT bus. The RISC processor is also optimized for database work, so it works faster than the host CPU could.

**Price:** $1995.

**Contact:** Advanced Data Servers, P.O. Box 4937, Boise, ID 83711, (208) 322-7800.

**Inquiry 1152.**

## Hercules Bundles VGA and 34010 Graphics

The Graphics Station Card is an inexpensive VGA and 34010 graphics board from Hercules that produces 16- and 24-bit color graphics on VGA color monitors. It includes a full megabyte of video memory.

You can drive the Graphics Station Card with 32,768 colors at 640 by 480 pixels and at a special 512- by 480-pixel resolution. Or you can opt for 24 bits with 16.7 million colors. The 512- by 480-pixel resolution, though displayable on a VGA, is also appropriate for broadcast use (with analog RGB signal output) when run through a scan converter.

**Price:** $1024.

**Contact:** Hercules Computer Technology, Inc., 921 Parker St., Berkeley, CA 94710, (415) 540-6000.

**Inquiry 1151.**

## Turn Your Z-241 or Z-248 into a 25-MHz 486

The Z-Master 486 is a processor upgrade board designed for the Zenith Z-241 and Z-248 286-based desktop computers.

Both those systems have passive backplanes. The new Z-Master processor replaces the old CPU board with a one-slot 25-MHz i486 and adds a 32-bit memory slot for an optional capacity of 16 MB in single in-line memory modules.

**Price:** $4995.

**Contact:** Aox, Inc., 486 Totten Pond Rd., Waltham, MA 02154, (617) 890-4402.

**Inquiry 1153.**

*continued*

## DBMS Case Study:

# Security for the Goodwill Games™*

**The Problem** The 1990 Goodwill Games: 2500 athletes in 22 events at 15 locations, drawing hundreds of thousands to watch them perform. A show-place for international goodwill. A potential target for terrorists. A challenge for security agencies.

With only 3,000 off-duty officers to fill 30,000 assignments, there's no room for confusion in scheduling. And scheduling must respond to last minute changes, as event times slip, as dignitaries arrive on short notice, or as threats arise. Hand-scheduling can't meet the challenge. But the Games' Integrated Police Planning Group (IPPG) found that no automated system had ever been developed for securing such events.

**The Application** Running on a VAX, Automated Manpower On-line Scheduling (AMOS) matches personnel to scheduling requirements, taking into account special training, language skills, and other factors. AMOS prepares an assignment sheet for each individual, explaining the assignment, when and where to report, how to get there – even where to park.

AMOS responds to changes quickly. The database is large and complex, yet thanks to the innovative combined technology of the underlying db_VISTA database engine, search, match, and update times are negligible. Data integrity is assured by avoiding data redundancy. That means the information is reliable.

*Command center personnel can adjust schedules without delay or confusion, thanks to db VISTA III's ability to handle large volumes of data with speed and accuracy.*

**The Solution**

AMOS was created by Raima's services subsidiary, Vista Development Corp., using the db_VISTA III DBMS. "We looked for months for a database that was fast, flexible, and could handle a huge volume of data while still maintaining speed," said Sgt. Alan Bernstein of the IPPG. "We also wanted to find a company that could not only furnish the product, but provide the development services. Then we discovered Raima and db_VISTA III."

Your end users may not be fighting terrorists, but they still need fast, reliable information to get their jobs done. If you develop applications for VMS, UNIX, QNX, OS/2, MS-DOS, MS Windows, Macintosh, and other environments, db_VISTA III is the solution.

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* *"Goodwill Games" is a trademark of the Turner Broadcasting Company.*

# *PC Magazine* says, "Northgate™'s SlimLine 320 ...


- Smallest full power 386™ system ever
- 386/20 Microprocessor
- No larger than a typewriter
- 2Mb Ram
- 40Mb Hard Drive
- 1.2 and 1.44 Floppy Drives
- NEC VGA Color Monitor
- 16 Bit VGA
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- MS-DOS 4.01/GW BASIC
- THE NEW Microsoft® WINDOWS™
- PLUS a genuine Microsoft Mouse!

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Upgrade to our new super fast Super Maxtor™ 200Mb Hard Drive with 15ms Access.
ADD ONLY **$699.00**

*You want maximum performance* and value in a space-saving desktop case. You get it in a Northgate SlimLine 320. It packs all the power of a full-size 386 into a performance package only 4.25" high and 16.5" square. And, at just 23 pounds, you can move it with ease.

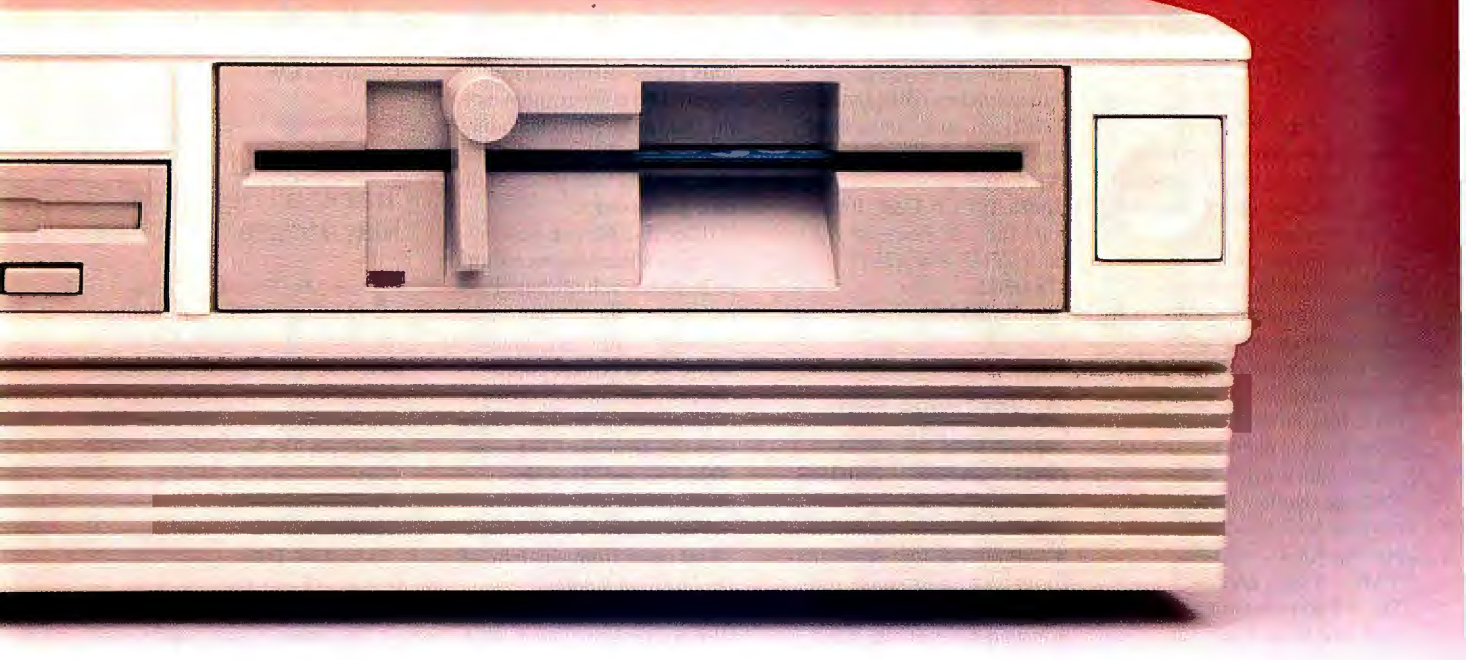
*PC Magazine said:* "(SlimLine) doesn't take up a lot of room...but it delivers plenty of computer for a price you might expect to pay for a 286 system."

*The heart of the system* is a new Northgate proprietary motherboard with built-in hard and floppy disk controllers, 2 serial and 1 parallel port and 16-bit VGA video. Smaller than a sheet of legal paper. It gives you a host of features that are add-ons in others' systems. Even our clock/calendar method is guaranteed for 5 years without using old-fashioned batteries. And with five expansion slots, you have plenty of room for all your peripherals.

*Use it at office or home.* Run the latest multi-tasking applications under Microsoft Windows™ or Northgate's OS/2®. Crunch numbers on the biggest spread sheets. Sort, search and select data in your databases at the blink of an eye. And if you're looking for high performance terminals in a network environment, SlimLine 320 is an ideal solution.

# "When it's this good, this cheap, why buy less?"*

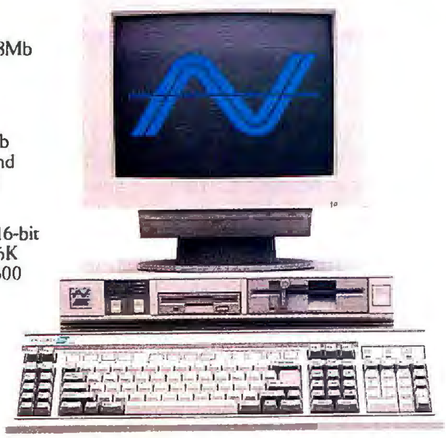
December 26, 1989



*And remember...* your Northgate SlimLine 320 is backed by expert technical support any time you need it. Call toll-free, 7 days a week, 24 hours a day. On-site deskside service is available 5 days a week (to most locations).

## SYSTEM FEATURES

- Intel 80386-20MHz microprocessor
- 2Mb of RAM; expandable to 8Mb on motherboard
- 40Mb hard drive with built in cache
- 3.5" 1.44Mb and 5.25" 1.2Mb Floppy Disks (reads, writes and formats low density diskettes)
- Page mode memory system
- Integrated high performance 16-bit VGA color controller with 256K video RAM supporting 800x600 resolution
- Integrated high performance floppy and hard disk controller on the motherboard
- 1 parallel and 2 serial ports
- 5 expansion slots (3 full-size 16-bit I/O boards; 2 half-length 8-bit)
- 14" NEC 2A VGA Color Monitor
- Exclusive *OmniKey*/PLUS Keyboard
- MS-DOS 4.01 and GW Basic Software Installed
- FCC Class B Certified



**TEST A SLIMLINE 320 AT NO RISK FOR 30 DAYS**

* *PC Magazine* December 26, 1989 reviewed the Northgate MicroStation 386/20. This system has been upgraded and is now named the "SlimLine 320."

*Of course, SlimLine 320* comes with a 1-year limited warranty on parts and labor; 5-years on the *OmniKey* keyboard. If a part fails, we'll ship a replacement to you overnight at our expense before you return your part.

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*Circle 184 on Reader Service Card*

## Hand Scanner Supports 256 Colors

ECA C&C Products claims that its Hico A4 Color Scanner, which scans a 4-inch-wide swipe of graphics, can recognize 256 colors. Accompanying DOS-compatible software lets you perform the standard desktop publishing functions of other black-and-white and 64-color scanners and lets you change the value, saturation, and hue of each color picture.

Key functions include merging scanned pictures, importing ASCII text, and support for file formats like .PMC, .VMG, and .SCF. The software supports more than 30 editing tools, including line, circle, move, rotate, enhance, air spray, area fill, scissors, copy, move, rotate, enhance, fade, reverse, outline, and undo.

The A4 Color Scanner, which includes an 8-bit scanner interface card, works with VGA adapter boards to display 640- by 480-pixel resolution and with EGA adapter boards that have at least 512K bytes of RAM. There's also support for HP LaserJet and PaintJet printers.

A minimum system configuration has 640K bytes of RAM, a mouse, and a hard disk drive.

**Price:** $699.

**Contact:** ECA C&C Products, Inc., 38 Route 46 E, Lodi, NJ 07644, (201) 478-0302.

**Inquiry 1155.**

## Inexpensive Film Recorder Makes High-Quality Slides

Polaroid says that its entry-level high-resolution film recorder produces presentation-ready photos and transparencies at one-third the price of its competition.

The Digital Palette CI-3000, which interfaces through a Centronics parallel port, is about half the size of a nine-pin printer. You use it to make 35-mm slides with presentation-graphics software like Ashton-Tate's Draw Applause and Software Publishing's Harvard Graphics.

The color and exposure data for several kinds of film is housed in the CI-3000's ROM to deliver predictable results across different film types. The color response of the internal CRT is accounted for as well, as are the changes that take place as the tube grows older.

The CI-3000 exposes slides at a maximum resolution of 2048 lines, half that of competing mid- to high-priced recorders. However, Polaroid says that, at typical conference-room distance, the eye is not sensitive enough to discern the difference between 4096-line and 2048-line images. Like other film recorders, this device delivers 24-bit color from a palette of 16.7 million colors.

An auto-winding 35mm film holder is included, with optional holders accommodating various other film types up to 4 by 5 inches. The CI-3000 recognizes the type of film holder installed and adjusts the image size accordingly. You can also program the film recorder with custom film characteristics and image sizes.

**Price:** $3995.

**Contact:** Polaroid Corp., 575 Technology Sq., Cambridge, MA 02139, (617) 577-2000.

**Inquiry 1156.**

## MicroSpeed Trackball Replaces Mac Mouse

The MacTrac is a Macintosh-compatible three-button trackball that's designed as a plug-and-play replacement for the Macintosh mouse, according to MicroSpeed. It measures 3¾ by 6¾ by slightly more than 2¼ inches (the diameter of the trackball).

MacTrac features a resolution of 200 dpi and has a cursor-drag lock button that eliminates the need to hold the button in order to drag the cursor.

**Price:** With ADB connector, $119; with DB-9 connector, $99.

**Contact:** MicroSpeed, Inc., 44000 Old Warm Springs Blvd., Fremont, CA 94538, (800) 232-7888 or (415) 490-1403.

**Inquiry 1157.**

*continued*

## For Privacy, Wear Your Monitor on Your Head

*Reflection Technology's Private Eye is a virtual 12-inch CGA computer monitor with a lightweight headset.*

The Private Eye is a 1-inch-wide monitor attached to a headband. You obviously use it differently than you do other monitors; you look into a postage-stamp-size window and see a legible image of a 12-inch 720- by 280-pixel screen superimposed on your field of vision and apparently floating in space 2 feet in front of you. The unit measures 3½ by 1⅕ by 1⅓ inches.

Mechanically, Private Eye consists of a column of LEDs, a magnifying lens, a resonating spring-mounted mirror, and a counterbalancing weight.

The operation draws less than half a watt of electrical power. The LED generates one 280-pixel line of the 720- by 280-pixel image every 1/36,000 second. The mirror oscillates every second to project 720 different versions of the 280-character horizontal line. And each image, which is red (from the red LEDs) on a black background, is made 50 times per second.

**Price:** $495.

**Contact:** Reflection Technology, 240 Bear Hill Rd., Waltham, MA 02154, (617) 890-5905.

**Inquiry 1154.**


# INSTANT WORKSTATION. JUST ADD OPEN DESKTOP.

Take a look at the vast majority of graphical workstations developed over the past decade and you'll see something they all have in common:

An integrated UNIX® System environment.

Now take a look at the vast majority of businesses that have put computing power directly onto their office desktops over the past decade, and you'll see something they all have in common:

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*Circle 249 on Reader Service Card*


*The Hayes Personal Modem 2400plus is a 2400-bps modem in an AC adapter.*

## First Low-Priced Modems from Hayes

New Hayes products include a 2400-bps modem, the Personal Modem 2400plus, and the software to make it run: Smartcom for the Mac and Smartcom EZ for DOS systems. Another software package in the series, HayesConnect, lets your Mac share its modem capabilities with other Macs on an AppleTalk network.

For simplicity, Hayes bundles the modem circuitry with an AC adapter in a single 13-ounce 2¾- by 3¾- by 1¾-inch case. Included are cables for the phone line and your computer's serial port.

Smartcom for the Mac and Smartcom EZ include a database for often-called numbers and associated dial-up parameters. They also include the industry-standard XMODEM protocol for uploading and downloading files.

When you're ready to use the Mac version of the Personal Modem 2400plus as a shared resource on your AppleTalk network, you use HayesConnect. The server software, which doesn't require a dedicated Mac system, does need 256K bytes of available RAM. The workstation version of HayesConnect requires 64K bytes of available RAM. It also works across multiple AppleTalk zones.

**Price:** Personal Modem 2400plus with Smartcom, $199; HayesConnect, $79.

**Contact:** Hayes Microcomputer Products, Inc., 705 Westech Dr., Norcross, GA 30092, (404) 449-8791.

**Inquiry 1160.**

## Watchdog Keeps an Eye on Small Networks

Network General, maker of the Sniffer Network Analyzer for large-scale networks, has announced a less expensive analyzer for networks of 20 to 30 nodes.

Watchdog has monitoring features that include station and network alarms, statistics for performance analysis, report generation utilities, and cable- and active-station testing. Watchdog's network-wide alarms alert you to problems of too much or too little network usage, activity by an unknown station, or broadcast storms (i.e., when the network is filled with broadcast messages). Alarms also signal other problems, such as an "unresponsive" station or one that uses too much of the network resources.

Watchdog displays statistics in real time to track network activity, including usage and error frequency rate. You can save this data, and you can print out tabular or graphical reports that summarize network activity.

The Watchdog Network Monitor offers Racal InterLAN AT or Micro Channel Ethernet boards for thick and thin coaxial cabling and unshielded twisted-pair cabling. Watchdog requires a dedicated PC unless you use a second network adapter card.

**Price:** Watchdog, $1995.

**Contact:** Network General, 4200 Bohannon Dr., Menlo Park, CA 94025, (415) 688-2700.

**Inquiry 1161.**

*continued*

## Remote Control for DOS and Apple Systems

Takeover is DOS-compatible remote-control software that features pull-down menus with keyboard or mouse control and all the functions of SoftKlone's Mirror III communications software. Microcom's Carbon Copy Mac is remote-control software that works over serial (including modem) and AppleTalk networks.

Both products feature their own communications software, background file transfers, a disable function to keep the host safe from unfriendly guests, and a "chat" function for real-time communication.

Takeover (for DOS systems) includes automatic callback, session recording with variable-speed playback, and an activity log. It has its own data-compression and error-correction protocols.

Takeover occupies 55K to 70K bytes of RAM on the host system and 480K bytes on the remote system (of which 375K bytes is the Mirror III communications package). The company says that the package works with all asynchronous modems, synchronous modems, and minicomputer and mainframe terminal-emulation packages. The standard package includes one guest and one host interface.

**Price:** $295; each additional host, $150; each additional guest, $195.

**Contact:** SoftKlone, 327 Office Plaza Dr., Suite 100, Tallahassee, FL 32301, (904) 878-8564.

**Inquiry 1162.**

Carbon Copy Mac comes with an identical 200K bytes of software for a host and a remote Macintosh.

You can use a queue to transfer multiple files from one Mac to another. The file transfer works with most modems (Microcom bundles over 20 modem scripts), and it will work across multiple AppleTalk zones and Token Ring and Ethernet networks.

For security, you can temporarily or permanently block remote Mac users from watching your screen, and a "peephole" function lets you identify remote Mac users before you allow them to view your screen. The minimum system requirement is a Mac Plus.

**Price:** $299; for each additional Mac, $199.

**Contact:** Microcom, Software Division, 500 River Ridge Dr., Norwood, MA 02062, (617) 551-1000.

**Inquiry 1163.**


***Logitech's foolproof desktop tools let anyone turn out smart looking documents. And now with Logitech's special prices, there's never been a smarter time to buy them.***

***ScanMan® Plus.*** *Scans images up to 4" wide into any document instantly. Works with all major applications. Adjusts to 400 d.p.i., 32 shades of gray, with three photo settings. Suggested Retail Price (SRP): $339.*

***CatchWord™ Intelligent O.C.R.*** *Lets you use text scanned with ScanMan in applications, just as if you'd typed it in. CatchWord accurately recognizes type from 6-20 points in virtually any typeface at speeds of up to 2,000 characters a minute. SRP: $249.*

***Finesse™ Desktop Publishing*** *lets you design brilliant documents effortlessly with direct scanner support, pre-designed page formats and automatic text wraparound. The only inexpensive DTP software to include Bitstream® Fontware™ absolutely free (a $545 value). SRP: $179.*

***Logitech™ Series 9 Mouse.*** *Awarded rave reviews for its comfortable shape, adjustable resolution and ballistic drivers for flick-of-the-wrist control. Includes Pop-Up DOS™ and mouse menus to mousify almost any application. SRP: Serial-$119, Bus-$139, PS/2-$119, Serial & PS/2-$149.*

***TrackMan.™*** *Ingenious thumb-operated stationary mouse offers comfort and precision without desktop motion. Guaranteed compatible with all PC applications supporting Logitech or Microsoft® mice. SRP: Serial-$139, Bus-$149.*

**SAVE A BUNDLE ON A BUNDLE!**

*Until the end of July, save up to $99 on these product bundles, at participating dealers.*

**Logitech Mouse (serial version) and Finesse DTP software**
*Suggested bundled price:* **$199**
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LOGITECH



*Circle 149 on Reader Service Card (DEALERS: 150)*

CONNECTIVITY

*Artisoft's Voice Adapter works with LANtastic 3.0 and supports voice chat and voice mail.*

## LANtastic Incorporates Voice

Artisoft's LANtastic 3.0 network operating system, which occupies only 30K bytes of RAM, now supports voice chat and voice mail with LANtastic-compatible network adapter cards and new 8-bit add-in cards called Voice Adapters. With both cards, you can use LANtastic's voice capabilities on the company's 2-Mbps network and on LANtastic-compatible Ethernet hardware.

Each Voice Adapter, which is cabled to a telephone handset, digitizes spoken messages or music and preserves them. It features simultaneous record and play, ports for importing and exporting audio, 8-bit D/A and A/D conversion, and background operation.

Power requirements are 12 V at 33 mA, sampling rate is 7990 Hz, and bandwidth is 200 to 3400 Hz.

The Voice Programmer's Interface lets you add sound effects, including speech and music, to network application programs.

**Price:** LANtastic 3.0, $495; Voice Adapter, $149; Voice Programmer's Interface, $195.
**Contact:** Artisoft, Inc., Artisoft Plaza, 575 East River Rd., Tucson, AZ 85704, (602) 293-6363.
**Inquiry 1166.**

## New Windows Package Simplifies Use of PROFS

SmartScreen is a graphical E-mail interface that makes it easier for PC users to access IBM's notoriously arcane PROFS mail system.

It runs under Microsoft Windows (including 3.0) on PCs. It presents a panel of icons that symbolize typical PROFS activities such as messages, documents, mail, calendar, notepad, and alarm clock. By clicking on an icon, you can access that part of the PROFS system without knowing its commands or syntax.

SmartScreen isn't, however, a terminal emulator in itself; it sits on top of an installed 3270 package such as Attachmate or Digital Communications Associates' IRMA.

The main benefit of the software—aside from eliminating the need to remember PROFS commands—is that it can improve E-mail by exploiting the PC, the manufacturer says. SmartScreen lets you prepare messages with PC text editors, off-line from the host, which reduces connect time; SmartScreen gives access to the Windows clipboard, which simplifies actions such as pasting a piece of a spreadsheet into a mail message; and because a PC is a lot smarter than a terminal, the software can do things like check for PROFS mail at a set time and notify the user if any has arrived.

**Price:** $495 per user.
**Contact:** Capella Systems, Inc., 8601 Dunwoody Place, Suite 632, Atlanta, GA 30350, (404) 552-9910.
**Inquiry 1170.**

## Inexpensive Fax Software Requires Dedicated Mac

Zap Fax is send-only fax server software for the Macs on your AppleTalk network.

You need to dedicate a Mac 512 or higher with a hard disk drive, and you need a fax modem. Host software is RAM-intensive, so you can't run any other software on this server. But Sunrise Services replaces print drivers on the networked Macs and therefore has no RAM overhead on these nodes.

You access the fax print driver through your Mac's PICT files within QuickDraw.

**Price:** $295.
**Contact:** Sunrise Services, 705 West Valley Dr., Suite 1, Campbell, CA 95008, (408) 377-3753.
**Inquiry 1169.**

## D-Link Introduces Pocket Ethernet LAN Adapter

The D-Link Ethernet Pocket LAN Adapter kit gives you a parallel-port interface to coaxial Ethernet networks.

The kit includes a 4-ounce adapter (without battery) that measures 4½ by 2½ by 7/10 inches, a 5-ounce wall-mount AC adapter, and your choice of t-connectors for thin or thick coaxial cabling.

D-Link Systems says that the parallel-port interface kit is compatible with all the popular network operating systems.

**Price:** $495.
**Contact:** D-Link Systems, Inc., 5 Musick, Irvine, CA 92718, (714) 455-1688.
**Inquiry 1167.**

## Cardinal Introduces 2400-bps Modems with MNP 5

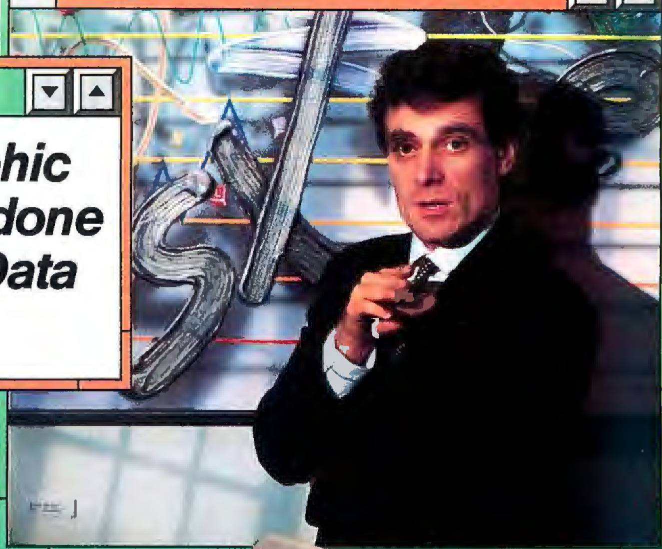
Cardinal Technologies' 2400 Series MNP modems feature the 2400-bps data transmission speed of the CCITT V.22bis standard and the 4800-bps speed of the de facto MNP 5 data compression standard. The modems are also backward compatible with 1200-bps (and lower) standards.

Both the external and the internal units feature automatic dialing and answering and a configuration view that lets you view the current and stored telephone numbers and associated telecommunications settings. The internal unit is an 8-bit half card, and the external unit measures 1½ by 5½ by 9⅗ inches and weighs 4 pounds.

**Price:** Internal, $279; external, $299.
**Contact:** Cardinal Technologies, Inc., 1827 Freedom Rd., Lancaster, PA 17601, (800) 233-0187 or (717) 293-3000.
**Inquiry 1168.**

*continued*

## "I was looking for a graphic example of what could be done with a laptop PC...Zenith Data Systems showed me two."



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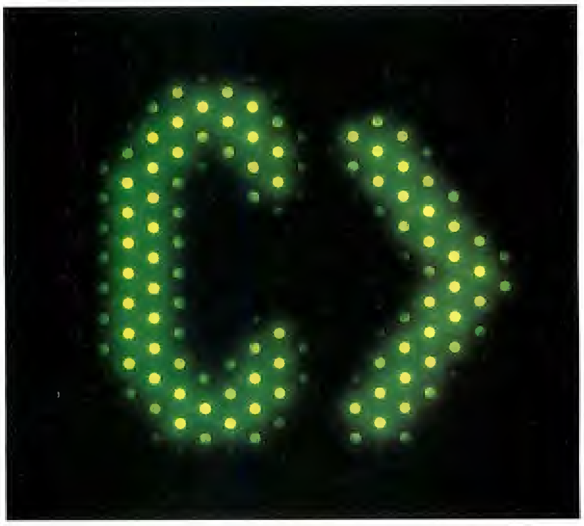
Graphics simulate Microsoft® *Windows*™ *3.0,* a product of Microsoft Corporation.
Intel386SX is a trademark of Intel Corporation.


***Circle 313 on Reader Service Card***

# Kiss it goodbye.




# Introducing new Windows 3.0.

The graphical user interface (GUI) environment on an MS-DOS® PC, and subsequent demise of the "C" prompt, is a reality today. Sure, you say.

Microsoft realizes you may have heard this one before. And we agree that you have every reason to be skeptical.

Well, all of this was before new Microsoft® Windows™ version 3.0. A GUI environment that will forever transform the way you use your PC.

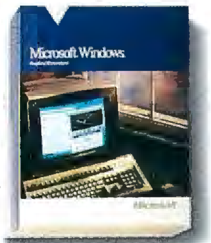
Now, before you wonder what to do with all of your existing DOS applications (to say nothing about your existing DOS experience), the Windows environment works within your MS-DOS system. This is not a traumatic thing.

As a matter of fact, once you see the environment created by Windows 3.0, you'll think quite the contrary.

The first time you see it, you won't believe it. Archaic characters, mundane instructions, and even entire command sequences, have been replaced by a program manager full of clear, friendly icons. You're immediately comfortable.

When you work on more than one thing at a time, you'll quickly reap the benefits. Because the program manager welcomes on-screen multitasking of large Windows applications. Of course, without ever visiting the "C" prompt.

Through something with the complicated name of Dynamic Data Exchange (DDE), you can simplify your life. For example, with DDE, you can change information in a Microsoft Excel spreadsheet, and have those changes automatically show up in a "linked" table in a word processing document. Or vice versa.




You can also easily access a network from within Windows. So, no matter how big the rivalry between research and accounting is on the softball field, everybody's on speaking terms in the office.

Even the setup program is graphical, only needing a few easy steps.

At this point, you probably think your machine will slow to a crawl the first time you try any of this.

We thought about that, too. So new Windows 3.0 breaks the 640K memory barrier that saddles other DOS programs. Giving you access to all the memory and power your 286 or 386 PC can muster.

It all sounds incredible. Which it is. And, it's taking place in an intuitive, consistent graphical environment.

For more information or to learn about upgrading your current Windows version, call (800) 323-3577, Dept. L83.

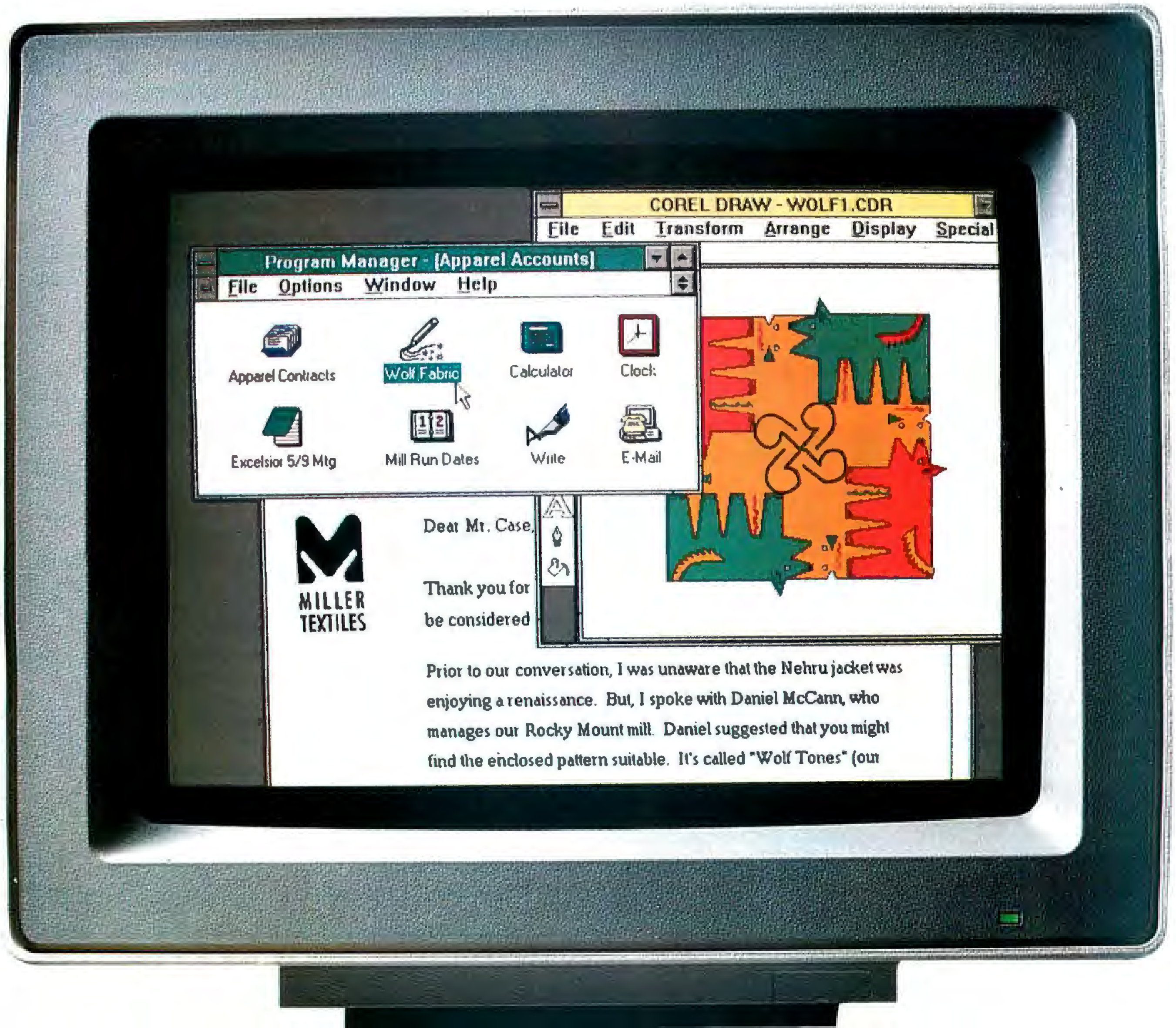
Graphics-based software is how people will run their PCs in the 1990s.

And there's no better way to get yourself acquainted than Windows 3.0.

**Microsoft**

Making it all make sense™





## Code Generator and Transformer for Windows 3.0

dAnalyst for C, a development environment that now supports Windows 3.0, features a documentation facility that takes unintelligible scraps of C code and transforms them into structured code that complies with the standard specified by Kernighan and Ritchie. According to Buzzwords International, the transformed code compiles, links, and executes just as it did in its original form.

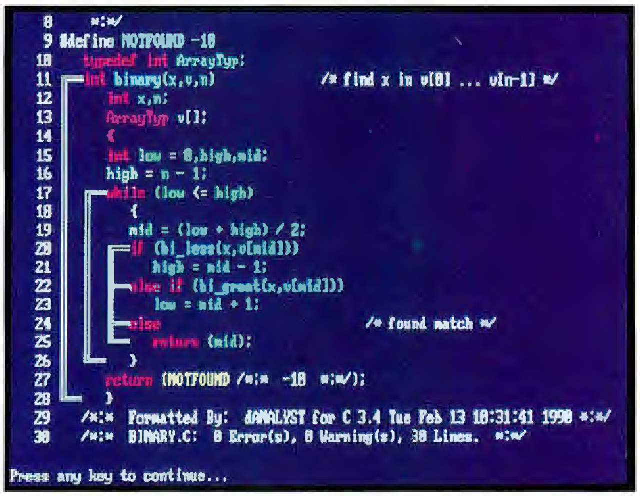
Working in or out of the Windows environment, you can use dAnalyst's screen painter and report writer to generate portable C source code that supports multiuser dBASE, FoxPro, and Clipper data files, Paradox table interaction, and spreadsheets. While the program automatically generates multiuser applications, you can run an application on single-user systems without modification.

Other features of the program include a debugger, a linker, and a Make facility.

**Price:** $295.

**Contact:** Buzzwords International, 2879 Hopper Rd., Cape Girardeau, MO 63701, (314) 334-6317.

**Inquiry 1120.**




*A portion of C code that's been transformed by dAnalyst for C. The different colors help with readability: Here, variables are green and # defines are yellow.*

## Full-Screen Text Editor for Windows 3.0

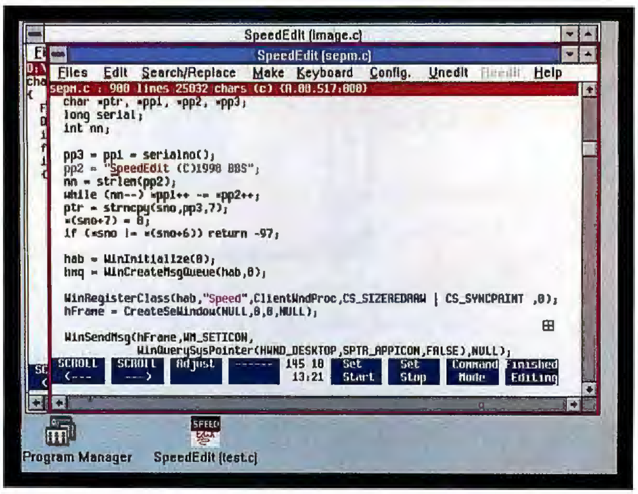
The new version of Bradford Business Systems' SpeedEdit provides a full-screen text editor for Windows 3.0 programmers. A Windows application itself, SpeedEdit supports scroll bars, pull-down menus, list boxes, and multiple windows.

The editor supports Dynamic Data Exchange, keyboard macros, and search and modification of multiple files as if they were one file, the company reports. You can compile and test the program without leaving SpeedEdit, and the program includes Undo and Redo facilities. SpeedEdit provides more than 150 editing functions. A remote program facility lets you work on files that reside on the host system.

**Price:** $295.

**Contact:** Bradford Business Systems, Inc., 25301 Cabot Rd., Suite 201, Laguna Hills, CA 92653, (714) 859-4428.

**Inquiry 1121.**




*Two overlapping SpeedEdit text windows running under the Windows 3.0 program manager. SpeedEdit can handle up to eight windows at a given time.*

## Prologs for the Mac and OS/2

Arity now offers Delphia Prolog, the platform that's used on many systems in Europe, for the Macintosh. With Delphia Prolog, you can write HyperCard scripts that make calls to Prolog, giving you a hyper-Prolog development environment.

Delphia Prolog includes an optimized version of the Edinburgh syntax; an interpreter, a debugger, and a compiler; an application manager; a lexical analyzer generator; and tools for connecting to other languages, graphics packages, and Oracle and Ingres. The program is sold without royalties or run-time fees and requires a Mac Plus.

**Price:** $395.

**Contact:** Arity Corp., 29 Domino Dr., Concord, MA 01742, (508) 371-1243.

**Inquiry 1122.**

PDC Prolog now supports network file sharing in its external database system, allowing you to use the database in a networked or multitasking environment, such as OS/2 or Unix, Prolog Development Center says. The OS/2 version, with which you can create text-mode applications that run in Presentation Manager, supports the exchange of Prolog terms among multiple Prolog processes over named pipes.

PDC says that because its Prolog is typed, requiring you to declare data types of variables and data structures, it lets you create applications with executable speeds comparable to those of programs written in C. Version 3.2 lets you embed its editor in the application you're creating. A new command-line feature of the program lets you compile or make programs from within batch files or from the command line, without having to enter the development environment.

The DOS version of Prolog requires DOS 3.0 or higher on an IBM PC with 512K bytes of RAM. For OS/2, you'll need version 1.1 or 1.2. The Unix version should be available later this summer.

**Price:** $249; OS/2 version, $599.

**Contact:** Prolog Development Center, 568 14th St. NW, Atlanta, GA 30318, (404) 873-1366.

**Inquiry 1123.**

*continued*

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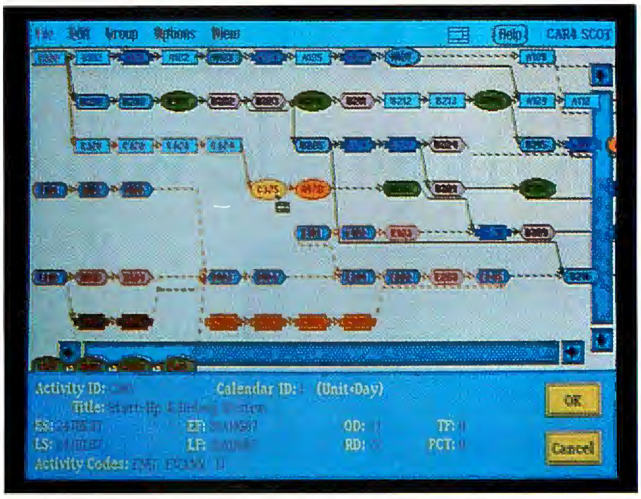
## Project Manager Offers E-Mail, Graphics Interface

The latest version of Primavera Project Planner has a new graphical user interface that lets you edit and review project networks with up to five levels of zoom. Other additions include file and record locking on Novell networks and an integrated E-mail system and BBS.

When it runs on a network, a project administrator establishes access rights with multiple levels of security, including read-only and exclusive access to specific projects. The program's P-Mail feature allows private electronic messaging, and the BBS lets you post public messages.

Primavision, the graphics system that works with Primavera Project Planner, supports the plotting of resource and cost graphics as combined histograms and cumulative curves. You can compare up to two target projects plus a current project simultaneously, the company reports.

Primavera Project Planner 4.0 runs on the IBM XT with 640K bytes of RAM, a hard disk drive, and a mouse. The program now supports PostScript output devices.
**Price:** $4000.
**Contact:** Primavera Systems, Inc., Two Bala Plaza, Bala Cynwyd, PA 19004, (215) 667-8600.
**Inquiry 1125.**




*The Primavera Project Planner proprietary graphical interface lets you add activities and relationships in interactive mode.*

## Database of Venture Capitalists

Whether you're planning to start a new company or expand an existing one, the search for venture capital can take a long time. To help businesses quickly locate and qualify potential sources of financing, a company called DataMerge offers the Financing Sources Databank.

The program lets you search for venture firms by several different criteria. Once you've narrowed the search, it provides information on what types of financing and companies the potential source prefers, the kind of information you'll need to supply, and other policies.

The program runs on the IBM PC with 256K bytes of RAM and a hard disk drive.
**Price:** $199.
**Contact:** DataMerge, Inc., One Cherry Center, 501 South Cherry St., Suite 500, Denver, CO 80222, (303) 320-8361.
**Inquiry 1128.**

## Scitor's Project Scheduler for the Mac

Project Scheduler 4 for the Macintosh lets you open up to eight windows for entering, editing, and viewing data, Scitor says. Other features of the midrange project scheduler include support for multiple projects, the ability to automatically account for resource-cost inflation, and what-if scenarios.

You can use the program to create presentations and reports with up to 10 levels of information. Like the version for the IBM PC, Project Scheduler 4 for the Mac lets you identify each task with a code for Work Breakdown Structure and Organizational Breakdown Structure.
**Price:** $685.
**Contact:** Scitor Corp., 393 Vintage Park Dr., Suite 140, Foster City, CA 94404, (415) 570-7700.
**Inquiry 1127.**

## A Guide to Accounting Software

To help companies identify, analyze, and select the PC-based accounting systems that best suit their needs, Solutions has developed The Accounting Library, a compendium of books and software that covers more than 70 DOS- and Unix-based accounting programs ranging from inexpensive single-user systems to more sophisticated ones. Solutions says that it will soon start compiling information on accounting programs for the Macintosh.

The software portion of the library consists of 10 modules containing more than 900 processing features. You identify the features that pertain to your company and rank them on a scale. You end up with a weighted average, which the program then uses to recommend the best accounting programs for you. As vendors add features to their accounting programs, you receive new disks as the changes are implemented, rather than quarterly or yearly updates.

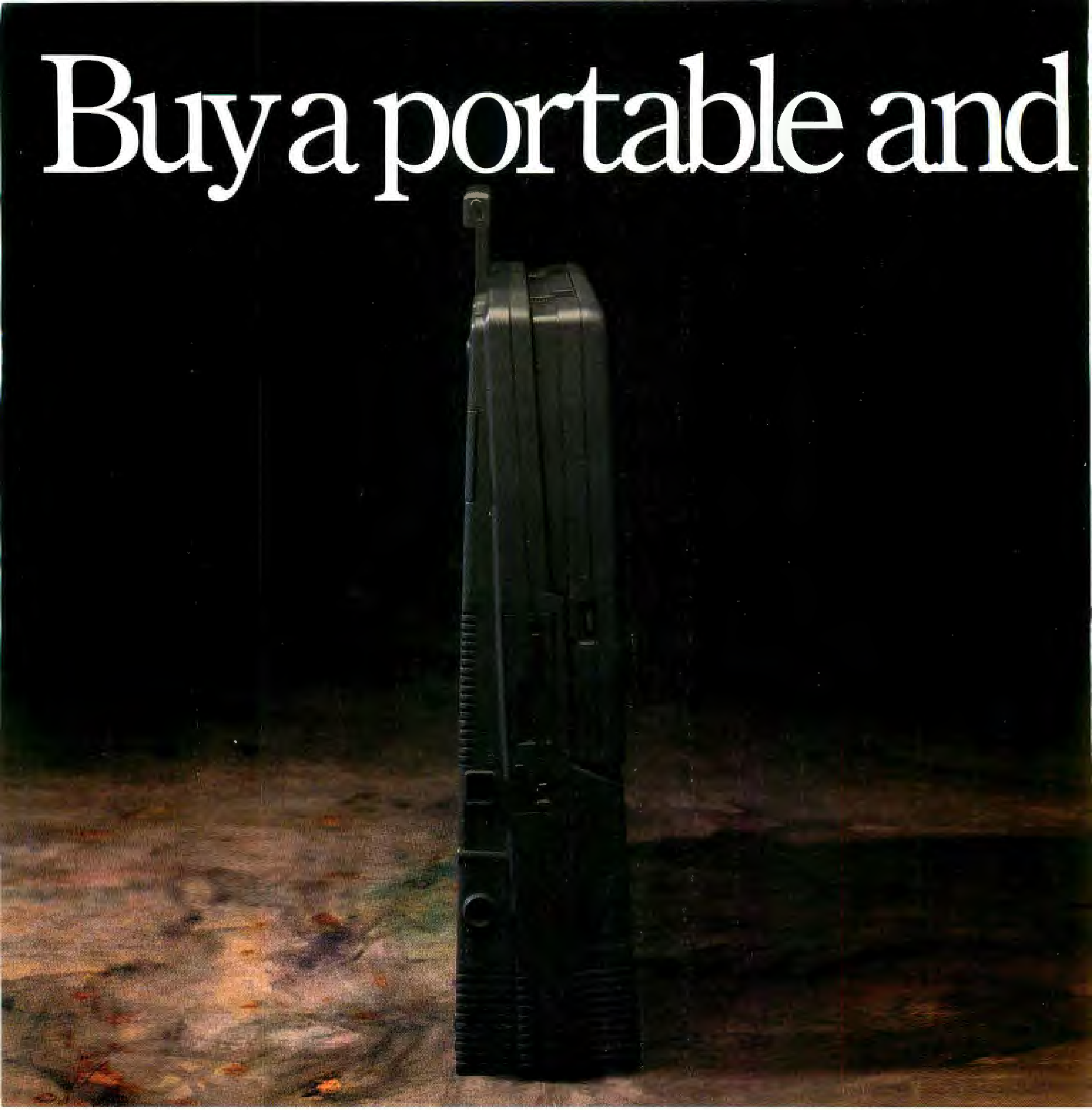
The Accounting Library runs on the IBM PC with 640K bytes of RAM and a hard disk drive.
**Price:** $479.
**Contact:** Solutions, 8630 Claypool Rd., Richmond, VA 23236, (804) 745-5361.
**Inquiry 1129.**

*continued*

## Office Automation Software for Unix

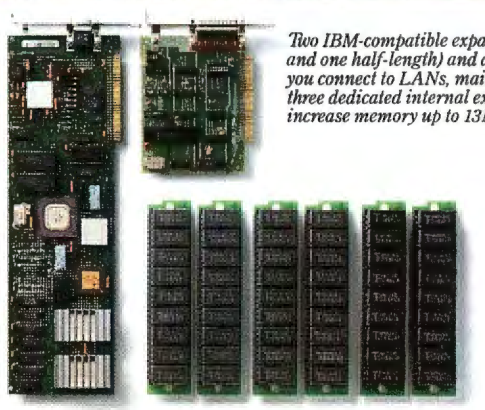
Enable/OA (for office automation) software in its new version 4.0 for Unix and Xenix offers an improved character-based user interface with windows, pull-down menus, and mouse support.

The company says that the word processing module has been enhanced with improved column handling and a collapsible outline feature. The spreadsheet (which already offered three-dimensional worksheets) now has colored cells, hidden ranges, and external links to other applications. Version 4.0 has a page preview option.
**Price:** $695.
**Contact:** Enable Software, Northway Ten Executive Park, Ballston Lake, NY 12019, (518) 877-8600.
**Inquiry 1126.**




*T3200SX: 17.0 pounds, 16MHz 386SX with 80387SX-16 coprocessor socket, 5 built-in ports, 40MB hard disk with 25msec access, 1MB RAM expandable to 13MB, gas plasma VGA display with 16 gray scales, 1.44MB 3½" diskette drive. IBM is a registered trademark of International Business Machines Corp. 386 is a trademark of Intel Corporation.*

*For more information call 1-800-457-7777.*



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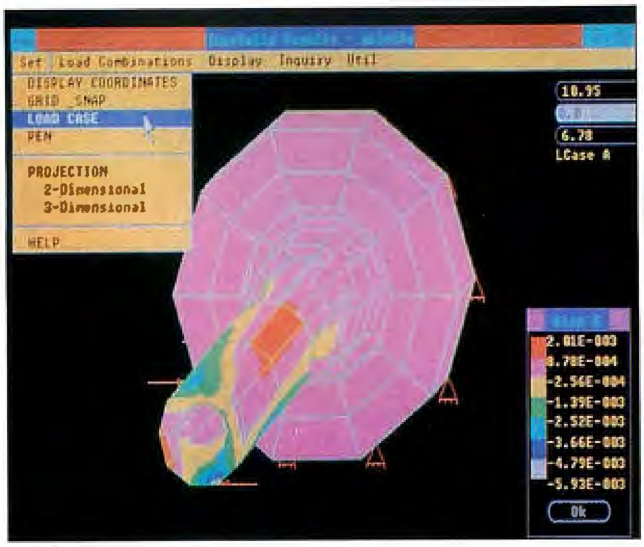
## FEA and Dynamics Analysis for Windows 3.0

Inertia, the software package that integrates finite element analysis (FEA) and large displacement kinematics and dynamics analysis in one system, is now available for Windows 3.0.

With Inertia 3.0, you can construct a complex mechanical model consisting of flexible elements, integrating dynamics analysis with FEA, without having to perform each type of analysis in sequence or transfer data between the two applications. The program includes design rulebases to help you comply with design code specifications, and customizable libraries.

The program comes in several modules for stress analysis, heat transfer, kinematics, architectural design, structural vibration, and sectional properties calculations.
**Price:** $1000 to $9995.
**Contact:** Modern Computer Aided Engineering, 1231 Cumberland Ave., Suite A, West Lafayette, IN 47906, (317) 497-1550.
**Inquiry 1130.**



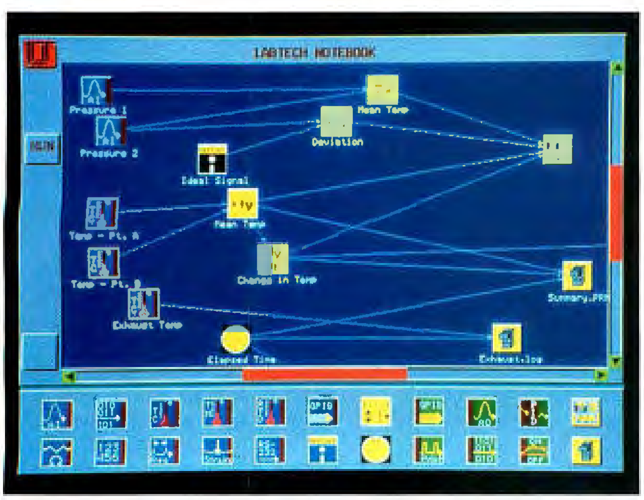

*InerSolid, the stress-analysis module of Inertia, shows the results of analysis on a spindle.*

## It Slices! It Dices! It's Spyglass

Spyglass has introduced four new programs for bringing data exploration capabilities to the Mac II.

Spyglass Transform converts floating-point numbers resulting from calculations or simulations to a two-dimensional color raster image. Spyglass View lets you customize the color image so that you can conceptualize the data set and reveal aspects that were previously hidden.

With Spyglass Dicer, you can display volumetric data as a cube of colors from which you can slice or dice portions to reveal any aspect of the interior, displaying a series of horizontal, vertical, and parallel slices of data. Spyglass Format lets you generate animations and layouts for presentation output.
**Price:** Spyglass Transform, $395; Spyglass View, $395; Spyglass Dicer, $495; Spyglass Format, $195.
**Contact:** Spyglass, Inc., 701 Devonshire Dr., C17, Champaign, IL 61820, (217) 355-1665.
**Inquiry 1131.**




*By double-clicking on an object in Iconview, you pop up a menu for detail work, such as choosing the type of I/O or engineering conversion unit.*

## An Icon Interface for Notebook and Control

A new graphical user interface that's now bundled with Laboratory Technologies (Labtech) Notebook and Control data acquisition programs lets you build your data acquisition application by manipulating objects with a mouse instead of using pull-down menus, the company says. Iconview provides a common GUI for Labtech products running under DOS, OS/2, and Unix.

Notebook, for general-purpose data acquisition, and Control, for continuous manufacturing applications, along with Iconview for DOS, each require 640K bytes of RAM and DOS 3.0 or higher. The OS/2 versions require an AT with 4 MB of RAM. The Unix version requires a PS/2 running AIX, a DECstation 2100 or 3100 running Ultrix, or an Apollo 3000 or 4000 running Domain/OS.
**Price:** Notebook, $995 and up; Control, $3995 and up.
**Contact:** Laboratory Technologies Corp., 400 Research Dr., Wilmington, MA 01887, (508) 657-5400.
**Inquiry 1133.**

## Image Processing and Visualization in Unix

BDS Systems' Xcalibur image-processing software supports integer pixel types of up to 64 bits and warps of any order with any number of tie points, allowing you to use it for complex applications in medical imagery or satellite and aerial reconnaissance. The program consists of a PixScript-based user interface engine that supports the X Window System/Motif environment, an Image Processing engine, and libraries of algorithms.

Some of the program's capabilities include multiple image objects per image, data fusion from multiple sources, and unlimited image sizes and dynamic range.

Xcalibur runs on a 386 or higher machine.
**Price:** $3000 to $8000.
**Contact:** BDS Systems, Inc., 105 Carpenter Dr., Sterling, VA 22170, (703) 437-7651.
**Inquiry 1132.**

continued

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SOFTWARE • OTHER

*Collage PM's telescope-like window, shown in the lower right of the screen, displays a magnified view of an image in real time.*

## Image Management for OS/2

Inner Media says that its Collage PM desktop image handler for OS/2 Presentation Manager (PM) includes a preview function for eliminating the trial and error associated with importing images into desktop publishing and paint programs.

Collage PM has several tools for previewing, capturing, manipulating, and converting bit-mapped or raster images. You can convert files from or into the PCX, TIFF, metafile, and system clipboard image formats. Basic editing tools let you crop, reverse, and dither images. As you view, a telescope-like window provides a magnified view of a segment of the image. You can also view images by filename or by using wild cards.

Collage PM runs on the IBM AT with OS/2 and PM 1.1 or higher and 2 MB of RAM.
**Price:** $199.
**Contact:** Inner Media, Inc., 16 Proctor Hill Rd., Hollis, NH 03049, (800) 962-2949 or (603) 465-2990.
**Inquiry 1134.**

## Ask God at the Speed of Sound

Ask God is the first retail product to incorporate a search-and-retrieval engine called IQ Text that combines hypertext with AI. Using the engine, you can find any occurrence of a word or words in a 4-gigabyte ASCII text file in just two disk seeks. Business Solutions also says that Ask God can find the more than 22,500 occurrences of the word *the* in the Bible in 70 ms on a 35-ms hard disk drive.

Once Ask God finds all occurrences of a text string, you can save the matches to a study file. Other vertical applications in which the company might incorporate the IQ Text engine include programs for the legal, medical, and accounting sectors.

Ask God runs on the IBM PC with 384K bytes of RAM and 4.5 MB of free disk space. IQ Text itself can run on DOS or Unix systems.
**Price:** Ask God, $129; IQ Text, phone the company for prices.
**Contact:** Business Solutions, Inc., 15395 Southeast 30th Place, Suite 310, Bellevue, WA 98007, (800) 648-6258 or (206) 644-2015.
**Inquiry 1135.**

## Multilingual Spelling Checkers, Thesauri

Word Finder Plus is a 120K-byte TSR multilingual spelling checker that includes support for English, German, and French in its core product and for Spanish and Italian as options. The program runs on the IBM PC, and all five languages require about 3.2 MB of disk space for a total of about 1.5 million words.

You can pop up the thesaurus or spelling checker over most word processing programs to look up words, and you can change from one language dictionary to another.
**Price:** $199; additional languages, $79 each.
**Contact:** Microlytics, Inc., Two Tobey Village Office Park, Pittsford, NY 14534, (716) 248-9150.
**Inquiry 1137.**

With Linguist, you can translate word to word from Russian to English and vice versa. Although microTrans says that the program is not a substitute for a professional translator, you can use it to translate article abstracts or technical documents.

The Linguist system includes a bilingual text editor, a translator, and dictionary editing routines. Linguist itself is language independent; you add modules to add language capabilities. The company says that new modules in addition to the English-Russian and Russian-English ones will be available later this year.

As you give Linguist new translations, it updates the dictionary. The program runs on the IBM PC with 512K bytes of RAM and a hard disk drive.
**Price:** $385.
**Contact:** microTrans, 348 Turnstone Dr., Livermore, CA 94550, (415) 447-0596.
**Inquiry 1138.**

## Guide for Windows 3.0

With Guide 3.0, a publishing tool that allows you to create and distribute electronic hypertext documents, you can combine text, graphics, maps, video images, sound, and animation running under Windows 3.0. The program also supports the Macintosh.

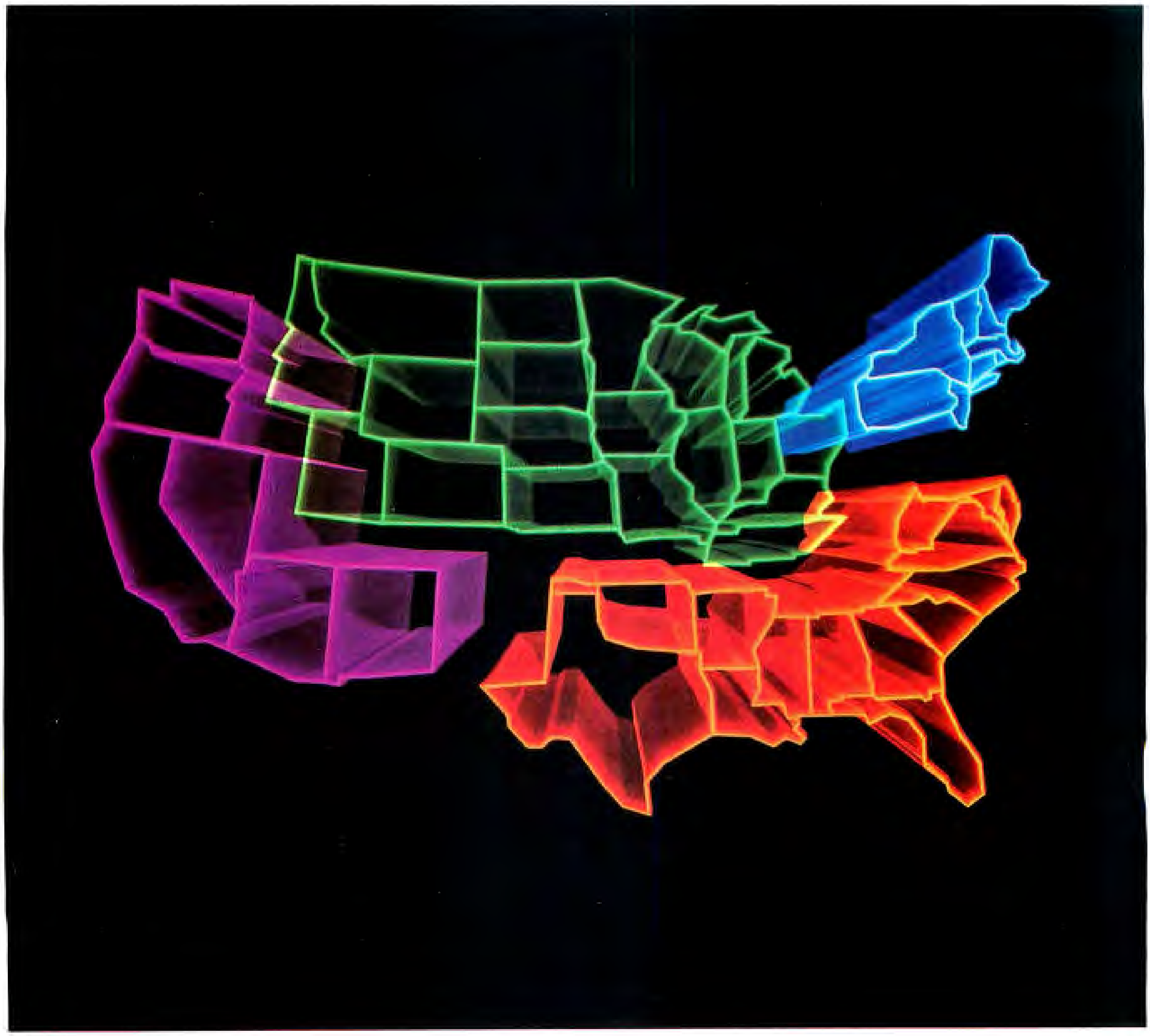
Owl International says that Guide is the solution for organizing documents that contain thousands of pages. The program provides four types of link origins: reference, note, expansion, and command links. Links are located at specific points in a document, and the form in which information is displayed depends on the type of link you activate.

Guide 3.0 directly supports TIFF, PCX, Windows Paint, bit-mapped, and metafile formats. It supports video and sound through external functions. On the IBM AT, it requires Windows 2.03 or higher, 640K bytes of RAM, and a hard disk drive. On the Mac, you need 512K bytes of RAM and a hard disk drive.
**Price:** $495; Mac version, $295.
**Contact:** Owl International, Inc., 2800 156th Ave. SE, Bellevue, WA 98007, (206) 747-3203.
**Inquiry 1136.**

BYTE

# REGIONAL

## MIDWEST



PHOTOGRAPHIC IMAGE: ALEX PIETERSEN © 1989

## Vendors Welcome Users Groups with Open Arms

Users groups continue to receive strong support from software vendors, who understand that the groups are a strong marketing force within which to demonstrate their products.

As a result of this thinking, groups attending meetings of the National Apple Users Group Conference held during April in Chicago found a warm reception from vendors.

Bitstream's Larry Jordan, for example, offered every users group four free type fonts if it would send him a copy of the group's newsletter, in an attempt to end the tendency for most groups to use Times Roman and Helvetica as standard typefaces.

"Try something different," he told the groups. "You may make mistakes. Who doesn't? But the idea behind typefaces is to get people to read your newsletter."

Bill Hulbig, president of 1st Desk Systems, wants to get his company known and recognized by users groups as a way to gain acceptance in the marketplace. That's why he has agreed to give away $1.25 million worth of his newest product. His first BBS is being sent to every Apple and Macintosh users group.

"My company needs the credibility that working with users groups can give it," Hulbig admitted to the crowd. Hulbig's company purchased the 1st Desk line of products several years ago for its own use, just hours before the venture capitalists who were funding the company were going to padlock the doors. But he bought the company because he was using its software to run his own company and didn't want to change.

"Now that we have the software where it is competitive, I've got to get the word out, and I'm doing that with users groups," Hulbig said.

*—Reported by David Reed*

## Apple II Guru Tries to Dispel Rumors at NAUGC

Many of the more than 450 people attending NAUGC in Chicago wore badges showing the roman numeral II printed atop the symbol for infinity. No longer was the cry, "Apple II Forever"; it was "Apple II ad Infinitum!"

Rajiv Mehta, Apple II product manager since last summer, was among those touting support for the original Apple computer and its successors, the IIe, IIc, and IIGS, amid rumors that Apple will introduce a low-cost Macintosh.

Mehta did his best to reassure the faithful during a presentation. "I am here to set the record straight and to stop some rumors yet again," he said.

"There are over 5 million Apple II computers out there in schools, small businesses, and used by individuals. . . . The Apple II is not dead, it is

*continued*

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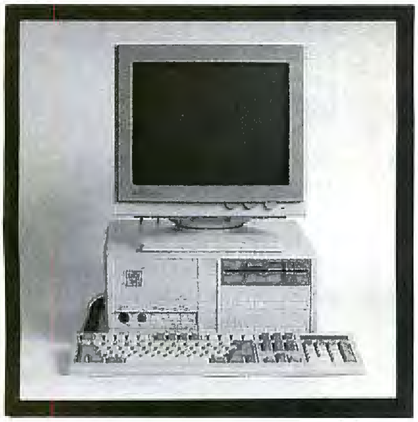

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alive and well, and we expect it to be a working and viable machine well into the 1990s," he said.

Mehta pointed to the recently introduced fast SCSI card for the IIGS that allows the computer to break through what has been perceived as a 1-MB barrier of information flow, thanks to access to large, fast hard disk drives and CD-ROM players.

He also noted the vast amounts of software that are available for the II line that let it remain a viable computer for many applications, especially education. And with the SCSI card, products designed for use with the Mac may also be used with the II line.

Mehta admitted that things have not been as bright for Apple II enthusiasts as it might have been. But he said the problems were being solved and that Apple was committed to supporting the II.

He also admitted that shelf space for Apple II products is shrinking in computer stores, but that he expected major cities to have several stores that would still provide strong support for the line.

"We are moving ahead with the Apple II line and will be around for a long time," Mehta said. Many people in the audience, however, were still skeptical, especially with Apple looking for a way to introduce a new low-end Mac product that could speed the demise of the Apple II.

"I'll believe Apple is really still behind the II when I see them devoting 25 percent of their advertising budget to it," noted one users group officer. "It isn't going to happen."

Meanwhile, other users were seen discussing the state of Apple support. They were wearing buttons that read, "Apple III Survivors."

*—Reported by David Reed*

## Gates: Windows Is Good for Mac Users

Speaking to an audience consisting mostly of Macintosh users at NAUGC, Microsoft chairman Bill Gates said that Microsoft Windows will pressure Apple to develop new technologies. He also said that because Windows offers an alternative graphical interface, it provides incentive for Apple to lower its prices.

*—Reported by David Reed*

## Users Groups Raise $7500 for the Handicapped

Not everything that happened at NAUGC was designed for users group officers to take from the manufacturers.

The officers showed their own generosity through the Johnny Appleseed Awards Auction, raising nearly $7500 for the program, which will recognize users groups and individuals who help the handicapped and others in their communities.

The Johnny Appleseed Awards are sponsored by the Computer Users for Social Responsibility and the MUG News Service.

*—Reported by David Reed*

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- Dexxa Mouse w/Paint Program
- Desktop Case

**$1,745.00**

## 386SX-65 KEY

- Landmark speeds: 10/20MHz
- 2MB RAM Installed
- 1.2MB 5.25" and 1.44MB 3.5"
- 65MB Hard Drive, 33ms, 1:1
- 14" VGA Color Monitor
- 16-bit VGA-800x600 w/ 256K
- 2 Serial/1 Parallel/1 Game Port
- MS DOS™ v4.01/GW BASIC
- 8-In-1 Integrated Software
- Dexxa Mouse w/Paint Program
- Desktop Case

**$1,995.00**

## 386SX-68 PRO

- Landmark speeds: 10/20MHz
- 2MB RAM Installed
- 1.2MB 5.25" and 1.44MB 3.5"
- 68MB Hard Drive, 21ms, 1:1
- 14" VGA Monitor - 1024x768
- 16-bit VGA-1024x768 w/512K
- 2 Serial/1Parallel/1 Game Port
- MS DOS™ v4.01/GW BASIC
- Super Tower Case

**$2,195.00**

## 386-68 PRO

- Landmark speeds: 25MHz
- 2MB RAM Installed
- 1.2MB 5.25" and 1.44MB 3.5"
- 68MB Hard Drive, 21ms, 1:1
- 14" VGA Monitor - 1024x768
- 16-bit VGA-1024x768 w/512K
- 2 Serial/1Parallel/1 Game Port
- MS DOS™ v4.01/GW BASIC
- Super Tower Case

**$2,695.00**

## 386-120 PRO

- Landmark speeds: 25MHz
- 4MB RAM Installed
- 1.2MB 5.25" and 1.44MB 3.5"
- 120MB Hard Drive, 28ms, 1:1
- 14" VGA Monitor - 1024x768
- 16-bit VGA-1024x768 w/512K
- 2 Serial/1Parallel/1 Game Port
- MS DOS™ v4.01/GW BASIC
- Super Tower Case

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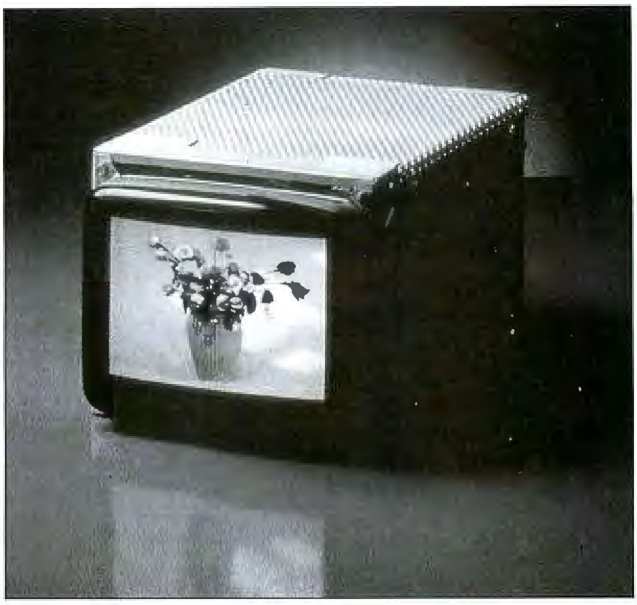
DerbyTech Computers Inc.

## Display's Industrial-Strength Color Monitor

Display Technologies' new 7½- and 9-inch VGA-compatible Color Pix.L monitors can withstand temperatures of up to 140°F, shocks of up to 30 g's, and vibrations of up to 2.5 g's on all axes. Both monitors use Trinitron CRTs, which provide the sharp images and bright colors necessary for use in test instrumentation, medical, and process control applications, the company reports.
**Price:** 7½-inch monitor, $1050; 9-inch monitor, $1169.
**Contact:** Display Technologies, Inc., 1355 Holmes Rd., Elgin, IL 60123, (708) 931-2100.
**Inquiry 1015.**



*The Color Pix.L monitor includes a self-compensating 85- to 264-V power supply, making it compatible with any voltage input in the world.*

## Test ROM Images Without Burning EPROMs

ROM-IT, a ROM emulation system that lets you test ROM images without having to burn EPROMs, lets you emulate up to eight 1-Mb EPROMs from one host serial port through the addition of ROM-IT cards. The ROM-IT system itself measures 5 by 5 by 1⅜ inches and connects to any serial port capable of 9600-bps operation. The card supports host serial interfaces that transmit at up to 38,400 bps. You can also connect the stand-alone system through the computer's parallel port.

Incredible Technologies says that the system can download 128K bytes in less than 11 seconds when used with a parallel interface. The system provides ROM emulation of most types of EPROMs in use today, from 64,000 bits to 1 Mb.
**Price:** ROM-IT with 256,000-bit emulation, $395; with 512,000-bit emulation, $415; with 1-Mb emulation, $455. Additional 256,000-bit RAM, $135; 512,000-bit RAM, $155; 1-Mb RAM, $195.
**Contact:** Incredible Technologies, Inc., 709 West Algonquin Rd., Arlington Heights, IL 60005, (708) 437-2433.
**Inquiry 1018.**

## Give Your Atari Workstation Performance

The Atari Color Isac is a graphics board for the Atari ST that touts a 1024- by 768-pixel display resolution with 16 colors from an extended palette of 4096. (The standard Atari palette is 512 colors with 320- by 200-pixel resolution in a 16-color mode.)

The Image Systems Atari card is fully compatible with the Atari blitter (a graphics accelerator) and supports GEM programs like Page Stream and Calmus Publishing. A socket for a 68881 coprocessor lets you speed graphics processing.

The Isac works with autosynchronous monitors that often boast 48 kHz for enhanced display resolution. It also works with multisync monitors with resolutions as high as 50 kHz horizontal.
**Price:** $800.
**Contact:** Image Systems Corp., 11543 K-Tel Dr., Hopkins, MN 55343, (612) 935-1171.
**Inquiry 1017.**

## Automate Batch-File Menu Creation

The Batch'in utility from Leber Enterprises combines an expert system and a screen painter to automate the process of making batch-file menus. By answering a set of files, you can create a menu screen file that's compatible with the ANSI.SYS screen driver and MS-DOS-compatible batch files.

The batch-file writer supports up to 10 environmental variables and 10 program parameters per batch file, and it automatically cleans up after itself by removing environmentals and restoring changes to the path after the program executes, Leber reports. The program also provides for calling a batch file from another batch file.

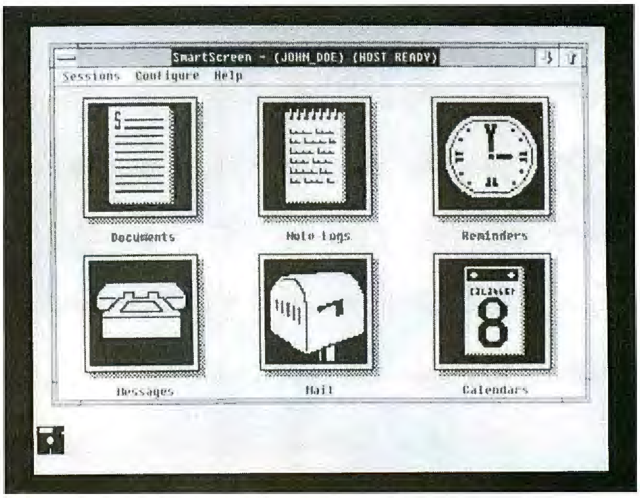
Leber says that the menus are ideal for a network environment and other situations where secondary shells are undesirable. The number of submenus and separate menu systems is limited only by disk space.

Batch'in runs on the IBM PC and requires 512K bytes of RAM.
**Price:** $40.
**Contact:** Leber Enterprises, P.O. Box 9149, Peoria, IL 61614, (309) 693-0634.
**Inquiry 1016.**

## Contact Management for Under $100

A contact management program called Sales Machine includes a built-in word processor, up to 30 definable fields in its database, and the ability to automatically print daily follow-up correspondence and automatically construct daily call lists.

According to Advanced Marketing Concepts, these automatic functions differ from the tickler capabilities of the program. The program tracks where each prospect and customer is in his or her individual sales cycle and which ones are due for correspondence or calls on a given day. You can create up to 99 different marketing tracks for different types of customers.
**Price:** $99.
**Contact:** Advanced Marketing Concepts, Inc., 515 Ogden Ave., Downers Grove, IL 60515, (800) 888-5340 or (708) 969-4400.
**Inquiry 1019.**




*SmartScreen replaces the arcane text-based screen of IBM's PROFS E-mail system with icons.*

## A Graphical Interface for IBM's PROFS

Capella's SmartScreen graphical interface, which replaces the character-based terminal interface of IBM's Professional Office E-mail system, lets you cut and paste from your Microsoft Windows application directly into a PROFS message, the company says. A Windows application, SmartScreen includes an editor for creating and editing E-mail off-line, saving time and money normally spent on the mainframe.

In addition to converting all PROFS commands into Windows' icon-oriented interface, SmartScreen provides a scheduler that can check for mail at a predetermined time, notify you when you've received mail, and automatically send and receive messages.

SmartScreen is not a terminal-emulation program and requires a 3270-emulation program. It runs on the IBM AT or higher with 640K bytes of RAM and a hard disk drive. The program includes a run-time version of Windows.

**Price:** $495.

**Contact:** Capella Systems, Inc., 8601 Dunwoody Place, Suite 632, Atlanta, GA 30350, (404) 552-9910.

**Inquiry 1021.**

## Point of Sale for Retailers

With Storekare, you can control point of sale, cash management, inventory control, and back-office accounting of retail stores that use IBM PCs or PC-compatible cash registers running under DOS, OS/2, Xenix, or Unix.

Developer SK Technologies says it designed the program so that new personnel can quickly learn how to ring up a retail transaction, which is important for stores with a high incidence of personnel turnover.

When you install the program, it automatically configures itself to work with your particular bar code scanner, magnetic card reader, and other peripherals.

To run the program, you need 640K bytes of RAM and a minimum of a 20-MB hard disk drive for your server. A hard disk drive is not required for remote PCs.

**Price:** $2495.

**Contact:** SK Technologies Corp., 1650 South Dixie Hwy., Boca Raton, FL 33432, (407) 393-7540.

**Inquiry 1023.**

## Organizational Chart Drawing on the Mac

MacOrg lets you draw organizational charts with up to nine boxes and nine boxes down, Claybrook says. You can export charts to Microsoft Word, PageMaker, MacPaint, and other Macintosh applications. The program lets you link up to two assistants or secretarial boxes per department head.

MacOrg runs on the Mac 512KE.

**Price:** $109.

**Contact:** The Claybrook Co., P.O. Box 744182, 7306 Claybrook Dr., Dallas, TX 75374, (214) 341-9438.

**Inquiry 1024.**

## Two VGA-Compatible Graphics Cards

STB Systems has introduced two VGA-compatible graphics cards for advanced graphics applications.

The VGA EM-16 Plus features support for Interactive Systems' 386/ix operating system and version 11 of the X Window System. It supports up to 256 colors and is designed to display resolutions of up to 1024 by 768 pixels with multiple-frequency analog monitors.

The lower-end VGA 800/16 card supports 256-color Super VGA (800- by 600-pixel) resolution and the X Window System, and it includes drivers for Microsoft Windows, AutoCAD, GEM, Lotus 1-2-3, Ventura Publisher, WordPerfect, and Framework II.

**Price:** VGA EM-16 Plus, $499; VGA 800/16, $249.

**Contact:** STB Systems, Inc., 1651 North Glenville Dr., Suite 210, Richardson, TX 75081, (214) 234-8750.

**Inquiry 1022.**

## User Interface Library Supports Watcom C 386

Magna Carta Software says that its user interface library for C programmers, C Windows Toolkit, now supports the Watcom C 386 compiler, letting you use its functions in programs that execute in 386 protected mode using the 32-bit instruction set. Programs can be up to 4 gigabytes in size.

The C Windows Toolkit includes routines for adding windows, help screens, pop-up menus, and spreadsheet-style menus to any application. To convert a program to run in 386 mode, you simply recompile code developed with Microsoft C, Borland Turbo C, or Watcom C under Watcom C 386, the company says.

Watcom C 386 requires a DOS extender and tools from Phar Lap Software or Ergo Computing.

**Price:** Watcom C 386 version of C Windows Toolkit, $199.90; if you already have the standard C Windows Toolkit, $99.95.

**Contact:** Magna Carta Software, P.O. Box 475594, Garland, TX 75047, (214) 226-6909.

**Inquiry 1025.**

# MYODA

MYODA computers are manufactured by PAO-KU Group, a highly respected, public-held corporation. The MYODA product line includes a full selection of desktop and laptop computers. Myoda is the one source supplier for costumer looking for quality, service & price.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- INTEL 80286-12cpu
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- 80287 coprocessor socket
- 1MB on board (expand able to 4MB)
- Gas Plasma 640 x 480 EGA mode, 4 Gray scale
- 40M HDD (28 ms)
- 1.44MB FDD
- 2 serial, 1 parallel port
- 1 EGA/CGA /MGA CRT port

Options for LT-3500:
Memory expansion board(2MB/4BM)
Expansion chassis(4 external expansion slots)
33 key keypad
External FDD(360KB/1,2MB)
Coverter (12V-110V) for use in car
5hr external battery

## LT5200CD $3799

- INTEL 80386-25cpu
- 0 wait state
- 80387 coprocessor socket
- 1MB on board(expandable to 8MB)
- 32KB CACHE memory
- Gas Plasma640/480
- VGA mode, 16 gray scale
- Other configrations are as same as LT5200sx

## LT5200NV $2599

- INTEL 80286-16 cup/0 wait state
- 80287 coprocessor socket
- 1MB on board (expandable to 8MB
- Other configrations are same as LT5200CD (no CACHE memory)

## LT5200SX $3099

- INTEL 80386-SX
- 0 wait state
- 80387-SXcoprocessor socket
- 1MB on board(expandable to 8MB)
- Gas Plasma640/480
- VGA mode, 16 gray scale
- 40M HDD(28ms)
- 1.44MB Floppy Drive
- 2 serial, 1parallel port
- 1VGA/EGA CRT port
- 2 full size expansion slots
- 90-260V auto switch power supply

Option for all models:
External FDD(360KB/1,2MB)
Coverter (12V-110V) for use in car
5hr external battery


## MD286-12
### 40MB VGA
## $1499

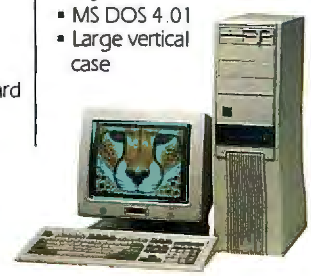
- INTEL 80286-12cpu
- 0 wait state
- 80287 coprocessor socket
- 1MB on board (ex panable to 4MB on motherboard)
- 1:1 interleave HFDC
- 1.2 MB Floppy Drive
- 40MB hard drive(28MS)
- 2 serial, 1parallel, 1 game port
- 16 bit, 512K VGA card
- 8 expansion slots
- 14" VGA monitor
- 180W power supply
- Baby AT case
- 101enhanced keyboard

## MD386sx-16
### 65MB VGA
## $1799

- INTEL 80386SX-16cpu
- 80387SX coprocessor socket
- 1MB on board (expand able to 8MB on mother board)
- 1:1 interleave HFDC
- 1.2 MB Floppy Drive
- 65MB Hard Drive(28MS)
- 2 serial,1parallel,1game port
- 16bit, 512K VGA card
- 14" VGA monitor
- 8 expansion slots
- 200W power supply
- 101 enhanced keyboard
- MS DOS 4.01
- Mini vertical case

## MD386-25
### Super VGA
## $3499

- INTEL 80386-25cpu
- 0 wait state
- 80387 coprocessor socket
- AMI CACHE386-25 MarkII
- 64 KB cache memory
- 4MB on board (expand able to 16MB)
- 1:1 interleave HFDC
- 1.2 MB Floppy Drive
- 1.4 MB Floppy Drive
- 120MB hard drive
- 2serial,1parallel,1game port
- 16bit, 512K VGA card
- 14" super VGA monitor (resolution 1024 x 768)
- 8 expansion slots
- 220W power supply
- 101 key enhanced keyboard
- MS DOS 4.01
- Large vertical case



## MD8088
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- Reset Switch
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## Manage Bits of Information Selectively

Micro Logic's Info Select is based on Tornado, one of the first personal information managers (PIMs) for the IBM PC, and it adds several features, including hypertext linking, mail merge, sorting, dialing, fuzzy searching, support for information bases of up to 10 MB, and appointment ticklers, to name but a few. With Info Select, you can plan projects, draw forms, track sales leads, organize names and addresses, and manage people, Micro Logic says.

Unlike other PIMs, Info Select doesn't provide you with endless views of information. Instead, the program displays in multiple windows memos, multipage reports, and other bits of information. You can cut and paste among windows and join several windows into one, the company says.

You can install Info Select as a TSR program, and it requires just 7K bytes of RAM when running as a TSR. It requires about 128K bytes of RAM when running as a standard application.

**Price:** $99.95.
**Contact:** Micro Logic Corp., P.O. Box 70, Hackensack, NJ 07602, (800) 342-5930 or (201) 342-6518.
**Inquiry 1026.**


*The Info Select screen lets you organize data in multiple windows. You can apply a command-like search and replace or a fuzzy text search to all the windows.*

## Compare What You Eat with What You Should Eat

A program for the Macintosh called MacDine lets you track the foods that you eat and compare them to the calories and nutrients recommended using numerical analysis and charts and graphs. You can tailor the program to suit special situations (e.g., diabetics), and you can configure the program to work on a daily, weekly, or monthly basis.

Once you've entered your actual eating record, the program rates your diet and tells you if you're within your dietary guidelines. The program can also account for physical activity.

MacDine requires a Mac Plus or higher.

**Price:** $199.
**Contact:** Dine Systems, Inc., Five Bluebird Lane, Amherst, NY 14228, (716) 688-2492.
**Inquiry 1029.**

## Smaller Sharp Laser Printer Prints Faster

The JX-9500, a small-footprint 6-ppm laser printer, comes with five printer emulations, including Hewlett-Packard LaserJet Series II, Epson FX-80, IBM Graphics Printer, IBM Proprinter, and Diablo 630. Print resolution is software-selectable up to 300 dpi.

Also standard are two slots for Sharp's five proprietary font cartridges, 512K bytes of RAM (upgradable to 4.5 MB), and 250-sheet input and output trays. Options include the RAM cards, a 40-piece automatic envelope feeder, a second 250-sheet paper cassette, and input trays for legal, letter, and executive-size (7¼- by 10½-inch) paper. The printer measures 13⅜ by $14\frac{3}{16}$ by 10½ inches; the second (optional) paper tray has the same footprint.

**Price:** $1795; 1.5-MB RAM card, $599; 2.5-MB RAM card, $999; 4-MB RAM card, $1899.
**Contact:** Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430, (201) 529-9500.
**Inquiry 1030.**

## Portable 33-MHz 386 Offers Choice of Monitor

The Modgraph GX-2386 is a 33-MHz 386-based portable computer that resembles the Compaq Portable.

Standard equipment includes a 9-inch monochrome monitor that supports 800- by 600-pixel graphics. An option is an 8½-inch 256-color monitor that also displays 800- by 600-pixel graphics.

You can use the embedded video controller to display 1024- by 768-pixel graphics through external video ports.

The Modgraph GX-2386 measures 17½ by $14\frac{1}{10}$ by $6\frac{4}{5}$ inches and weighs 26 pounds, including a 40-MB hard disk drive, a 5¼-inch 1.2-MB floppy disk drive, a 3½-inch 1.44-MB floppy disk drive, and an 86-key keyboard. Three 16-bit slots and a math coprocessor socket are also provided.

**Price:** $4995; color model, $6995.
**Contact:** Modgraph, Inc., 149 Middlesex Tpk., Burlington, MA 01803, (800) 327-9962 or (617) 229-4800.
**Inquiry 1028.**

## Mac Accounting Program Notices the Details

The Insight Expert General Ledger 2.20 accounting module for the Macintosh lets you keep detailed records of postings, allowing you to examine not only numbers, but the facts behind them, Layered reports. The module also supports detailed postings from the Insight A/P (accounts payable) module and financial statements with up to 12 columns.

You can add international flavor to the accounting module by tailoring the program to support different types of currencies, languages, and date formats, Layered says.

When creating a new data set, you can choose from several charts of accounts customized for a particular type of business. A historical journal can act as a business diary by letting you store all posted general journals for up to 99 months.

**Price:** $695 per module.
**Contact:** Layered, Inc., 529 Main St., Boston, MA 02129, (800) 622-4436 or (617) 242-7700.
**Inquiry 1027.**

## Anchor's 24E5 Modem Secures Your Computer

Anchor Automation's 24E5 Secure modem includes MNP-level-5 error correction and three levels of security in its hardware to prevent someone from accessing your computer's files through the modem.

At the first level, you can program the modem to require a correct password. For added security, you can program the modem so that once you provide the correct password, it hangs up and calls a predetermined number, say, your home phone number, that corresponds to the password. The third level of security requires you to provide another passsword once the modem calls you in return.

The 24E5 is Hayes-compatible and supports the extended AT command set. The program is downward-compatible with other modems that support error correction from MNP levels 1 to 4.

**Price:** $499.

**Contact:** Anchor Automation, Inc., 20675 Bahama St., Chatsworth, CA 91311, (818) 998-6100.

**Inquiry 1031.**


*You can program Anchor's 24E5 Secure modem to support passwords and other security features for up to 64 users. Operating in MNP-level-5 mode with data compression, throughput speed can approach 4800 bps.*

## Back Office Retailing with the Macintosh

Houlberg Development has released a Retail Engine Sales Recorder module for its family of retail sales programs that lets you enter daily sales transactions at the end of the day. The program works with the company's Retail Engine Manager and supports bar code reading for scanning tags with SKU (Stock Keeping Unit) or UPC (Universal Product Code) information.

Other products available from the company include Retail Engine Accounting ($395), Point of Sale ($3145 with the Engine Manager), and a cash drawer ($497.50).

The program runs on the Mac Plus with a hard disk drive.

**Price:** $1690 (includes Engine Manager); Bar Code Reader, $595.

**Contact:** Houlberg Development, 4533 Contour Blvd., Suite 4, P.O. Box 151501, San Diego, CA 92115, (619) 287-7444.

**Inquiry 1033.**

## What Day Is It?

Calendar Master 1.0 is a simple calendar that lets you zoom from month to week to day to hour at the touch of one key.

You can schedule any number of items per hour at any interval up to 1000 items per month. And you can attach notes to any item or to any day, the company reports. You can pop up any hour and see all scheduled items listed for that hour with notes. An edit window lets you edit or reschedule events.

The program runs on the IBM PC with DOS 2.1 or higher.

**Price:** $69.

**Contact:** Software Marketing Enterprises, Inc., P.O. Box 2965, Vista, CA 92083, (619) 758-2580.

**Inquiry 1034.**

## Lines Turn into Numbers with Forecaster

A new version of the Sales and Market Forecasting Toolkit for the Macintosh will convert a line on a graph that has nothing but high and low values and horizontal tick marks into numbers for a spreadsheet. According to Palo Alto Software, this feature lets you do practical business forecasting of common expense and revenue items when there isn't enough data for rigorous data analysis. By converting graphs to numbers—the opposite of the usual spreadsheet method of converting numbers to graphs—the Forecaster tool makes business forecasting less rugged.

The Toolkit itself includes Excel worksheets, charts, macros, and other tools to help in business forecasting with a spreadsheet. The Forecaster tool generates output for the Clipboard, so you can use it with any Mac spreadsheet. Version 2.0 of the program requires a Mac Plus and works best with MultiFinder.

**Price:** $129.95.

**Contact:** Palo Alto Software, 260 Sheridan Ave., Suite 219, Palo Alto, CA 94306, (415) 325-3190.

**Inquiry 1032.**

## FORTRAN Editor for the Mac

Freditor 1.5 for the Mac now handles files of up to 32,000 lines. It lets you open up to 12 files at once and simultaneously scroll up to five windows, Battelle reports. The editor lets you launch source code out of Freditor and into your compiler, a feature that's handy if you're not running MultiFinder.

Freditor 1.5 lets you draw vertical dotted lines in columns 6, 72, and 132. You can manually or automatically split long lines (more than 80 characters) with the extra portion wrapped and indented with a continuation mark in column 6. Print formatting options include two columns to a page and page breaks after each FORTRAN end statement. The program also contains a form of grep for text searching.

The program runs on the Mac 512KE or higher. You can run the editor under A/UX and MultiFinder.

**Price:** $99.95.

**Contact:** Battelle, Pacific Northwest Laboratories, Battelle Blvd., P.O. Box 999, Richland, WA 99352, (509) 375-2360.

**Inquiry 1035.**

# LIFE, LIBERTY, AND THE PURSUIT OF CD-ROMS

Jerry celebrates the Fourth with a look at graphics, maps, and the Constitution on a CD-ROM

I am writing this in an Anaheim motel room. In a few minutes, we'll walk over to the Anaheim Convention Center to rush through the exhibits at the National Computer Graphics Association (NCGA) show. Then it's home to finish this column a week early, because in two weeks we're going to Moscow.

I've never been to Russia before. I don't really know anyone over there, either, except Arkady Borkovsky, a programmer for the Soviet Academy of Sciences, whom you've heard of here before. I do have some acquaintances there, and I have letters of introduction to people in the Academy as well as the Soviet Union of Writers. And you may recall that last year the Soviet Programmers' Association voted me the most popular computer columnist in the U.S.S.R.; apparently, BYTE is circulated widely over there, so perhaps someone will know who I am. Anyway, the trip should prove interesting; meanwhile, I have a lot of work to catch up on.

## NCGA

It's easy to summarize NCGA: graphics capabilities are getting *much* better, but they're still pretty expensive.

Some of the exhibits were spectacular. AT&T is moving into the field with a vengeance. You'll recall that AT&T's PC 6300 had graphics superior to EGA before anyone else had EGA. That was their low end. Their high-end imaging is nothing short of amazing.

One outfit that isn't expensive but has great stuff is Sota, which is rapidly becoming one of my favorite companies; they have done some wonderful things with VGA. I've said this before, but it's worth repeating: if you're interested in the state of the art, you ought to be familiar with what Sota is doing.

One system at NCGA that used the Sota OEM 340i video board was the Cheetah 486, which was on display in the Sterling Microsystems (3164 East La Palma Ave., Anaheim, CA 92806, (714) 632-7429) booth. This is the new name of Larry Aldridge's Sterling Solutions; longtime readers will recall that he sells a lot of customized high-end PCompatibles, and he installed the Distributed Processing Technology hard disk drive controller in my Cheetah 386. Incidentally, Big Cheetah remains my main machine; I've had no problems with either it or the DPT controller.

The Cheetah 486 with the Sota video board on display at the Sterling booth was blindingly fast; it could redraw the Autodesk San Antonio Riverwalk project, a huge CAD drawing, in under a second; I've seen supposedly fast systems take nearly 15 seconds to do that. Aldridge has updated the box built around the Cheetah motherboard to include a Perceptive Solutions hard disk drive controller that can handle data at throughput rates of 12 megabytes per second. That's *fast.* I'm scheduled to get one of the new Cheetah 486s with a Perceptive Solutions controller and a Siemens hard disk drive about the time that I get back from the Soviet Union.

We mostly went to NCGA to see what is going on; I've arranged for quite a lot of stuff to be sent here, including super-fast Super VGA boards, new input devices, and a low-cost box that can add color to your Macintosh Plus; with any luck, some things will arrive while we're overseas and I can report on them next month.

On that score, I have installed VideoLogic's DVA-4000 video board in the Premier 33-MHz 386. I do not lightly use the word *awesome*; but I think it fits here. The VideoLogic board lets you have full-motion video graphics—for example, the *MacNeil, Lehrer Newshour*—in one corner of the Zenith Flat Technology Monitor, with the rest of the screen devoted to Q&A Write, or a Windows application, or whatever you use your computer for. Getting the VideoLogic board to run was a bit tricky, but it can be done by a user. I will give a full report in BYTE's *IBM Special Edition,* which will be out this fall.

The VideoLogic board has audio output, but it also works with Ad Lib's Personal Computer Music System, which adds jukebox, composition, and musical editing capabilities with multivoice synthesis. I've only just got this installed, and at the moment the only thing I'm doing with it is games; it, too, will be in the *IBM Special Edition*, where I expect to compare it with the Canadian M-Sound board recommended by Aldridge.

## Battle Chess

VGA and Super VGA have pretty well caught up, but for many years the Amiga was the real state of the art for low-cost graphics systems; there are still things done with it that I haven't seen anywhere else. Remember the movie *Star Wars*, in which the characters play a form of chess, and when one piece takes another, there's an animated battle. I'm not sure, but I think that was done by ordinary film animation techniques. Now, however, you can do the same thing on your Amiga.

Battle Chess is a beautifully animated game that can be played by two people or by one person against the computer. The computer is not all that good a chess player; for that, you want Chessmaster 2000 from The Software Toolworks. Battle Chess is confoundedly *slow*, and by slow I mean minutes, sometimes, while the computer is thinking about

*continued*

what to do at higher levels of play. What is outstanding about Battle Chess is the graphics.

When you move a piece, it actually moves. If it's a knight (they're on foot, not mounted), the other pieces move out of the way as he lumbers past. When the queens move they slink, and the Red queen has the figure to do it, too. The rooks at rest look like castles, but when they move they turn into rock monsters. The bishops are very clerical. Kings are tired old men (with young queens like those, it's no wonder).

If a capture is made, the pieces battle. The Society for Creative Anachronism once had live chess games, with real people in full armor as the pieces, who fought it out in similar fashion. Unlike the SCA game, though, Battle Chess is standard chess, so the "attacker" always wins. Each piece uses a different fighting technique. Knights use their swords. Pawns have spears. Bishops use their shepherd crooks. The queens use magic. It's really fun to watch.

Having said all that, I can't really recommend Battle Chess beyond the graphics. The view of the board is from a low angle, so it's difficult to see what square your piece is standing on; it's even more difficult to see what squares an opponent's piece threatens. Playing Battle Chess is a little like playing while blindfolded. You can switch to a two-dimensional overhead view of (nicely drawn) conventional chess pieces, but that defeats the whole purpose of Battle Chess, doesn't it?

*If normal chess isn't your bag, there's also a new version of Leong Jacobs's Xian, which is Chinese chess for the IBM PC.*

Anyway, what with the slowness of the program at any but the most elementary levels, I fear you won't *play* the game very often; on the other hand, if you have it, you'll drag it out to show to every visitor you have, and once in a while just to look at it yourself. Also, it's bound to be a hit at any party. Sure is pretty.

### Xian

If normal chess isn't your bag, there's a new version of Leong Jacobs's Xian, which is Chinese chess for the IBM PC. The new version can make use of VGA in full color if you have it; otherwise, it works with what you've got, including Hercules and CGA.

Chinese chess is similar to Western chess, but not very. The rules are a bit more complex, with more powers and restrictions on the pieces. Jacobs's program comes with a complete tutorial and help files; you can learn the game in an afternoon.

The program plays well enough to be challenging; in fact, I haven't beaten it yet. Although few Anglos know (or have even heard of) the game, Chinese chess

*continued*

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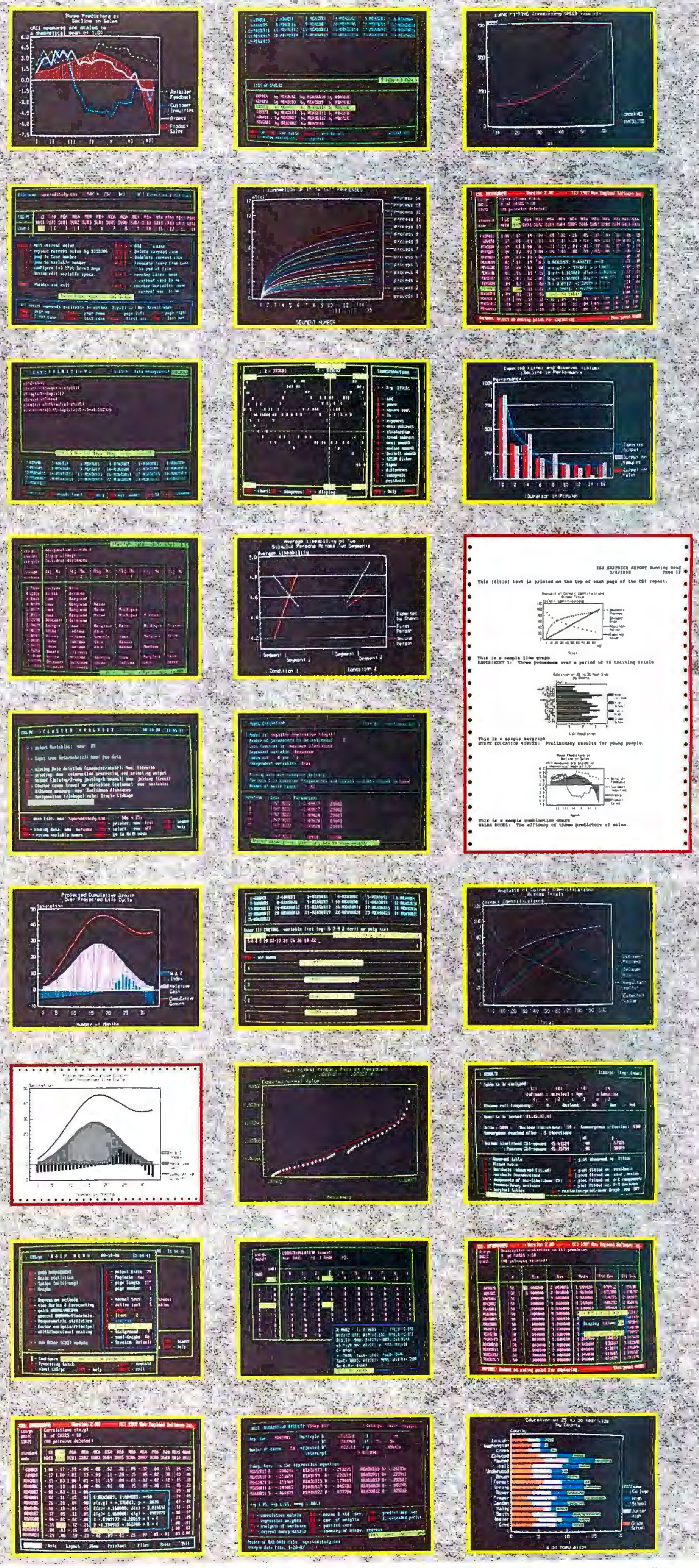

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is still quite popular in China and in some communities in the U.S.

I have only one real complaint: Xian employs key-disk copy protection. It's the mildest form, meaning that when you first invoke the game, you must have the original disk in any floppy disk drive. Since I can never find floppy disks—this really is *Chaos* Manor—I haven't played as much Chinese chess as I might. This is a pity, because it really is interesting, and someday I may accept an invitation to lecture at Beijing University, assuming the government ceases shooting its students.

Better-organized people probably will not have a problem with the copy protection. I think Jacobs is making a mistake, by the way: what he ought to wish for is for Chinese chess to become popular so that he can sell updates of his programs to a larger market base; in other words, while he shouldn't encourage piracy, he should try to expose a lot of people to the game. But then it's easy for me to have an opinion; I didn't invest any time in developing the program.

Anyway, it's an interesting game.

### ScanMistress

Logitech's new ScanMan Plus page scanner can be set up and installed by users. I can say that with some authority because Roberta did hers all by herself. It required her to open up the Zenith Z-386/15 and install a board—she'd never done that before—and then install the software, which she says goes in fairly automatically. It took her about an hour, and I deliberately didn't watch.

ScanMan Plus can work at various resolutions. It can be used as an optical character reader (such a program came with the package), but it's not terribly reliable for any input but good, clean typescript. It will read printed (kerned) text, but there are enough errors, particularly if your printed version has broken letters or ink runs, to require some editorial work.

If you have a lot of scanning to do and your time is worth anything at all, I recommend that you make contact with one of the professional outfits that can get the job done. For us, ScanMan Plus is basically a way to get visual images into the machine for incorporation into desktop publishing or, in Roberta's case, as graphics for computer programs; she's revising the graphics on her reading instruction system programs.

The software for ScanMan Plus was largely written by Mrs. Enrica Zappacosta, causing Roberta to wonder why Logitech president Pierluigi Zappacosta insists it has to be called Scan*Man* Plus. Misnamed or not, it works as advertised, and it's easy enough to get running. My only complaint is that they don't have a version that will work through a serial port; slow as that would be, it would be useful to be able to go to a library with, say, the Zenith SupersPort SX and get images. ScanMan Plus would easily fit into a briefcase. Maybe the solution is to get Zenith to come up with a small portable box that can hold the ScanMan Plus bus card.

Recommended.

> *If you have a lot of scanning to do, I recommend that you make contact with one of the professional outfits that can get the job done.*

### Vopt

We installed the ScanMan Plus on the Z-386/15 because that's the machine Roberta uses to work on her reading program. It's also the machine John Carr uses for our science fiction stuff; Baen Books is reissuing some of my older works, and many of them have maps we can scan in for revision with a paint program. Roberta's main machine, though, is the Kaypro 386i, one of the earliest 386 systems, but with Quarterdeck's newest versions of QEMM-386 and DESQview, the machine's still thoroughly useful.

A few months ago (see my March column), we installed a Perstor PS180-16FN hard disk drive controller on the Kaypro 386i, effectively doubling the hard disk capacity. This controller works with most hard disk drives, although if you have a very old one, it might be best to check to be sure it works with yours. Certainly Roberta's has worked well.

Her only complaint was that Golden Bow's Vopt wouldn't work with the Perstor controller. Vopt is a disk optimizer program. When you use a hard disk a lot, the data files tend to become more and more fragmented until they're scattered all over the place, like a gerrymandered

*continued*

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legislative district. Thus, the disk heads have to move around a lot to bring in or write a file, and that slows your file access time.

Disk optimizer programs like Vopt reorganize your hard disk, moving files around so that they're compact and contiguous, the way the Constitution specifies congressional districts should be. Alas, there isn't a Vopt that will run against Washington; but there's now a Vopt version that works fine with the Perstor controller. It really does speed things up, too; I ran it on Roberta's machine last night, and the time saved in reading in a large text file is noticeable.

Vopt comes with several other disk programs, including Vmarkbad, which will find and mark bad sectors. Unlike Gibson's SpinRite II, the Golden Bow programs do not rewrite the disk formatting information; but SpinRite won't work with the Perstor controller. For that matter, SpinRite doesn't work with my Priam hard disk drive in Big Cheetah, or any system like the Premier 386/33 that has on-board disk caching. Vopt and Vmarkbad do, which is why I'll continue to rely on them until the next generation of disk tools comes out.

## Liberty

Liberty is a program that gives me problems.

On the one hand, Liberty is a step in the right direction: a program built to illuminate and expound the U.S. Constitution, which in my judgment is one of the most beautiful works of human history. It gives you the text of the Constitution. They call it a hypertext version, but they mean only that you can hot-key in a table of contents and click on any article and section, and that portion will appear onscreen. There are no hypertext linkages within the document itself. In addition to the Constitution, there are related materials.

The whole thing is visually well done and will make use of whatever graphics capability you have, from monochrome to VGA. There's mouse support, and windowing, and menus, and text scrolling. There are materials on the Constitutional Convention and its delegates, some Constitutional law cases, and that sort of thing.

That's the good news.

The bad news is that there isn't very much related material. The data about the delegates to the convention is one screen's worth, not enough to get you through a decent game of Trivial Pursuit. There's almost nothing on the history of the debates, or the Connecticut Compromise, or anything like that.

You can get a great deal more information on the Convention by reading a good book, such as Clinton Rossiter's *Seventeen Eighty-Seven: The Grand Convention*, which can be obtained for $9.70. Copies of the Constitution itself are, I presume, still available free to any civics class teacher who wants them. I know when I was a professor of political science at Pepperdine University, I was deluged with both commercial companies and private foundations who wanted to give my students copies of the Constitution and the Bill of Rights.

It's the same with the court cases. Liberty's citation of *Marbury* v. *Madison* isn't very accurate and conveys nothing of the political flavor of that decision, in which the Federalists stole a march on Jefferson in a way that left him without any remedy to the Supreme Court's assertion of the power to interpret the

*continued*


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Constitution. (That power is *not* given explicitly in the document.)

Liberty, in other words, is a good start on what it ought to be. The programming is very good indeed. The linkages work. It's easy to find what information is in there. The problem is that there isn't enough to it. The summary data pages aren't bad, but they don't lead anywhere. It's as if someone set out to write a book but ran out of steam after doing a good chapter and an outline.

I sure would like to see the Liberty software used to do the job right. It wouldn't even be all that hard; the data is all in the public domain. As it is, I'd recommend that you buy Rossiter's book, and maybe one of Daniel Boorstin's books; you'll spend less money and learn a lot more.

## Constitution Papers

Of course, the best way to make up a collection on the Constitution is to use a CD-ROM, and I recently got a new one from the Electronic Text Corp. The Constitution Papers has, in addition to the U.S. Constitution, the constitutions of all the 13 founding states, all the *Federalist* papers, and a fairly good selection of other early documents, such as Hamilton's "Plan of Union," Paine's "Common Sense," and suchlike. All in all, a useful CD-ROM indeed.

There's only one problem. The retrieval software is Word Cruncher View. This is a sort of general-purpose software that is best described as wretched. In theory, you can use the same software to look at more than one CD-ROM; in practice, changing from one CD-ROM to another is difficult without resetting the computer in between. But it's all right, because once you get into WCV, you aren't really tempted to browse through the documents on the disk anyway.

The colors chosen for presenting documents are green on black. It turns out there is a way to change colors, including the line number colors, and when the rather nonintuitive word search is properly used, it works. The formatting of the output is still ugly.

Electronic Text Corp. is working on updates; there's considerable potential improvement on the way.

The company also sent another CD-ROM called Word Cruncher, but my attempts to access it with the software loaded from the Constitution Papers CD-ROM got messages saying that software was restricted to that disk, and I should make contact with Electronic Text Corp. However, I found a subdirectory called BATCH on the WCV disk, and switching to that revealed an Install program.

Running that got me a snide message about how I might be violating their license agreement. All right by me. By then I was ready to dwark their license in a vlendish manner. I ran the Install program and discovered that there are indeed a *lot* of documents on the Word Cruncher CD-ROM. One of them claims to be the complete works of Shakespeare. Good enough, let's look at that. I tried *Henry IV, Part I*, since that was the first work I studied in freshman literature at the University of Iowa.

I got it on the screen; it's single-spaced in wretched green on black, with no line spacing between the speeches, about as ugly a way to read Shakespeare as any I have ever seen.

Frankly, that was enough for me, even though the CD-ROM has a number of other documents that might be worth looking at. There are King James and

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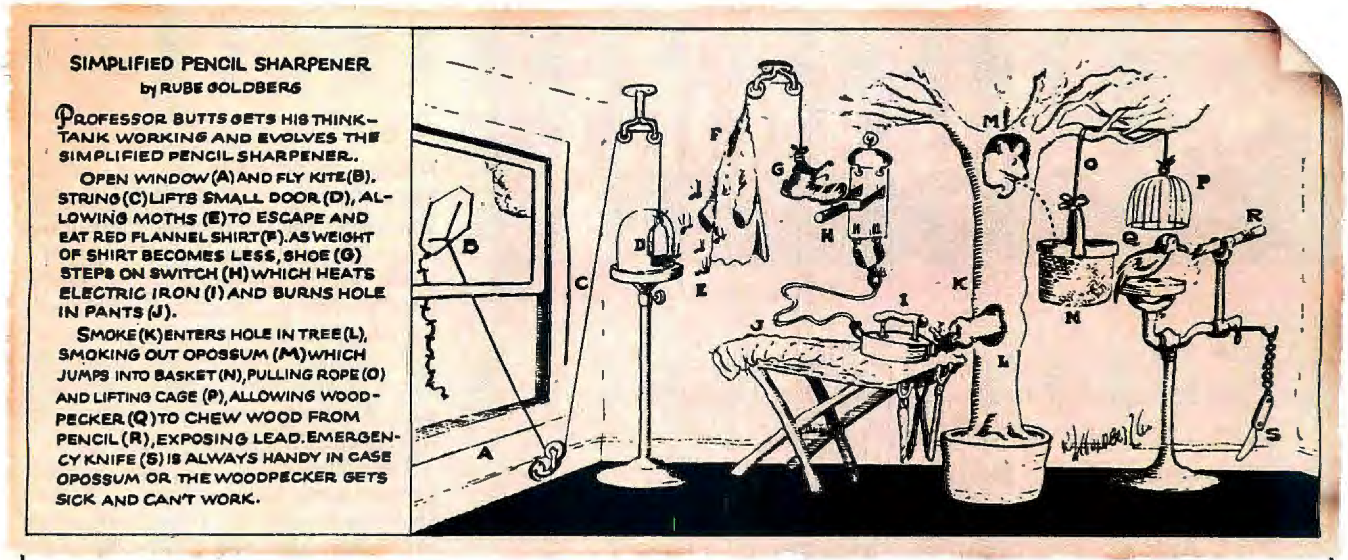


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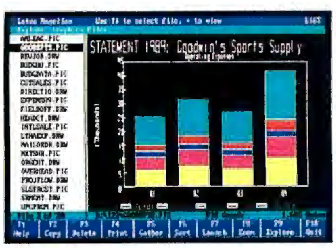


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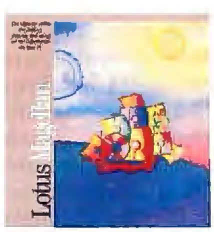


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New International Bibles; WordPerfect manuals; a number of American literary works, including four by Mark Twain; a bunch of speeches, including some by Churchill; and a whole lot more. Alas, for all of those the format remains hideous, and the retrieval procedure awkward. You *can* use this disk, but you won't have much of an aesthetic experience.

The odd part is that back a few years ago, the WCV software was one of the more advanced text presentation systems available for CGA systems, which, I guess, tells you just how bad things were in those days, because I don't think WCV has got any *worse* since then. Alas, it's no better, either.

## DiscPassage

The WCV software had one positive effect: it made me appreciate just how good the DiscPassage retrieval system is by comparison. DiscPassage is another of the "universal" retrieval systems; CMC Research hopes to license its use to many CD-ROM publishers.

Frankly, until I saw WCV in action, I wasn't all that fond of DiscPassage; but by comparison to most of what's available, it's wonderful.

CMC is the outfit that gave me my first Sherlock Holmes on Disc. They have "improved" their software since that time. One of the "improvements," alas, has been to present all text in stark white on black; the original Sherlock Holmes on Disc used softer colors and was much easier to read, with quite subtle colors for the line of command key interpretations across the bottom. Now that line is blue on white, and the line of white across the black background is a bit obtrusive—but I'll take it, I'll take it. Anything is better than hideous green on black.

The new CMC Sherlock Holmes CD-ROM has one thing going for it: it's now possible to display all the illustrations on Big Cheetah's Video Seven VGA card. The illustrations also work with the Tecmar board in the Z-386/25 and with a few other VGA boards I popped in. The illustrations are quite handsome, and there are also maps, and the "dancing men" of the story by that name. There's not as much on the Holmes disk as I'd have liked—all the stories are there, but they could have given a good map of Victorian London, and there are no end of public domain articles about Holmes. CMC says they're accumulating more material for a subsequent release.

I also have the CMC Shakespeare CD-ROM. That came with yet another update of their retrieval software—one so updated that it won't work with the Sherlock Holmes CD-ROM. Fortunately, the Holmes CD-ROM has retrieval software on the disk itself, and that does work; interestingly, the program on the Holmes disk is about twice as large (144K bytes) as the newest version. The new version installs easily and works reasonably well with the Shakespeare disk (for some reason, it has trouble locking in on the Video Seven board, but it eventually will). Naturally I have just called up Act One, Scene One, of *Henry IV, Part I*.

The contrast with the Word Cruncher presentation is quite dramatic. The CMC Shakespeare tells me the proper names of the characters, and these are set out in a nicely formatted header. The lines are indented properly and set in the middle of the screen. Character names are given in full, "Hotspur," "Falstaff," and "Prince Henry," not "Hot," "North," and "Fals," as in many cheap one-volume editions. Line numbers are given off to the right, every 10 lines, in an unobtrusive manner, not numbered like a BASIC program as with Word Cruncher. The search and retrieval software is a lot easier to use, too.

The Word Cruncher CD-ROM gives you many more documents on the disk, but to read them you have to endure their wretched software; CMC gives you less but lets you enjoy it more. I suppose you can't have everything.

## BOOTCON

I have for some time lamented the problem of booting up a system with different CONFIG.SYS files: for example, if you want a choice between DESQview and Windows/386, or you sometimes want to bring up a very clean DOS with no TSR programs at all. Up to now, the only remedy has been a variation on the theme of batch files.

No longer. Now we have BOOTCON, and it solves the problem nicely. It sets your system up so that on boot-up, you are offered a choice of up to 26 different CONFIG.SYS and AUTOEXEC.BAT combinations; these can be utterly different from each other. If you do nothing, the system is booted with the default CONFIG.SYS and AUTOEXEC.BAT; you can tell it how long it will wait for you to intervene.

There isn't an awful lot to say about this program. It works, and as far as I can tell, it's bulletproof; it hasn't crashed anything I've tried it with, and I run a lot of goofy software. It works well with both DESQview and Windows. The interface is well thought out. The setup is simple, and it requires only a DOS editor, such as the one in Norton Commander (DOS's EDLIN would do in a pinch). You can, but don't have to, set up the system with a password that must be given before the machine will boot. The program uses only 200 bytes of system memory, it isn't copy-protected, and you get both 3½- and 5¼-inch disks.

This thing is great for hackers: no more booting up with a floppy disk because you installed some driver that locks up the system. Now you can just make the new stuff option C of BOOTCON, and if that locks up, reboot with option A or B; it really is that simple.

I've had this running for a couple of months and have yet to have the slightest problem with it.

Highly recommended. You need this program.

### MicroClean

There are about a zillion outfits that make disk drive cleaning products, and I have no notion of how you'd go about choosing one over another. The MicroClean Professional Series PC Kit is certainly good enough, and it's better than many. It comes with the usual disk cleaning stuff, plus a bottle of high-pressure canned air. There are also some sealed packets of antistatic screen-cleaning towels that I've found work much better than Windex and paper towels.

It can be important to keep your system cleaned out. The other day, my high-density 1.2-MB floppy disk drive was having increasing problems in reading 360K-byte disks; eventually it became intolerable. I got a new drive from Barry Workman, but when I opened the machine, I found that the old floppy disk drive was clogged up with dust balls. I swapped for a new drive anyway, but once the dust was blown and vacuumed out and the MicroClean head cleaner was run, we couldn't find anything wrong with the old drive.

Do your machine a favor. Open it up, vacuum it, and use a good cleaning kit on it. It can't hurt. And if, like me, you have to put a lot of bad disks through your floppy disk drive—some companies ship their product on media so bad you can *see* the lumps of oxide on it—you really do need a good disk cleaning kit.

It's even more important to clean tape cartridge drives. MicroClean also makes kits for that. Of course, the brand isn't as important as getting in the habit of doing the job; but MicroClean is more than good enough.

### Maps, Wise and Informative

For weeks, I've been getting materials and updates on two programs, Mapwise and Mapinfo. As the stuff came in, I cleverly put it into one box, thinking I would get around to reviewing this program one day.

Of course, there are two programs, not one. Moreover, they have nothing whatever to do with each other.

Mapinfo is a highly sophisticated program for taking data—sales, income distribution, epidemic information, whatever you like—and plotting it on predrawn maps. The maps can be of the U.S., or a state, or a city, or a county. Mapinfo has metropolitan maps, rural maps, highway maps, city maps, census tract maps, congressional district maps; you name it, they can probably furnish it. Mapinfo works across networks, and it can integrate data from a variety of sources. If there's another program like it, I haven't seen it (although of course I have not really been looking, either). Certainly Mapinfo is good enough for nearly any professional map database requirement. Recommended.

Mapwise, on the other hand, has almost nothing to do with maps. Mapwise is a statistical analysis program; the "maps" in the title pertain to *conceptual* maps.

The best way to learn about Mapwise is to get the Bricklin demonstration program. This goes through just what Mapwise can do, which is quite a lot. It can do multivariate analysis and pretty well explain what it has done. At least I think it can. I put it that way because I didn't have any trouble understanding what Mapwise was trying to do; but I once had heavy-duty training in statistics. On the other hand, I haven't done serious statistical work since I got mad at *Runner's World*'s evaluation of running shoes and did my own analysis of their data with Zeke I back in 1978. Alas, they didn't want to publish my critique; I wonder why, since it demonstrated that their analytical staff didn't know what they were doing. If they had had Mapwise, they wouldn't have made that mistake.

At this point, I could get technical about what's going on underneath the more or less user-friendly Mapwise surface, but what's the point? Mapwise is the kind of program you don't know you need until you try it; but if your work involves any kind of statistical inferences at all—and most businesses do—it will not harm you to get the Mapwise demonstration disk and see if the program can help you. You may be surprised.

### A Minor Polemic

Our work would be a lot easier if the people who send stuff for review would follow some simple rules for dealing with columnists. I'm writing about my own situation, but the rules apply pretty well

continued

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to all the BYTE columnists. First, most of us don't work at the headquarters—I'm not in Peterborough—but that's still the best place to send most products.

There are very efficient people in Peterborough who look after my interests, and once or twice a week they make up a large package that comes by Federal Express direct to Chaos Manor. Some companies manage to find my Hollywood address and send stuff here, which is fine if it's a very large box or I'm looking out for it; but, alas, all too often it gets mixed in with family mail, and from there it can be put almost anywhere.

The important thing about sending stuff to Peterborough is that it must have *my name on it.* If it doesn't and goes direct to BYTE, it falls into the hands of the BYTE review staff. Whatever happens after that is out of my hands, but it's very unlikely I'll ever see it. There's a corollary to that: if it's sent to *me*, the BYTE

*continued*

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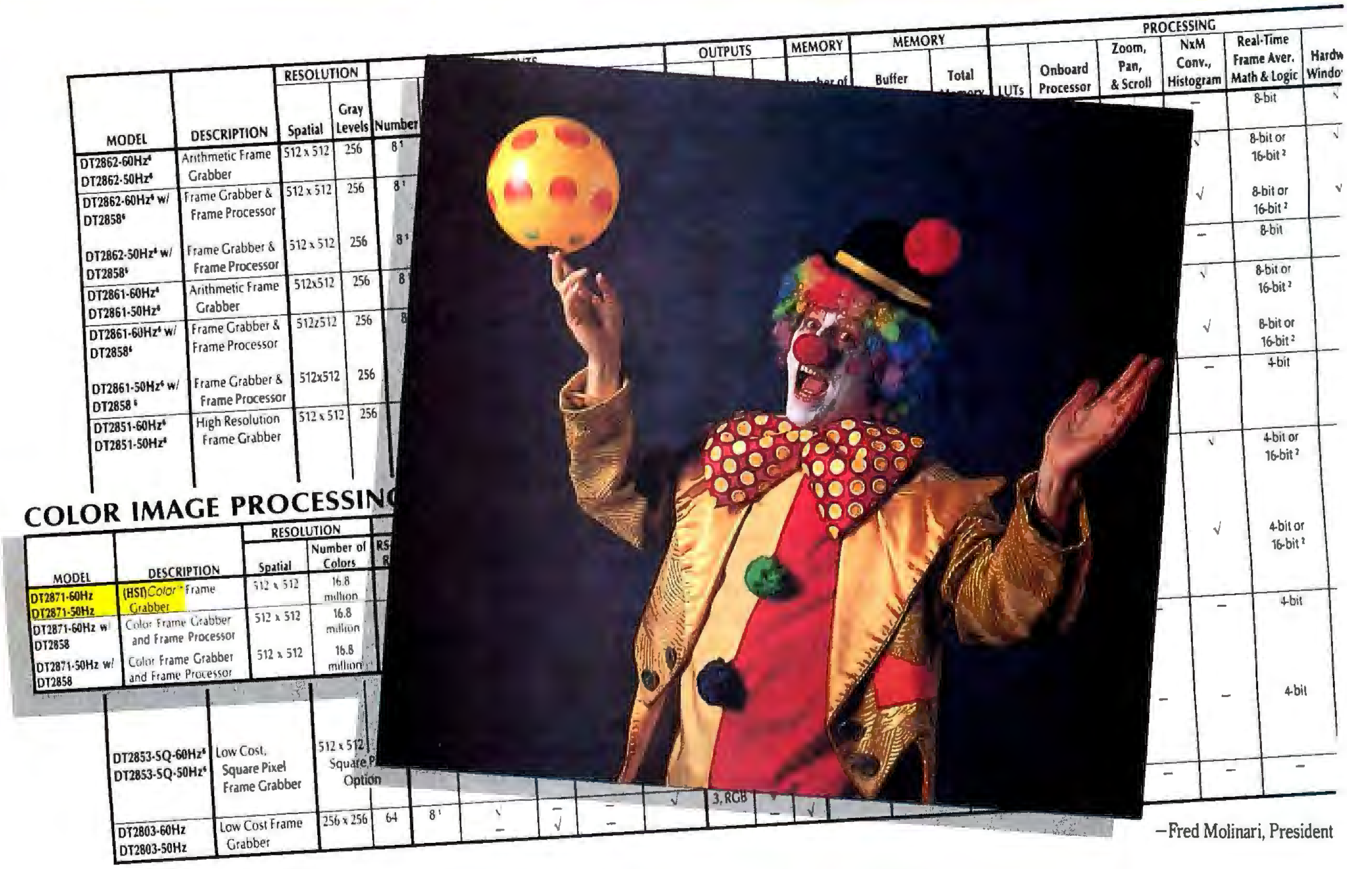


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review people won't ever see it. In other words, if you want me to look at it, send it to me; if you want the BYTE staff to look at it, send it to them; and, not to put too fine a point on it, if you want both me and the BYTE staff to look at it, you'd better send it to both.

Secondly, those who are sending revisions of software should understand that columnists and reviewers get a *lot* of software. While BYTE in Peterborough may be a tad more efficient than I am, neither the Peterborough staff nor I really have either the room or the resources for truly efficient filing and retrieval of unsolicited review materials.

Case in point: today there arrived a CD-ROM from a company containing, according to their blurb, an enhanced world atlas. The cover page of the supplementary materials they sent shows a map of the U.S.S.R., which is appropriate just now. Alas, I can't tell you much about it: attempts to read the directory of the CD-ROM on either the Amdek drive on Big Cheetah or the Denon drives on the Z-386/25 report a general read failure. There was included with the CD-ROM an instruction card telling me how to install their reader software from a floppy disk. There was no floppy disk, since this was apparently an update of a product previously sent to me.

The problem is that I don't *have* their floppy disk, at least not ready to hand. Every CD-ROM publisher has its own proprietary retrieval software. Most put that software on the CD-ROM, which is where it belongs. This company has put it on a floppy disk. This is, I suppose, no problem for someone who habitually uses the company's CD-ROM, but since I don't, I have not the foggiest notion of where that floppy disk is. Now sure, I once installed the company's drivers; but even with a 330-MB hard disk drive, I haven't room for every CD-ROM driver in existence. Consequently, I can't tell you anything more about this new CD-ROM than that it exists.

The moral of the story should be clear: when sending review copies of software revisions, you'd be *much* better off to send the entire package, including a duplicate of the original program and manuals. If the overworked reviewer you're sending it to has kept the original, no harm done; if he or she hasn't, you're miles ahead in getting him or her to look at your product.

## Winding Down

My oddest new acquisition is Corporate Voice from Scandinavian PC Systems. The company calls it the world's first

> *Corporate Voice analyzes writing styles so that you can juggle your own writing around to be more like some standard—or someone else's work.*

"style replicator," and that's no bad description: what it does is analyze writing styles so that you can juggle your own writing around to be more like some standard—or someone else's work. What they've done is take Roland Larson's Readability program and modify the emphasis. The result, though, is worth a look. More on this another time.

The book of the month is *The Tempting of America: The Political Seduction of the Law* by Robert Bork (Free Press, 1989). Bork tells his side of the story and looks hard at what Constitutionalism is all about. In a less serious vein, I enjoyed a science fiction novel: Susan Schwartz's *Heritage of Flight* (Tor Books, 1989). The computer book of the month is Tom Rugg and Phil Feldman's *QuickBASIC Programmer's Toolkit* (Que Books, 1990).

The game of the month is Panzer Battles by the Strategic Studies Group. This is a well-designed and interesting simulation of WWII action on the Russian Front, with plenty of tools to let you modify their scenarios or create your own in handsome color and detail.

Next month I should have a report on what's happening in the U.S.S.R., assuming that my visa comes and I get my taxes done.... ■

---

*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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# GO AHEAD, MAKE MY DAY

## Owning and installing free Unix software


In May's column, I mentioned a number of useful programs that are available free of charge. Some of these (e.g., pathalias, uuhosts, and smail) could be considered administration-level programs. Others (e.g., elm and xcomm) are utility programs meant to be used by ordinary users, although installing them generally takes some effort and access to system directories or devices.

What about more general programs that can be fairly easily compiled, run, and understood by users who aren't system administrators, gurus, or even programmers? Do such things exist?

A great deal of free Unix software fits the above criteria. The software development facilities available on most Unix systems let you just type make, in many cases, and wait until your new program is ready.

If your Unix system doesn't have a C compiler, you are just about out of luck unless you can find a friend on a compatible system who is willing to compile programs for you. There are some programs that are written in shell or awk language; they are accessible to anyone with a Unix system.

### Getting and Keeping Software

Finding software distributed via Usenet is simple if you're on the network and subscribe to one of the comp.sources newsgroups. Otherwise, you can contact one of the public access or archive sites in the list I mentioned last month. Or you can retrieve the files through UUNET at (703) 876-5050 through their UUCP, Internet, or 900-number links.

But there are more ways to combine source files than simply sharing them. Shar earned its popularity because it facilitates mass distribution of ASCII-based program source files through E-mail or news. When you get programs from archive sites or on disk, they generally will be packed, compressed, or in some way reduced to save as much space as possible. Many systems have pack/unpack or compress/uncompress, and some have arc (see the table). These are all free, so getting the source code to these should be a top priority for any new Unix user. My personal preference is to use compress on single files. Arc is great for gathering all the files in a directory into a single, efficient larger file. Arc will automatically select the most efficient compression method.

You should also establish the name of a directory where all the "finished" (compiled and debugged) software should go. A poor choice would be /bin or /usr/bin or any directory that comes with your delivered system, because the next time you receive a system upgrade, all your software is likely to be wiped out. Regular users have no choice; since you can't modify system directories, the only reasonable place is a /bin directory under your home directory.

If you're running Unix on your own PC or have system administration access to your Unix machine, you can do anything you want. Make up a separate directory on the root file system, such as /usr/lbin or /usr/local/bin. This is more convenient and faster when searching but, again, can cause problems when you upgrade or restore your system. I recommend that you set up a systemwide directory for your own binaries (that's what bin stands for, by the way) on a separate file system and then include that directory in the system $PATH (see the November 1989 Unix /bin).

Another caution to system administrators: Never unpack or unshar programs while you're running as "su" or "root."

continued

**FILE SUFFIXES**

*Free software is usually distributed in either compressed, archived, or packed form.*

| Suffix | Method | How to retrieve |
|---|---|---|
| .Z | Compressed | Uncompress filename |
| .z | Packed | Unpack filename |
| .arc | Archived | Arc -x filename |

They could have unwelcome surprises that might affect everyone on the system. This is another reason to unshar files in their own directories.

## A Beginner's Guide to Makefiles

The make program on Unix allows an entire executable binary program to be compiled, built, and installed by simply typing the command make in a directory where a Makefile can be found. The Makefile contains the instructions necessary to efficiently construct the entire program. For instance, a line in a Makefile such as

```
piece.o: piece.c mydefs.h
```

means that a compiled object module called piece.o is dependent on both the source file piece.c and the header file mydefs.h. If either of these text files is modified, typing make will recompile piece.c (automatically using cc with the -c flag) to create piece.o. Typing make again will do nothing, as the make program knows that the modification time of piece.o is later than that of piece.c and mydefs.h, so that recompilation is unnecessary. In fact, even listing piece.c in the dependency line above is unnecessary, since the make program understands that a C source file is needed to produce an object file: It's the header file that's not obvious to the make program.

An entire Makefile typically looks like this:

```
DEFS = -DSYSV
#
# use -DBSD or -DXENIX
# as appropriate

CFLAGS = -O $(DEFS)
LIBS = -lm
BIN_DIR = /usr/lbin
OBJS = piece.o section.o

program: $(OBJS)
  cc $(CFLAGS) $(OBJS)\
  -o $@ $(LIBS)

piece.o: mydefs.h
install: program
  strip program
  cp program $(BIN_DIR)
```

This is not half as complex as it looks at first glance. The uppercase definitions followed by equal signs are used to easily identify parameters that you are likely to change. For instance, even if you don't know anything about the internals of this program, the comment lines (starting with a # sign) imply that if you're working on a Xenix system, you can simply edit the DEFS entry to read -DXENIX to configure the program for your system.

Similarly, if you have problems getting the program running, you could change the CFLAGS entry to use the -g flag (useful for debugging) rather than the -O flag (which forces optimization). And the BIN_DIR line can be altered to fit the directory where you have chosen to put your binaries.

Luckily, most Makefile writers put these definitions at the top, where they are easy to see right away. Get into the habit of scanning the Makefile before you begin compiling any program, and you will save yourself a lot of work. Of course, it never hurts to read the instructions, and that's why I always try to go over the README (or equivalent) and *.1 or *.man files that are often included with a software distribution. There may be hidden "gotchas" listed here that might save you a lot of effort. Why spend 4 hours trying to get a graphics system compiled cleanly on your PC, just to find it runs only on Sun workstations?

The $@ is simply shorthand for "the name of the target file" (in this case, program). This is useful in case you already have a program by that name: Just change it in one place in the Makefile, and you're done. Typing make alone is shorthand for typing "make program," or whatever is to the left of the colon on the first dependency line in the Makefile itself. The command make install would first run every command needed to compile program, and then strip and copy the resultant executable file. Typing make -n shows you what will be accomplished by a make, without actually running the commands.

Speaking of hidden gotchas, the most devastating to new Makefile users is this: Program instruction lines (such as those beginning with cc, strip, or cp above) *must* begin with a tab character,

*continued*

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rather than spaces, to avoid errors like "must be a separator on rules line."

## Head(er)aches

Sometimes you edit the `Makefile` and then are bombarded by dozens of C compiler errors. At times like this, I go straight for the `*.h` header files, as there is inevitably something buried there.

The most common is the `index()`/`strchr()` problem. Berkeley-based systems use a function called `index()` to deal with substrings of a string, while Unix System V variants call exactly the same function `strchr()` (plus, there are reverse functions!). So, if either of these shows up as undefined, simply put two lines in the source, or (better yet) one of the header files that defines each in terms of the other, such as the following:

```
#define index strchr
#define rindex strrchr
```

or the opposite:

```
#define strchr index
#define strrchr rindex
```

Load errors, on the other hand, can be equally mystifying. Suppose you compile all the source files and then get loader errors at the end because certain routines are still undefined. You can sometimes save the day by changing the LIBS parameter to include more libraries that can be found on your system, such as `-lx` or `-lm`. Use the command `ls /lib/lib*.a /usr/lib/lib*.a` to find them all—you can add a file such as `/usr/lib/libplot.a` to your `Makefile` simply by listing it as `-lplot`. This assumes that the program wasn't written for a Berkeley or Sun system—expecting certain libraries to be found there—while you're running Xenix or Unix System V.

If you are really brave, you can try porting an otherwise incompatible program to your system—in which case, it would be nice if you posted the changes to the network so others could benefit from your work. If you don't have the time, just wait. In a few months or years, someone else will probably do it! ■

*David Fiedler is executive producer of* Unix Video Quarterly *and coauthor of the book* Unix System Administration. *He has helped start several Unix-related publications. You can reach him on BIX as "fiedler."*

*Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*




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# UP CLOSE AND PERSONAL

Personal organizers bring the office to you and ease your work wherever you are

It's really Fred Langa's fault. After I'd reviewed a couple of hand-held computers in the form of the Sharp Wizard and the Psion Organiser last year, and found them less than completely useful, Fred suggested that I didn't really appreciate them as they were meant to be used. In September, as Fred and I covered NetWorld, I had the opportunity to see a personal organizer in action. Fred was right.

As you may know from experience, a major trade show is hectic indeed. It's easy to get involved in a meeting and completely miss another appointment. In this environment, I noticed that as each appointment approached, the Sharp Wizard in Fred's pocket would chirp, he'd open it, read notes about the meeting, the people involved, and the location of the meeting, and we'd be on our way. This would all happen while I was still trying to find the right page in my Day-Timer.

I watched the performance repeated at Comdex in November and decided that the time had come to take another look at personal organizers, not as a review this time, but as a way to extend the reach of your computer as well as a way to organize your day.

### Pocket Packets of Power

As interesting as pocket-size electronic gadgets are, not all of them are particularly relevant to computer users. One of the best potential uses for these devices is to have them somehow bring at least part of the power of the office computer to the field. To do so, they need a way to communicate with a personal computer.

If a pocket organizer can transfer meaningful programs or data, or if it can transfer data collected in the field to the PC back in the office, it can be useful indeed. Of course, it must have other aspects that make it useful as well, such as good displays, well-chosen software, and a transfer interface that works.

I looked at four such devices, three of which are marketed as personal organizers, the fourth as a calculator. Actually, they are all calculators, just as they are all organizers, data storage devices, and much more. However, each is aimed at a specific segment of the market.

The four machines I looked at are the Sharp Wizard OZ-7000, along with a couple of new IC cards; the Casio BOSS SF-8000, along with two programs for it; the Selectronics DataStor 8000, which comes with SideKick; and the Hewlett-Packard HP 48SX Scientific Calculator, which comes with several proprietary programs. With prices starting at $350 and under, each seems to be aimed at users on the move. Each has an electronic appointment calendar like the one Fred used to convince me to do this piece.

### But How Useful Are They?

Of course, for one of these devices to be really useful, it needs to do more than just beep at a certain time and move data around. To be truly valuable as a piece of support equipment, it must be a tool. It is hard to be specific about criteria, though, because each user's needs can vary quite a bit, and because these machines are quite different despite their similarities. The best measure of usefulness is that these machines must be able to help their users perform tasks in and out of the office.

As it turns out, all these devices are useful, and all but one is extremely useful. That doesn't mean, however, that they are universally easy to learn or simple to use. They are a compromise, after

*continued*

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## ITEMS DISCUSSED

**BOSS SF-8000** ........................ $260
Casio, Inc.
570 Mt. Pleasant Ave.
P.O. Box 7000
Dover, NJ 07801
(201) 361-5400
**Inquiry 1101.**

**DataStor 8000** ......................... $40
Microlytics, Inc.
2 Tobey Village Office Park
Pittsford, NY 14534
(716) 248-9150
**Inquiry 1103.**

**HP 48SX Scientific Calculator** .. $350
Hewlett-Packard, Inquiries
1000 Northeast Circle Blvd.
Corvallis, OR 97330
(503) 757-2000
**Inquiry 1102.**

**Wizard OZ-7000** .................. $300
Sharp Electronics Corp.
Sharp Plaza
Mahwah, NJ 07430
(201) 529-8200
**Inquiry 1104.**

all—like every other product in this business. They must trade size for memory capacity and ergonomics. This means that storage space is limited, displays are small, and the keys are hard to type on. On the other hand, if they didn't make these trade-offs, they wouldn't be so portable.

One real measure of usefulness is the variety of the software that's available with or for these machines. A great deal of available standard software adds versatility to the machines and makes them productive instantly. You are much less likely to use a machine for which you must write software, simply because you are much less likely to write the software.

### Software for Field Use

Along with the ability to set alarms and appointment information, each of these devices contains software aimed at making its user's life easier. They all succeed at this to some extent, although the DataStor's success is more limited. It has a sort of free-form database that allows full text searching. You can put anything into the machine and search for it later. It does not, however, include a collection of preprogrammed software that handles other functions.

It's important to note, though, that the DataStor costs less than $100, including a free copy of Borland's SideKick. You can transfer data into the machine from SideKick files or from dBASE files. Once the information is in the machine, you can search for it using the built-in software. Unfortunately, the screen is tiny, so you can't see a whole calendar at once, nor can you see a lengthy record in the database without scrolling.

If all you need is a place to stash information until you get back to the office, the DataStor is fine, and it's certainly inexpensive enough. In addition, it will work as a basic calculator, although it is not programmable at all. You do need to be careful of its battery life, though. I inadvertently left the alarm set so that it went off once each day, and then I went out of town. It beeped plaintively in my office once a day until the battery died.

The Casio BOSS and the Sharp Wizard are both aimed at the same general market, and they succeed from completely different directions. The Wizard is shaped like a pocket calendar and opens like a book. It has a keyboard on the right and an eight-line screen on the left. There's a slot for IC cards below the screen. The slot has a pressure-sensitive membrane covering it, so you can press your finger over icons on the IC card to choose actions.

The IC cards that fit into this slot contain various applications, including a trip planner and money planner that I tried out, as well as a dictionary, language translator, and others. The Wizard also has numerous built-in functions, including the appointment calendar, a calculator, a telephone directory, an electronic memo pad, and various clocks.

The BOSS has a similar selection of built-in functions. The screen is about twice as large, however, and will allow two monthly calendars to be displayed side by side. Meetings and appointments are shown as hourly bar charts—a nice idea. The biggest difference is that the BOSS has a tiny QWERTY keyboard, and you must download all your application software from a PC. The disk-based BOSS applications, though, which are similar to those available for the Wizard, are much less expensive than the Wizard's IC cards.

### Pocket Cruncher

The real star of this class of device is the HP 48SX. Although billed as a calculator, there's really a lot more to it. Calling it just another calculator is like calling a Mercedes-Benz 560 just another car. Doing things like running an appointment calendar with it is like driving the Mercedes half a block to the store at 15 miles per hour. This is a machine that has its own programming language and will accept code that you create on your PC or Macintosh and use the resultant software to run models, collect data, display graphics, or solve large equations. Once you've accomplished all this, it will load the information back into your computer for further processing.

The HP 48SX looks like a calculator with a very large screen. Each key has as many as four functions, making it complex to use. But once you've learned how, it's very powerful. The version I looked at had an extra 128K bytes of memory as well as the equation-solver package. The HP 48SX does everything from graphics to calculus. I never did use all its functions, but I never got tired of trying.

### Justifying a Purchase

There's no doubt that these little devices are fascinating. I never failed to draw a crowd when I used one in public. More important, they can significantly ease your work. The HP 48SX is clearly aimed at engineers and scientists who, besides using it for their work, also need to attend meetings. The Casio BOSS and the Sharp Wizard seem more useful to the traveling executive. The little DataStor is useful for less demanding tasks, but it can't keep up with the bigger machines.

There's no question that these machines do provide a limited, but very real, link with the computer while you're away from the office. All of them let you move information between your office computer and the one that resides in your pocket, and they'll support your day-to-day activities in the process. Fred was right. They may not replace a Day-Timer, but that's not their purpose. Instead, they bring a piece of the office to you. ■

*Wayne Rash Jr. is a contributing editor for BYTE and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.*

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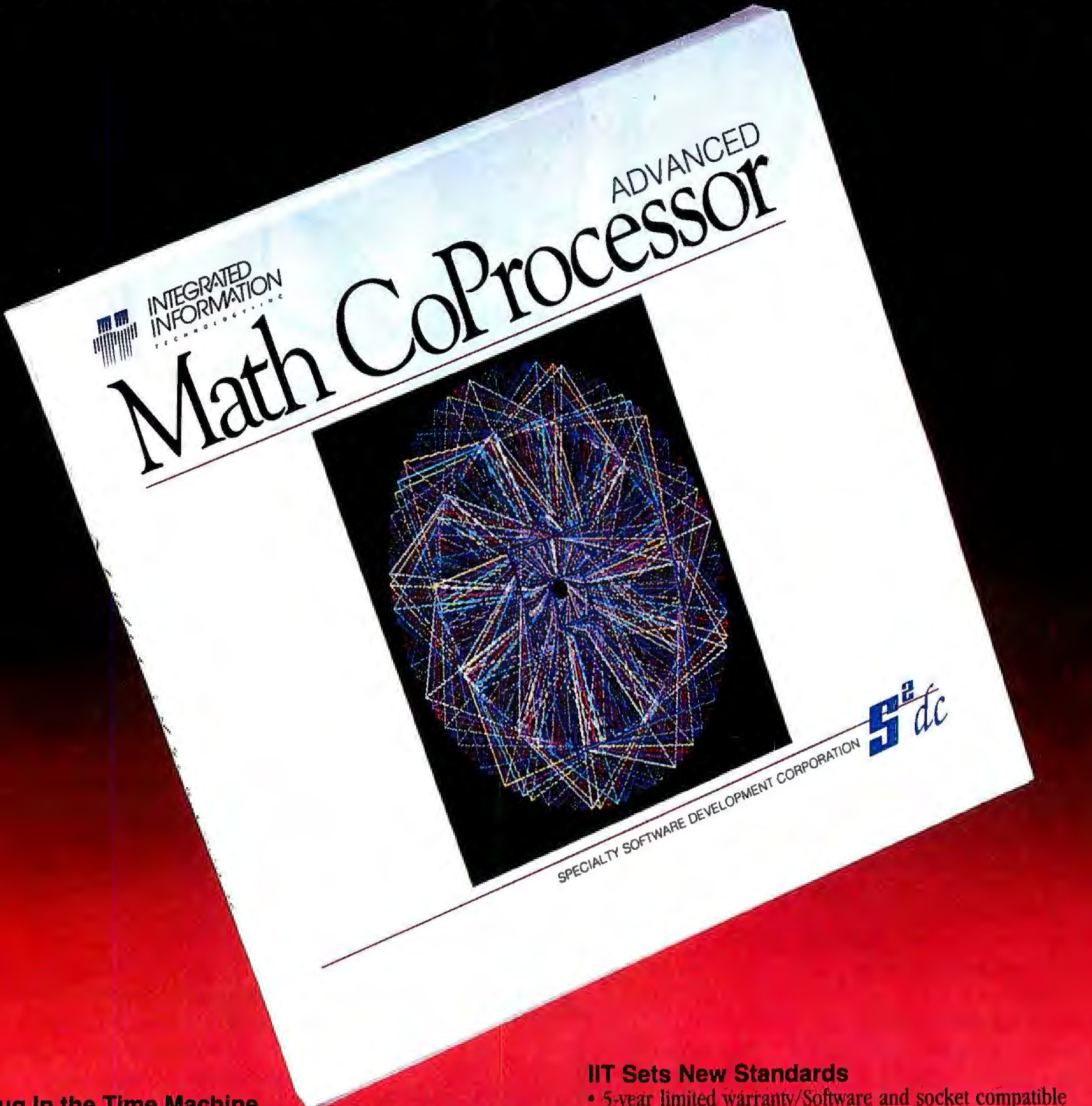


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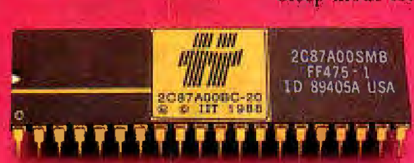


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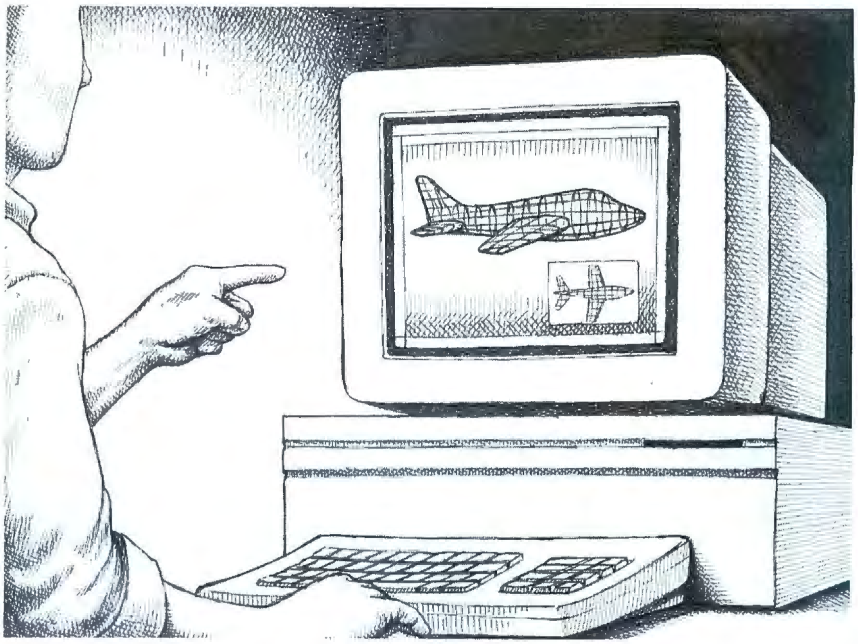
# CAD: THE MAC CAN DO THAT?

## Yes, it can—and other things as well



Several months back, I did a consulting gig for a large electronics company in the San Francisco Bay area. The company wanted recommendations for buying a new batch of computers. It sounds like a simple job, but it isn't. First, I will give you a little background: The company employs hundreds of engineers to design and fabricate specialized electronic components for the U.S. military, research firms, and universities. This means that the components are sold to a single customer in very small quantities. The end result is that the company does an awful lot of new design work, because the custom components are so different each time around.

Some time ago, the company settled on AutoCAD, with its many design libraries, as its basic design program. The first choice was (naturally) fast 386-based PCs, so it bought 25- and 33-MHz Everex 386 machines with VGA graphics. The company's only real concern was how fast its boxes could run AutoCAD, since screen editing and redrawing can take a long time with complicated drawings. Interface issues got short shrift, as did data interchange with other computers. Overlooked was the idea that the company might want to use the computers for anything other than AutoCAD work. The company was focusing so much on solving its immediate problems that it had forgotten to look ahead.

Well, I don't mind solving immediate problems; after all, that's one thing a consultant is supposed to do. I suggested that perhaps these 386 boxes weren't the best solutions for its long-term engineering needs. I mentioned the NeXT cube, the Sun SPARCStation, and the Macintosh as alternatives.

For many complex reasons, the company was not ready for Unix, so the NeXT and Sun systems were out. The reaction I got to my suggestion of the Macintosh was unexpected: It was amazingly hostile.

Most of the managers I talked with were significantly misinformed about the capabilities of the Mac and how it could fit their needs. They didn't know that the Mac had models with processing power comparable to that of their 386 machines. They also didn't know that the Mac supported gray-scale and color large-format (19- and 21-inch) monitors, or that you could run CAD applications (like AutoCAD). But overall, they were mostly amazed that a Mac could run CAD as fast as (or faster than) the 386 systems.

So I pulled together a demonstration using a Mac IIci and a Mac IIfx set up side-by-side with an Everex 386/33. Each Mac had 8 megabytes of RAM, and the IIci had a DayStar FastCache processor cache card (the IIfx has its own built-in cache). For displays, I used a 19-inch SuperMac color monitor with an accelerated 24-bit color card on the IIci, and an Apple 13-inch RGB monitor and the new Apple 24-bit AMD29000 accelerated QuickDraw card on the IIfx. Both Macs ran System 6.0.5 and AutoCAD. The Everex had 6 MB of RAM with EMS, VGA, and a custom graphics accelerator card running DOS 3.3.

I invited the biggest Mac skeptic in the group to sit down in front of the machines and try AutoCAD. Without telling him how to use AutoCAD on the Mac, save for a 5-minute demonstration of the Finder and using the mouse, he was off. His skepticism remained for about the first 5 minutes beyond that, but then you could almost see his scowl lift. The Macs were at least as fast as the Everex (and much faster on some AutoCAD operations).

*continued*

ILLUSTRATION: DAVID ROSE © 1990

All the computers used the same working AutoCAD drawings taken from the Everex machine. This was so that the managers would have familiar drawings to manipulate and to see just how easy it was to network the Macs with their Everexes. In addition, I had installed a bunch of Mac productivity applications. (The managers weren't very satisfied with their 386s' productivity programs.) I included MacWrite II and Nisus 2.02 for word processing, Think Pascal 3.0 for personal programming, WingZ and Excel for spreadsheets, FileMaker II for personal databases, and a number of attractive utilities, desk accessories, communications applications, and drawing aids.

When the demonstration was officially over, I couldn't get these managers to end the meeting. So we kept working on the Mac IIci and IIfx for several hours more, finding out just how much easier it was to work on the Mac—particularly, getting lots of allied work done (like all the paperwork that has to accompany each AutoCAD drawing), while not sacrificing a fast and familiar CAD application.

*I find myself gravitating to the Mac IIfx, even though the Everex is an awfully fast machine.*

**A Truth Revealed**

The one-day hands-on with the Mac IIci and Mac IIfx convinced the company that it had been shortsighted in dismissing the Mac out-of-hand. This is because the Mac mythology it had heard was wrong. The company won't be dumping its 386s—nor should it—but it will be bringing in Mac IIcis and IIfxs from now on instead of just more 386s. The company also tried to make its existing 386s a bit more palatable for non-AutoCAD work by adding Windows and DESQview to them.

This whole CAD episode reminded me of how easy it is to believe in the wrong things about the Mac and its supposed shortcomings for technical applications. While there are certainly some specialized scientific applications that only run on fast DOS machines (especially some instrument telemetry-gathering programs), the Mac has largely caught up with fast DOS machines as a strong platform for CAD, simulation systems, business and scientific statistics, and engineering programming support.

Since this consulting experience, I have been working with a Mac IIfx and an Everex 386/33 side-by-side to see if my gut feeling—that the Mac has really become a serious technical workstation competing with the best of them—is borne out for other applications. So far, I find myself gravitating to the Mac IIfx, even though the Everex is an awfully fast machine. I need to keep at this for a while, but the best advice I can give you now is that the high-end Macs really do not have any serious technological bottlenecks keeping them from stellar technical work.

*continued*

**Tip of the Month—**
**Take It to the Limit**

One of the reasons that I have so many problems with hard disk drives is that I stress them to the limit. I'm writing this column, for instance, on a Mac IIci, saving it to a Jasmine DirectDrive 180. The drive has about 150 MB on it in about 9000 files. The trouble is, the Mac's Hierarchical File System was created long before 180-MB SCSI hard disk drives became available. As such, HFS really doesn't like all these files on my DirectDrive 180. It would just as soon forget about them and convince me to drop the number of files down to something under 5000.

I placate HFS a bit and help the Finder out as much as I can by rebuilding my desktop at least once a month. This cleans out dead file markers and leftover icons from deleted files. I nest folders like mad (so the Finder doesn't have to wade through so many folders lying about loose on the desktop) and partition the disk into manageable sizes.

In addition, I use SUM II to keep copies of my volume directories and back up these shadow directories to other disks. I also use it to perform regular incremental tape dumps. As nice as all that is, it still is not enough to insure the contents of my hard disk or speed up maddeningly slow Finder operations like file copying.

Until we can all benefit from the blandishments of System 7.0, which will improve the situation, I have found a temporary solution. Or rather, during my BYTE review of the Jasmine DirectServe file server ("AppleShare Without a Mac," March), I found an INIT I had never tried before: the Apple Desktop Manager INIT (DTM). This specialized INIT is sitting, big as life, in the System Folder on the AppleShare server installer disk.

This INIT replaces the Finder's standard methods of managing the desktop with a minidatabase that's optimized to work with large numbers of files and big disk volumes (which is why AppleShare uses it). Although DTM doesn't come on Apple's System upgrade disks yet (it doesn't have the Cupertino Seal of Approval for single-user applications), you can easily copy it from the AppleShare disk to any Mac's System Folder. System 6.0.4 and 6.0.5, in fact, were built to work with DTM from the start, and System 7.0 uses it with extensions like FileShare as the file-managing heart of System 7.0's improved Finder.

If you have big disks with lots of files (or maybe even if you don't), I advise you to get hold of a copy of the DTM INIT and install it. In case it doesn't work (which occasionally happens), back up your hard disk first. Then get into the habit of biweekly or monthly desktop rebuilding. Together, these will make the Finder work faster and reduce your ennui while waiting for your Mac to catch up with you. And they'll also help you to avoid some disk failures. Of course, if you're careful like me, you'll also already have lots of tape backups, just in case. ■

*Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."*

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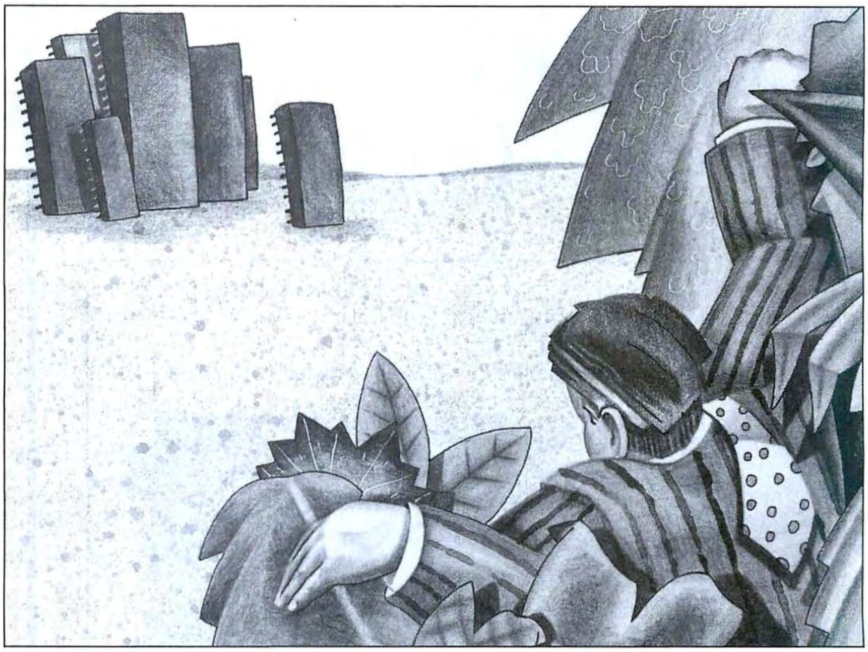
# FREE AT LAST!

## Farewell, 64K-byte segments; hello, wide-open memory spaces



Well, at least I *hope* so. Last month, I told you about one of the two big features of OS/2 2.0: multiple virtual DOS machines. The other big feature is access to the 386's memory management capabilities.

The Intel microprocessor line, from the 8086 through the 286, relies on a *segmented* architecture. That means that the chip can't just say, "Let me look at location 351,799 in the memory." Instead, it must divide the memory into segments, each no larger than 64K bytes. The minimum number of segments required to describe DOS's 640K-byte space is 10. The idea with segments is that they make it easier to keep the system neat and tidy. Each program or subroutine can go into a *code* segment, and the data or a given data structure can go into a *data* segment. Any given location within a segment is described by its *offset*.

There's nothing intrinsically wrong with a segmented architecture. It eases some system housekeeping tasks, like code relocation. Convincing a piece of 6502 machine code on an Apple to move from the address it was originally loaded into took patience and knowledge of 6502 assembly language; moving some 8088 code from one place to another takes only a "memory move" command and a reload of the pointers to the code and data. The problem is the 64K-byte limit.

Truthfully, most code segments are not affected by the 64K-byte barrier, although it does pose a minor hindrance. The way around this limit for code segments is to simply put different subroutines in different segments. Subroutines can then call one another by jumping from one code segment to an entirely different one. This is called a *far call*. On the other hand, putting multiple subroutines into the same code segment means that the programmer needn't jump from code segment to code segment, and this is called a *near call*. Far calls take a bit longer to process.

The larger annoyance comes from data areas. It's much easier to write code that keeps each data structure entirely in a single data segment. Data structures that require more than one 64K-byte segment require constant loading and reloading of the pointers to the data segments. As is the case with avoiding far calls, avoiding dealing with segments improves performance.

It's easy to see this. Just write a simple program that creates and fills an array smaller than 64K bytes. Compile it as a small memory model (all near references) and run it. Then recompile it as a large memory model (force all references to be far) and rerun it. You're not getting anything more accomplished, but the program will probably take about 20 percent longer to execute.

That's a lot of time to waste in system overhead. Imagine what a pain it must be to write a spreadsheet program for earlier versions of OS/2 if you want to let a spreadsheet grow to 16 megabytes: You would potentially have to manage 256 64K-byte segments! It's not only an annoyance to programmers, it's also depriving you and me—tons of good Unix and mainframe programs have never been ported to the IBM PC just because dealing with this 64K-byte segment nonsense seemed like too much trouble.

Enter the 386. It can address 4096 MB of memory, again using a segment:offset addressing scheme. But the segments

*continued*

ILLUSTRATION: CHRIS SCHMIDT © 1990

themselves can be as large as 4096 MB. Thus, a programmer can choose to make all the memory one big segment: OS/2 2.0 does that, and that's the "0:32 memory model" that you see references to in the press. Version 2.0 essentially discards the notion of segments.

Making all the memory a single segment means that all code and data references are near references. The payoff is immediate: I created a 1-MB data structure using 64K-byte segments and then rewrote the program for OS/2 2.0 without segments. Despite the fact that both programs ran on the same machine, both under version 2.0, the no-segment version was almost 20 percent faster.

"Wait a minute," you ask. "How can OS/2 make the memory one big pool, yet keep buggy applications from crashing the system and each other?" A good question—wasn't a protected-mode operating system one of OS/2's goals? Sure, and that hasn't changed.



Remember my discussion last month of paged memory? Each program gets a *memory page table*. The program then refers to this table of 4K-byte pages, not actual memory: It sees only the memory that it's supposed to see. The size of the table can be restricted by the operating system, and that's how the protection is accomplished. Although your 386 may have 8 MB of RAM, your application may know of only 2 MB.

Further, the virtual memory system still remains in place, although now it swaps to disk on the basis of pages rather than segments. That's more efficient (although I haven't tested it yet), because operating-system designers can plan on needing exactly 4K bytes of disk space for each memory page. Segments, on the other hand, could be smaller than 1K byte or as large as 64K bytes.

As the days go on and I find out where the minefields are, I use the machine running version 2.0 more and more. It's a real improvement.

**Applications Keep Pouring In...**

About a year and a half ago, I wrote part of a book on OS/2 (*Using OS/2* from Que) and needed very much to capture Presentation Manager screens. Microsoft included a screen grabber with its Software Development Kit, but it saved only to Windows Paint format. Better than nothing, but I still had to get proficient at taking photographs of computer screens. Many were the times I longed for a PM screen capture program.

Nowadays there are two: Charles Petzold has written one called PMCAP and put it in the public domain (you can find it in the ibm.os2 conference on BIX), and recently I've been using Hotshot Graphics from Symsoft. The latest version, 1.7, still runs only under DOS, but it includes a screen grabber that works under PM and produces great output on a laser printer. It also saves to .PCX format, so you can easily include screen shots in most desktop publishing systems. If you're documenting a PM application, I recommend Hotshot Graphics.

Last month, I mentioned an inexpensive text editor called Qedit, but I bemoaned the lack of block fills and command repeat prefixes. Both problems are now fixed in version 2.8. A mere $79 gets you this nifty OS/2 text editor from SemWare (4343 Shallowford Rd., Suite C-3, Marietta, GA 30062, (404) 641-9002). I've now converted to Qedit for all my daily work, under DOS and OS/2.

And if you're bored by the dull gray background of the PM desktop, get on

*continued*

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### Two Short HPFS Tips

I was asked by two readers—Jim Gilliland and Christopher Boaro—to add to my discussion of a few months ago about High Performance File System speed. I found HPFS's speed improvements over file allocation table–based systems to be measurable but nonspectacular. I said then that I really don't care about the speed improvement, as I was happy enough about long names, extended attributes, and the rest.

Both readers ask me to point out that the big HPFS performance improvement comes with a big cache—not the 64K-byte cache that gets set up by default, but a 256K- or 512K-byte cache. (You just change the line in your CONFIG.SYS that says IFS=C:\OS2\HPFS.IFS-C:64 so the 64 is expanded to whatever size your memory can bear.) Then you can turn on "lazy writes" by adding RUN =C:\OS2\CACHE.EXE /LAZY:ON to CONFIG.SYS.

A final tip for the month: When doing a class for a client, I reformatted an entire 20-MB hard disk drive and installed HPFS. The next day, the client called me, as he was trying to reformat the drive back to DOS. He'd boot from a DOS floppy disk, try to format C, and get "format failure." It took me a minute to realize what was going on: HPFS uses a new "partition ID" code. It's different from DOS's partition ID code—hence the format failure. The fix is easy. Run DOS FDISK, delete the HPFS partition, and then create a new DOS partition. Then you can format without trouble. ■

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*Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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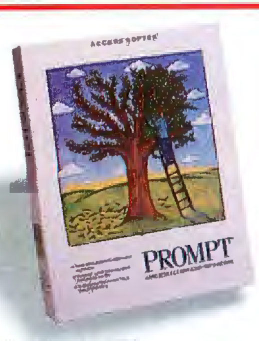


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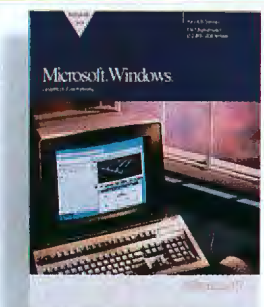


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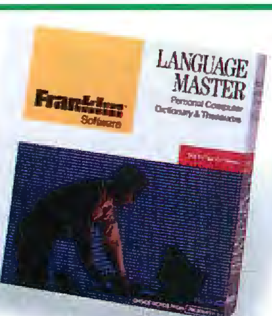


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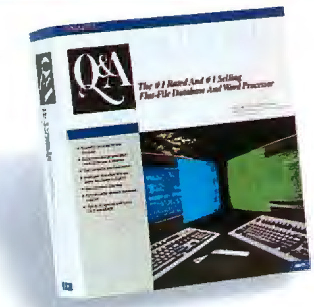


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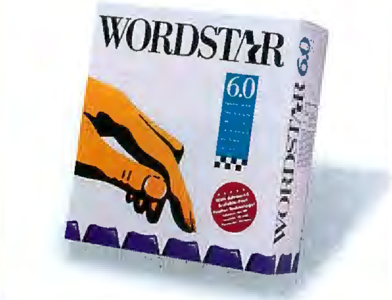


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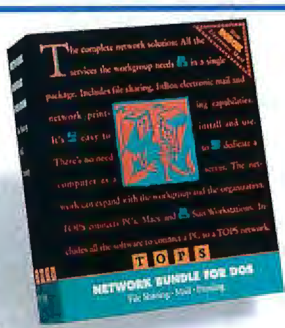
5851 ▣SimCity .................... 33.
Electronic Arts ... NCP
6436 ▣Hunt for Red October ......... 20.
4659 ▣Chessmaster 2100 *(CP)* ........ 35.
5804 ▣Deluxe Paint II *(Enhanced)* ..... 89.
Microsoft ... NCP
2858 □Flight Simulator 4.0 ........... 39.
Parlor Software ... CP
3159 □Bridge Parlor 2.3 ............. 49.
Penton Overseas ... NCP
▣VocabuLearn/ce Levels I & II (French, Italian, German, Spanish, Russian, and Hebrew) ............ *each* 39.
Sierra On-Line ... CP
6023 ▣Leisure Suit Larry III ........... 39.
6796 ▣Codename: Iceman ........... 39.
6972 ▣Conquests of Camelot ......... 39.



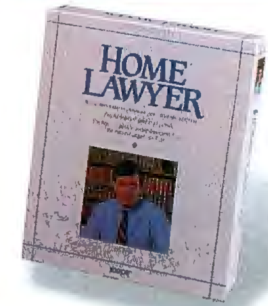

TOPS ... NCP
6675 □ *Network Bundle for DOS 3.0*–Allows you to quickly and easily share files, electronic mail, and printers between your Apple Macintosh, IBM PC and/or Sun Workstation. Now includes Inbox EMail software . $159.

Spectrum Holobyte ... NCP
5993 ▣Welltris .................... 22.
Stone & Assoc. ... NCP
3438 ▣Young Math *(ages 5 to 8)* ....... 22.
3439 □2nd Math *(ages 7 to 16)* ........ 27.
True BASIC, Inc. ... NCP
▣Kemeny/Kurtz Math Series: 10 titles ................. *each* 45.

## HARDWARE

**Manufacturer's standard limited warranty period for items shown is listed after each company name. Some products in their line may have different warranty periods.**

American Power ... 2 years
6812 200DL *(stand-by power source)* .. 155.
6811 360SX *(stand-by power source)* ... 255.
7107 450AT *(stand-by power source)* ... 339.
7106 520ES *(stand-by power source)* ... 399.
7105 600LS *(stand-by power source)* ... 469.




MECA ... NCP
7002 ▣ *Home Lawyer 1.0*–Let Hyatt Legal Services help you through the legalese by using plain English. Contains 16 commonly used documents and guides you step-by-step through each one ................ $69.

AST Research ... 2 years
1299 SixPakPlus 384k C/S/P ......... 187.
6795 SixPak 286 512k .............. 209.
4107 RAMpage Plus 286 512k ........ 419.
6980 VGA Plus *(w/512K) (800 x 600 res)* *159.*
Boca Research ... 5 years
7001 BOCARAM/AT PLUS *(0-8 Meg ext.)* 125.
7000 TophAT *(16-bit backfill 512K to 640K, with 0K)* ..................... 79.
6998 I/O Board for AT .............. 59.
6999 I/O Board for Microchannel S/S/P . 109.
Brother International ... 1 year
5787 HL-8e Laser Printer ........... 1799.
5788 HL-8Ps PostScript Laser Printer . 2949.
Compucable ... 2 years
1604 2-Position switch box ........... 25.
Cuesta ... 1 year
1608 Datasaver 400 Watt *(power backup)* 429.
Curtis ... lifetime
1694 Emerald SP-2 ................. 36.
1707 Ruby SPF-2 *(6 outlets)* .......... 55.
1708 Ruby-Plus SPF-2 Plus .......... 65.
Datadesk ... 3 years
6901 Switchboard ................. 175.
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5655 150 Plus Printer *(Parallel)* ........ 359.
Epson ... 1 year
*We are an authorized Epson Service Center.*
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1904 FX-1050 *(136 col., 264 cps, 9 pin)* .. call
5183 LQ-510 *(80 col., 180 cps, 24 pin)* ... call
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6765 LQ-1010 *(136 col., 180 cps, 24 pin)* call
1917 LQ-1050 *(136 col., 264 cps, 24 pin)* call
4116 LQ-2550 *(136 col., 333 cps, 24 pin)* call
5184 LX-810 *(80 col., 180 cps, 9 pin)* .... call
1052 Printer-to-IBM cable *(6 feet)* ....... 15.
5th Generation ... 1 year
7157 Logical Connection Plus 512k .... 599.
Hayes ... 2 years
2307 Smartmodem 2400 ............ 349.
2308 Smartmodem 2400B *(w/Smartcom II)* 279.
Hercules ... 2 years
2318 Graphics Card Plus ............ 189.

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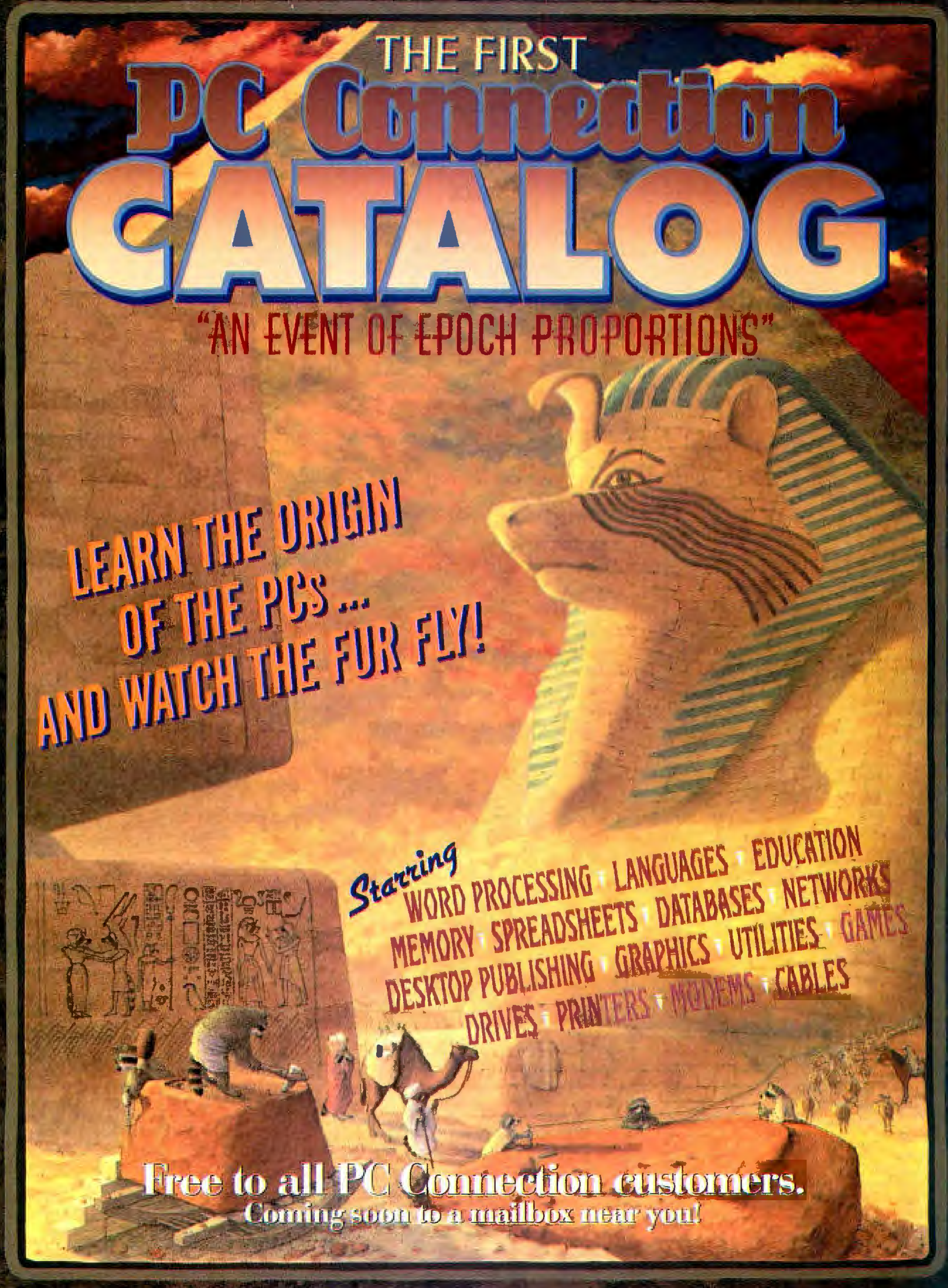

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**IOMEGA ... 1 year**
5116 Bernoulli II Single 44 Meg Internal $995.
5117 Bernoulli II Dual 44 Meg External 1969.
5113 44 Meg Cartridge Tripak *(5¹/₄")*... 249.
*Controller Cards (required)*
2499 PC2 Card .................... 169.
2500 PC2B Card *(bootable card)*...... 229.

**Mountain Computer ... 1 year**
2917 40-60 Meg Internal Tape Drive.... 379.
5502 83-152M Ext. Tape Drive........ 799.
5500 83-152M Int. Tape Drive ........ 629.
5190 DC2000 Pre-formatted Cartridges ea. 35.

**Pacific Rim ... 1 year**
5010 1.2 Meg External *(for PS/2's)*..... 215.
6602 1.44 External *(for PC/XT/AT)* ..... 239.

**Plus Development ... 2 years**
6425 Hardcard II 40 Meg *(19 ms)* ..... 599.
6424 Hardcard II 80 Meg *(19 ms)* ..... 699.

**Seagate ... 1 year**
*FREE PCTV® Hard Drive Installation Tape with purchase of 20, 30 or 40 Meg Seagate drive for the IBM PC (not for AT). Beta or VHS.*
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7028 *Foliopac 1* .................. $79.
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2286 30 Meg Int. Hard Drive ST238 *(w/controller and cables, 65 ms)*.. 289.
4554 40 Meg Int. HD ST251-1 (28 ms).. 359.

**TEAC ... 1 year**
4951 720k Drive *(specify XT or AT, 3¹/₂")* . 79.
4670 1.44 Meg Drive for XT *(3¹/₂")*...... 99.
4326 1.44 Meg Drive for AT *(includes Bastech software utilities, 3¹/₂" copy prot.)* . 119.

## MISCELLANEOUS

**Checkfree**
6360 CheckFree ................... 25.

**CompuServe**
1676 CompuServe Information Service . $24.

**Cables ... lifetime**
1019 Smartmodem-to-AT cable *(10 feet)* . 15.
5511 Right Angle Printer cable *(6 feet)*... 15.
1050 Parallel Printer cable *(15 feet)* ..... 19.

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**Maxell ... lifetime**
2789 5¹/₄" MD2-D 360k Disks *(Qty. 10)* .... 12.
2790 5¹/₄" MD2-HD 1.2Mb Disks *(Qty. 10)*.. 19.


**Reflection Technology ... 1 year**
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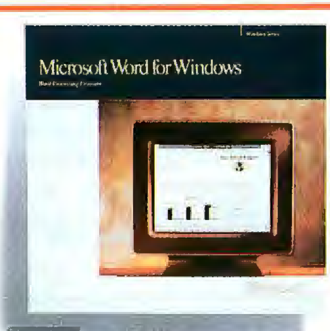


**Microsoft ... NCP**
6195 ▣ *Word for Windows*–Combines the power of Word for the PC with ease of use and WYSIWYG accuracy of Microsoft Windows. Supports cut & paste from other Windows programs.............. **$329.**

2792 3¹/₂" DS/DD 720k Diskettes *(Qty. 10)*.. 14.
2793 3¹/₂" DS/HD 1.44Mb Diskettes *(Qty. 10)* 27.

**Sony ... lifetime**
3291 5¹/₄" DS/DD 360k Disks *(Qty. 10)* .... 10.
3292 5¹/₄" DS/HD 1.2Mb Disks *(Qty. 10)* ... 19.
3297 3¹/₂" DS/DD 720k Diskettes *(Qty. 10)*.. 13.
3298 3¹/₂" DS/HD 1.44Mb Diskettes *(Qty. 10)* 22.
6659 QD 2000 Tape Cartridge......... 19.

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6556 256k DRAMs *(100 nanosecond)*... call
3248 256k DRAMs *(120 nanosecond)*... call
4366 1 Meg x 9 SIMMs *(100 nanosecond)* call
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**Epson ... 1 year**
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| | **Hewlett-Packard ... 1 year** | |
| 6754 | LaserJet III *(w/toner)* | 1699. |
| 6582 | LaserJet IIP *(w/toner)* | 1069. |
| | **Intel ... 5 years** | |
| 6421 | 2400B MNP Internal Modem | 199. |
| 2352 | 2400B Internal Modem 2 *(for PS/2)* | 249. |
| 5119 | 2400 Baud External Modem | 179. |
| 6420 | 2400EX MNP Modem | 229. |
| 2346 | Inboard 386/PC w/1 Meg *(w/free Ami)* | 519. |
| 4266 | Above Board Plus 512k | 419. |
| 4267 | Above Board Plus I/O 512k | 449. |
| 5336 | Above Board Plus 8 2 Meg | 599. |
| 5342 | Above Board Plus 8 I/O 2 Meg | 629. |
| 4272 | Above Board 2 Plus 512k | 169. |
| 5396 | Above Board MC 32 0k | 359. |
| 4275 | Connection CoProcessor *(w/Fax-it)* | 529. |
| | *MATH COPROCESSORS* | |
| 2370 | 80287-8 *(for 8 MHz 80286 CPU's)* | 199. |
| 2369 | 80287-10 *(for PS/2 Models 50 & 60)* | 229. |
| 4750 | 80387SX *(for 80386SX CPU's)* | 309. |
| 2371 | 80387 *(for 16 MHz 80386 CPU's)* | 349. |
| 2372 | 80387-20 *(for 20 MHz 80386 CPU's)* | 399. |
| | **Kensington Microware ... 1 year** | |
| 2582 | Master Piece Plus | 109. |
| 5697 | Expert Mouse *(Trackball for PS/2)* | 115. |
| | **Key tronic ... 3 years** | |
| 4518 | 101 Plus Keyboard | 99. |
| | **Kraft ... 5 years** | |
| 5801 | New Game Adapter *(2 game ports)* | 27. |
| 5800 | 3 button Thunder Joystick | 29. |
| 5802 | Trackball | 69. |
| | **Logitech ... limited lifetime** | |
| 5464 | C9 Mouse for PS/2's | 69. |
| 5151 | HiREZ Mouse *(C9)* | 85. |
| 6029 | Trackman *(Trackball) serial* 85. *bus* | 89. |
| 4297 | ScanMan Plus *(hand scanner)* | 185. |
| 6786 | ScanMan w/Catchword 1.0 | 315. |
| | **Micron Technology ... 2 years** | |
| 6669 | Intensify 2 Meg Expansion for HP LaserJet II *(upgradeable to 4 Meg)* | 329. |
| 6013 | Beyond Mem. Brd. for Model 50 *(512k)* | 359. |
| | **Microsoft ... lifetime** | |
| 2897 | Mouse with Paintbrush | 109. |
| 2898 | Mouse with Windows 3.0 | 149. |

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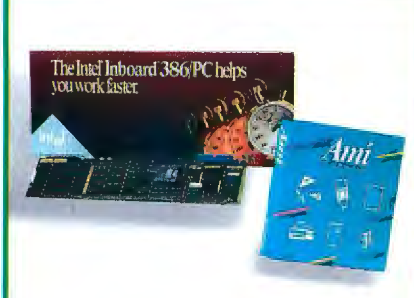
| | **MicroSpeed ... 1 year** | |
| 6007 | PC-TRAC Trackball *serial* $75. *bus* | $85. |
| 6010 | FastTRAP 3D Trackball *serial* 99. *bus* | 109. |
| | **Mouse Systems ... lifetime** | |
| 5997 | Trackball *(1 yr. wrnty.) serial* 75. *bus* | 85. |
| 4306 | PC Mouse II w/PC Paint+ | 89. |
| | **NEC ... 2 years** | |
| 4799 | Multisync 2A *(VGA Monitor)* | 499. |
| 5085 | Multisync 3D Monitor | 689. |
| 6208 | Multisync 4D Monitor | 1199. |
| | **Orchid Technologies ... 4 years** | |
| 4690 | ProDesigner VGA *(800 x 600)* | 249. |
| | **PC Power & Cooling ... 1 year** | |
| | *REPLACEMENT POWER SUPPLIES* | |
| 3202 | Turbo Cool 150 *(25° - 40° cooler)* | 129. |
| 3200 | Silencer 150 *(84% noise reduction)* | 115. |
| | **Pacific Data Products ... 1 year** | |
| 6779 | 25 Cartridges in One! *(for LJ II, IIP, IID)* | 275. |
| 7072 | 25 Cartridges in One! *(for LJ III)* | 349. |
| 7054 | Memory upgrade for LaserJet IIP/III *1 Meg* ..... 179. *2 Meg* | 249. |
| 6839 | Memory upgrade for LaserJet II *1 Meg* ..... 179. *2 Meg* | 249. |
| 6833 | Pacific Page *(PostScript Cartridge for LaserJet IIP/III)* | 379. |
| 6834 | Pacific Page *(for LaserJet II)* | 499. |

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2346 *Inboard 386/PC with Free Samna Ami*–Gives you 80386 processing power, 1 Mb RAM, and Samna's powerful windows-based word processor (regularly at $129). 30 Day Money Back Guarantee..... **$519.**

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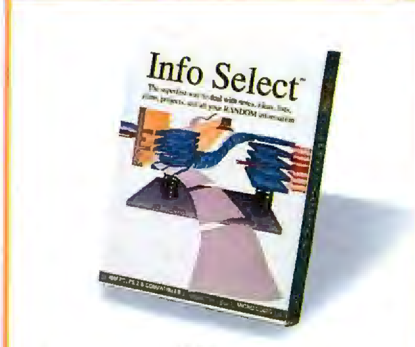
| | **Practical Peripherals ... 5 years** | |
| 3101 | 1200 Baud Internal Modem | 65. |
| 3100 | 1200 Baud External Modem *(mini)* | 77. |
| 3103 | 2400 Baud Internal Modem | 135. |
| 3102 | 2400 Baud External Modem | 179. |
| 5286 | 2400 Baud Int. MNP Modem *(Lev. 5)* | 175. |
| 5285 | 2400 Baud Ext. MNP Modem *(Lev. 5)* | 209. |
| 4542 | 2400 Baud Internal Modem for PS/2 | 229. |
| | **Reflection Technology .. 1 year** | |
| 7127 | Private Eye *(visual display)* | 499. |

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| | **SAFE Power Systems ... 2 years** | |
| 4562 | Safe 425W *(standby power bkup)* | 329. |
| 6747 | Safe 400S | 409. |
| | **SOTA Technology ... 2 years** | |
| 5111 | SOTA 286i-12 *(12 MHz accelerator)* | 269. |
| 5402 | SOTA 386i-16 *(16 MHz accelerator)* | 389. |
| | **Targus ... lifetime** | |
| 7028 | Foliopac 1 | 79. |
| 4899 | Nylon Laptop carrying case | 55. |
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| | **TheComplete PC ... 2 years** | |
| 5598 | TheComplete Half Pg. Scanner 400 | 189. |
| 5140 | TheComplete Page Scanner | 549. |
| 5828 | TheComplete Communicator | 559. |
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| 6199 | Isobar 4-6 *(4 outlets, 6 ft. cord)* | 49. |
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| 6019 | LS 600 Line Stabilizer | 85. |
| | **Video 7 ... 7 years** | |
| 5883 | 1024i VGA *(includes 512k)* | 289. |
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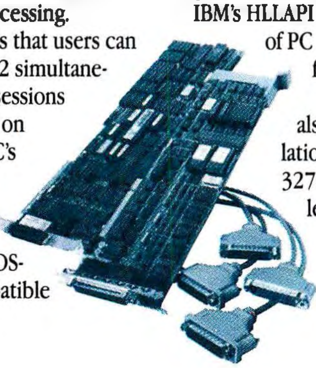

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# NETWORKS SHOULDN'T BE THIS HARD

## Getting ready to work on a LAN involves a lot of hassle. Why?

Anyone who's ever had to get a bunch of PC compatibles ready to go on a LAN will tell you that setting them up is too darn hard. First, you have to install the network adapter of your choice—Ethernet, Token Ring, ARCnet, or whatever. That job wouldn't be that bad if all you had to do was open your system, insert the board, and connect the network cable, but that's only the beginning. You have to make the network board work, which means fiddling with such PC goodies as interrupts (IRQs), DMA addresses, I/O ports, and memory addresses. Nothing is worse than having a LAN board that gives you only three interrupt choices, all of which you're already using with other boards in your machine.

The source of all this confusion, of course, is the PC architecture, which doesn't automatically recognize add-in boards (or much of anything else attached to the system, for that matter). The Micro Channel and Extended Industry Standard architectures promise some help in this area, but most people are still using PCs with the classic AT-bus architecture. The problem of managing add-in boards of any type is bad enough that a whole subindustry of products, such as Quarterdeck Office Systems' Manifest, exists to help you figure out what's going on in your PC.

Once you have installed the network adapter, you have to load the drivers for that board and your network operating system. With NetWare, that process involves generating the client software, or shell, by running a special program, SHGEN. Worse, you need a different combination of drivers and client software for every board configuration and LAN operating-system combination. The final step is to enter the right commands in the right sequence, and then you're ready to log onto the server of your choice—whose name you must already know.

None of this, by the way, even touches on the problems of network administration—we'll talk about them in future columns. This month, we'll focus strictly on the hassles that you must endure just to use the network.

### The Mac Alternative

If you're used to PC networks, this setup process might not seem too bad. It might even seem reasonable—but that only means that you can learn to live with anything. To see just how much easier it can be, consider the Mac.

To connect a Mac to a LocalTalk network, you plug the LocalTalk cable into the printer port that's standard on every Macintosh. Then you turn on the Mac and bring up the Chooser desk accessory (also standard on every Mac). Click on the AppleTalk icon and activate AppleTalk, and the Chooser presents you with a list of available servers. Pick the one you want, and you're in business; the server's disk icon will appear on your screen. The Chooser will even ask if you'd like to connect to this server automatically each time you turn on your Mac, so you don't have to go through this minor hassle again.

You couldn't ask for much more, although we would like to see the Mac automatically give you the option of connecting to any new servers when it boots up. The first time you turned on your Mac, it would ask if you'd like to connect to each of the available servers; thereafter, it wouldn't bother you unless a new server came on-line.

To be fair, even a Mac forces you to do more work if you want to use an Ethernet

*continued*

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or Token Ring adapter: then you have to open the case, stick in the board, and drag some drivers from the disk that came with the board into your system folder. Mac boards configure themselves automatically, however, so there's no messing with interrupts or DMA addresses or any other such rot.

**Why the Difference?**

This comparison between Macs and PCs may seem grossly unfair, but it's not. Why, after all, should millions of PC users have to work so much harder than Mac users to use a LAN?

The problem is that the PC world has become a multiparty system, while the Mac world is still a benevolent dictatorship. Apple, love it or hate it, set the Mac LAN standards, and now everybody's following them. True, TOPS and 3Com offer Mac LAN operating-system alternatives, but even those vendors are making their products compatible with Apple's AppleTalk File Protocol (AFP), the file access protocol at the heart of Mac LANs.

PC users, on the other hand, live in a world of relatively open standards, where they're free to choose from NetWare, LAN Manager (in all its many flavors), LANtastic, or any of several dozen other LAN operating systems. Each of those products uses different client software and works with a different subset of the many available LAN adapters.

So, what's a poor buyer to do? Don't get us wrong—we're not arguing for any kind of PC LAN dictator, benevolent or otherwise. The disadvantage to Apple's domination is obvious: Note, for example, how slow Apple was in bringing Ethernet and Token Ring to the Mac, and how high Mac prices are relative to the costs of PCs of equal power.

What we are suggesting is that LAN users and buyers everywhere start demanding better treatment.

Look at today's system vendors. You can call the PC vendor of your choice and order a PC with a monitor, a hard disk drive, and 2 megabytes of memory—or whatever other configuration you want—and it will arrive sometime later, ready to go—or darn close. OK, you might have to install DOS yourself, but many vendors of PC compatibles even do that for you. (Every vendor should follow their lead and install the operating system that you buy.) You should only have to hook up your monitor and plug in the system and monitor to get to work.

So why not add network adapters to the list? Why can't your vendor let you call up and say something like, "I need 10 PCs with [your configuration] and Ethernet for NetWare 286" and then deliver exactly that? When you get your system, you connect the keyboard and monitor and plug the network cable into the connector waiting on the back of your system. Let the vendor deal with the hassle of making the network adapter work with the rest of the system; after all, who knows the system better?

It's also time for vendors to start seriously considering adding network support to their motherboards; Ethernet and Token Ring chip sets are now available, and they're shrinking rapidly in size and cost.

That's not the end of it. The system vendor should set up each machine's AUTOEXEC.BAT (and, if necessary, CONFIG.SYS) file, so that you can connect to the network immediately, or the

*continued*


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*Circle 244 on Reader Service Card*

vendor should at least provide a batch file that does the job. (You still have to know the name of the server that you want, but that's a completely separate problem that the LAN operating-system vendors should solve.)

Let's also make LAN operating-system vendors do their part. They could cut down the configuration process and load the network adapter device driver at run time; who wants a generation process, anyway? Vendors should also standardize the client software, at least among different versions of the same network operating system. NetWare is already close, and the many versions of LAN Manager are heading in that direction, but users should demand that vendors get there more quickly.

### Is It Feasible?

Can this grand scheme really work? Yes—for the most part. So many different LAN operating-system and network adapter combinations exist that no system vendor can reasonably cover them all. Fortunately, they don't need to help everybody—just most of us. If every system vendor offered this setup for just NetWare and LAN Manager with only Ethernet, Token Ring, and maybe ARCnet, that would cover over 90 percent of the LAN marketplace. And that's good enough for us.

We're not alone in endorsing this idea. At least one vendor, Gateway 2000, already installs DOS and most add-in boards for its buyers and plans to extend that support to network boards—and the necessary drivers for, at the least, NetWare—in the near future.

You can do your part, too: Urge your system vendors to follow this path; if they won't, take your dollars elsewhere. Everybody's in this game for a profit, so enough lost customers will drive the message home to even the biggest vendors.

In the meantime, we'll keep griping at the vendors who force us to fiddle with IRQs and DMAs and network adapter drivers, and we'll praise the few who don't. Using a PC LAN just doesn't have to be this hard. ■

*Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.*

*Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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*—May 29, 1990*

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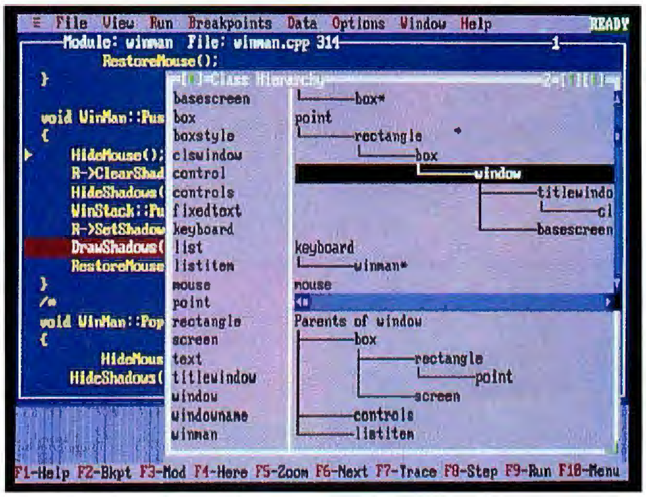
**Manufacturer's suggested retail price is $249 for LANtastic 2Mbps adapters and $349 for LANtastic Ethernet Adapters. 

*Circle 28 on Reader Service Card*

*BYTE editors' hands-on views of new and developing products*






## Bringing C++ to the Mainstream

Borland's **Turbo C++** introduces a wholly redesigned multiwindow development environment and a full implementation of AT&T's version 2.0 of the object-oriented C++ language.

The new Borland IDE (Integrated Development Environment) employs multiple overlapping and resizable windows, but it still runs in text mode rather than graphics mode. Windows have scroll bars, close boxes, and zoom boxes, and you can move, scroll, and resize them using the mouse with pull-down menus or by keyboard shortcuts; I found a mixture of the mouse and shortcuts very convenient.

Borland has incorporated its new VROOMM (Virtual Run-Time Object-Oriented Memory Manager) technology, so you can open as many windows as you like. When the main memory runs out, Turbo C++ starts swapping chunks to the hard disk, to extended or expanded memory, or to the RAM disk (command-line switches decide which). I was impressed to find 328K bytes of memory free when I shelled out to DOS with five windows open and SideKick Plus loaded!

You can point and shoot your way through the IDE with Macintosh-style buttons and check boxes for setting options. All dialog boxes that require you to enter text (e.g., filenames) keep a scrolling history list, so you can reuse previous entries. This is a generalization of the old Pick feature. The directory browser displays an Xtree-like picture of your subdirectory structure. Error messages are piled up in a scrolling window. You select one and press Return to edit the source file that has a cursor over the offending statement. You can also preserve messages from previous compiles.

The editor now has cut-and-paste commands and a viewable clipboard window, although the old WordStar commands are still supported. The new macro language proved disappointing; it allows only sequences of the existing commands, with no loops or conditionals. The powerful new Transfer option allows you to bind your own programs and utilities into the IDE, call them from a menu, and have them output messages via an IDE window. The Turbo Assembler (TASM) and Debugger come preinstalled as Transfer options. In a few minutes, I installed the Turbo Pascal command-line compiler and was able to compile Pascal programs from an IDE window. If Turbo Pascal produced object files rather than Turbo Pascal files, I could have linked mixed-language programs directly.

**THE FACTS**

**Turbo C++**
$199.95; Professional version, $299.95

*Requirements:*
IBM PC, 640K bytes of RAM, and DOS 2.0 or higher.

Borland International, Inc.
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95066
(408) 438-8400
**Inquiry 1010.**

Turbo C's projects, a visual form of the Make utility for large programs, are much enhanced in Turbo C++. The Project Manager now lets you browse each project's source modules in a window and edit them by pressing Return; ditto for their header files. Project Manager checks dependencies and recompiles only the minimum number of modules. You can specify what translator to use for each module (e.g., C++, TASM, custom preprocessors, or Turbo Pascal) and what nonstandard libraries to link it with.

To create overlays (which now employ VROOMM) you just tick a single check box for each chosen module; no more worrying about memory sizes or loading order. A minor irritation: Creating a project is the only way you can link your own libraries within the IDE. However, Borland still supplies TCC, the command-line version of the compiler.

Turbo C++ contains both C and C++ compilers, but the integration cannot be seamless. By default, it compiles files with the extension .CPP using the C++ compiler and those with .C extensions using the C compiler. Running the C++ compiler on old C programs usually ends in error, thanks to the stricter type checking in C++. Turbo C++ implements in full the new version 2.0 iostream class library, but it also offers the stream library from version 1.x to compile older C++ programs.

Borland has upgraded the C compiler in Turbo C++ to full ANSI conformance; it passed 72 of the 79 tests in the Plum Hall validation sampler, the remainder failing through known bugs in my beta-test copy. I tested

Turbo C++ on a 16-MHz 386SX machine without an FPU. Having no C++-specific benchmarks at hand, I ran the Sieve of Eratosthenes in 0.61 second for 10 iterations (twice as fast as Turbo Pascal 5.5). In the Plum Hall Simple Benchmarks, Turbo C++'s performance ranked close to Sun C's on a Sun-3/75 workstation.

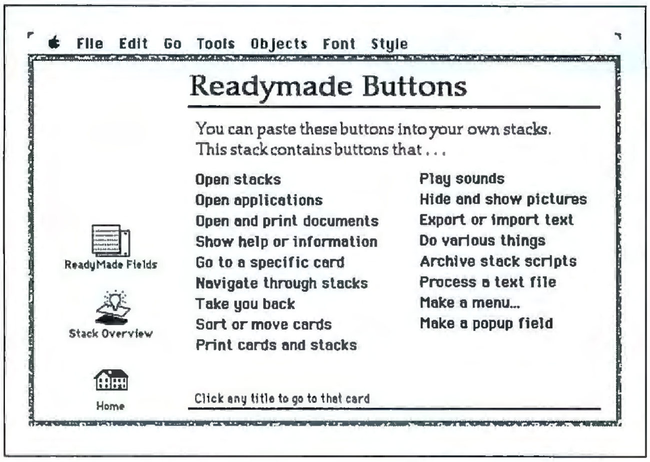
In short, I think Turbo C++ is another landmark product from the folks at Borland.

*—Dick Pountain*

## Apple Deals a New HyperCard

Apple's HyperCard program has been the major catalyst of the Macintosh's success in the multimedia and interactive training markets. The often-imitated program lets users manipulate data using the metaphor of a stack of index cards. In a smart marketing move, Apple bundled HyperCard with every new Mac, and HyperCard enthusiasts and commercial programmers responded by developing HyperCard stacks for applications ranging from teaching golf techniques to toolkits for composing music.

But, in spite of its popularity, HyperCard has been in need of some improvements, particularly when it is used for serious software development. The current version, 1.2, lets you work with only a single stack on the screen at one time. Also, the individual cards must be the size of the small Mac screen (512 by 342 pixels), and there is no support for color. In addition, HyperCard 1.2 had limited tools for designing the visual appearance of each card.




**THE FACTS**

**HyperCard 2.0**
$49.95 upgrade for existing Macintosh owners; free for new Macintosh purchasers.

*Requirements:*
Apple Macintosh with System 6.0.5

Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
**Inquiry 1011.**

Apple's new version of **HyperCard, version 2.0**, changes all that. The new version supports multiple HyperCard windows on the screen simultaneously. The size of HyperCard windows can now range from 64 by 64 pixels up to 1280 by 1280 pixels. There are also some new external commands (XCMDs) that allow you to display color PICT and gray-scale images.

Version 2.0 also includes new tools for creating graphical designs and visual effects on cards. There is a custom palette builder for designing control panels and other navigational tools. The new version also allows more flexible combinations of text fonts and sizes.

Probably the biggest improvements have been made to the HyperCard development environment. Version 2.0 includes a new script editor that can operate in a separate window while HyperCard stacks are also on the screen (the old editor took over the whole screen). There is also a debugger that can trace variables and perform step-by-step execution.

For increased performance, HyperCard 2.0 includes a quasi compiler, which compiles script commands at run time. However, although Apple calls it a compiler, the new system does not allow compiled binary data to be saved to disk. In other words, HyperCard compiles the script the first time it is initiated during a HyperCard session. Nevertheless, the technique does provide improved performance.

While Apple is often criticized for high prices, HyperCard is one of the best bargains available.

*—Nick Baran*

## Plus Gets Hyper Across Platforms

Unless you're a Macintosh user, *hyper* is just another obtuse industry buzzword. Still, as Apple has proved with HyperCard, the concept of interrelated stacks of cards is an eminently useful way of organizing and retrieving information.

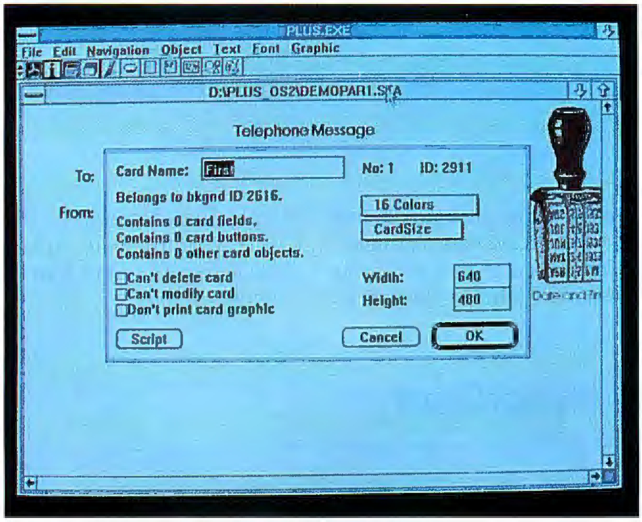
With **Plus**, Spinnaker Software has brought the power of HyperCard (and much more) to the IBM PC platform. Plus is available for the Mac and for the PC, with versions for both Windows 3.0 and OS/2. I tested a prerelease copy of the OS/2 version.

*continued*

At its heart, Plus is an applications development environment that uses an object-oriented paradigm to create stacks (applications) that can relate textual and graphics data on cards in just about any way you can imagine. The beauty of Plus is that it's one of the few applications currently available that offers true multiplatform compatibility. Because it uses an identical file format, an application that I created under OS/2 could be run on a Mac or under Windows 3.0.

Plus essentially has three levels of use, from very simple to extremely complex. At its simplest and most immediately utilitarian level, Plus can directly read a Mac HyperCard stack. Using BYTE's in-house network, I transferred a name and address stack from our resident Mac server and immediately had it available on my PC.

While the ability to use a Mac stack as is, is handy indeed, it's only a small part of Plus's utility. Because its programming abilities extend far beyond those in HyperCard 1.2.2, you can modify and expand an existing stack. I added color and addressable graphics objects to the basic stack and resized the cards in the stack to fit more cards on the larger PC screen.




**THE FACTS**

**Plus for OS/2**
$495.95

*Requirements:*
IBM AT, PS/2, or compatible running OS/2 1.1 or 1.2 Standard or Extended Edition with a hard disk drive with at least 2 MB of free space.

Spinnaker Software
One Kendall Sq.
Cambridge, MA 02139
(617) 494-1200
**Inquiry 1012.**

Creating an application from scratch in Plus obviously requires more effort. Since Plus's programming environment is graphics-oriented, I found that using it required a real (and slightly painful) shift in thinking away from the standard linear way of creating an application using a more conventional programming language.

I also had to continually think "objects." I created a simple time-planning stack by placing the objects on cards, which themselves are objects. Because it's highly interactive, Plus gave me plenty of help, with fill-in-the-blank menus popping up when I needed to define relationship scripts between objects.

Plus's third level is the most complex, and the most powerful. Included in Plus is PPL (Plus Programming Language). It's a complex English-like language that's essentially a highly extended version of HyperCard. And while basic non-PPL stack creation is powerful in itself, you really need to learn PPL to get full utility from Plus. For example, you need to write a PPL program to integrate graphics into a stack or to do something like exporting stack data into an external database.

Plus is a prime example of the power and the paradox of the new generation of applications development environments based on graphical user interfaces. While Plus is complex, has a long learning curve, and requires quite a commitment, it will create an unlimited variety of applications. Because of that, in-house developers who have the resources (and extensive programming experience) to commit to it will find Plus an invaluable tool for creating common cross-platform applications.

*— Stan Miastkowski*

# DaynaFile for NeXT Lets the Cube Use Floppy Disks

Steve Jobs proclaimed NeXT's 250-megabyte erasable optical disk cartridge the "floppy disk of the nineties," but it costs a bundle more than ordinary floppy disks. Not surprisingly, several vendors have come forth with 3½- and 5¼-inch floppy disk drives that plug into the SCSI port of the NeXT Computer. The first one I've had a chance to work with is the **DaynaFile** external floppy disk drive from Dayna Communications, a company that has specialized in devising DOS-compatible drives and file-exchange utilities for the Macintosh.

The DaynaFile system reads and writes DOS disks and also formats floppy disks using the NeXT file system, so that NeXT files can be stored on standard floppy disks. The only limitation with using NeXT formatted disks is that other NeXT machines must also have the DaynaFile drive in order to use the disks. You have to convert Mac disks to DOS format using Apple File Exchange and the Mac SuperDrive or the Dayna DOS Mounter utility that comes with DaynaFile for the Mac.

The DaynaFile system is available with a choice of 3½- or 5¼-inch floppy disk drives or in a dual-drive unit with both drive types. I tested the dual-drive setup. To install the drive, you plug in the SCSI cable, flip a switch, and install the software. Once installed, you have two new files, DaynaUnix and DaynaDOS, in your NeXT's LocalApps directory.

Once these files are installed, you have a completely transparent floppy disk system attached to the NeXT Computer. DaynaDOS and DaynaUnix provide a simple window and dialog box for copying files and formatting disks. The DOS system includes a text-translation utility that preserves the linefeeds and carriage returns in documents created in DOS. However, there are no file-conversion utilities for handling database, spreadsheet, or word processing formats.

You first have to convert these file types to ASCII text. You can directly transfer

*continued*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**2. Integrated C and Assembler:** You can write your code in any combination of C and assembly language.

**3. Readable Assembly Language Output:** The compiler generates assembly language code *with your C language source code embedded as comments*, so you can see each statement's compiled output.

**4. Optimized Code: CrossCode C** uses minimum required precision when evaluating expressions. It also "folds" constants at compilation time, converts multiplications to shifts when possible, and eliminates superfluous branches.

**5. Custom Optimization:** You can optimize compiler output for your application because *you* control the sizes of C types, including pointers, *floats*, and all integral types.

**6. Register Optimization:** Ten registers are reserved for your register variables, and there's an option to automatically declare all stack variables as *register*, so you can instantly optimize programs that were written without registers in mind.

**7. C Library Source:** An extensive C library containing over 70 C functions is provided in source form.

**8. No Limitations:** No matter how large your program is, **CrossCode C** will compile it. There are no limits on the number of symbols in your program, the size of your input file, or the size of a C function.

**9. 68030 Support:** If you're using the 68030, **CrossCode C** will use its extra instructions and addressing modes.

**10. Floating Point Support:** If you're using the 68881, the compiler performs floating point operations through the coprocessor, and floating point register variables are stored in 68881 registers.

**11. Position Independence:** Both position independent code and data can be generated if needed.

**12. ANSI Standards: CrossCode C** tracks the ANSI C standard, so *your* code will always be standard, too.

### There's More

**CrossCode C** comes with an assembler, a linker, and a tool to help you prepare your object code for transmission to PROM programmers and emulators. And there's another special tool that gives you symbolic debugging support by helping you to prepare symbol tables for virtually all types of emulators.

**CrossCode C** is available under MS-DOS for just $1995, and it runs on all IBM PCs and compatibles (640K memory and hard disk are required). Also available under UNIX, XENIX, and VMS.

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SOFTWARE DEVELOPMENT SYSTEMS, INC.
DEPARTMENT 23
4248 BELLE AIRE LANE
DOWNERS GROVE, ILLINOIS 60515 USA

**THE FACTS**

**DaynaFile**
$1105 for dual drives; $850 for a 3½-inch 1.44-MB drive; $750 for a 5¼-inch 1.2-MB drive

Dayna Communications
50 South Main St.
Salt Lake City, UT 84144
(801) 531-0600
**Inquiry 1013.**


TIFF and Encapsulated PostScript files, as well as WriteNow files. You can format DOS disks using the DaynaDOS utility as well as create new directories and work with hidden files. The DOS system worked flawlessly.

DaynaUnix lets you work with NeXT files stored on floppy disks. DaynaUnix "mounts" the floppy disk just like the NeXT system mounts optical disk drives. The floppy disk appears as another directory on the NeXT file system.

The only catch is that you have to remember to "unmount" the disk after using it, or else you'll get a system error. Otherwise, DaynaUnix works smoothly. Again, the only limitation is that other NeXT machines would also require the DaynaFile system to make this utility really useful.

One drawback is that the DaynaFile system is not cheap. NeXT vendors are faced with the problem of a small potential customer base until the NeXT Computer becomes more established in the market. Therefore, they charge higher prices than we're accustomed to paying for products in the Mac and DOS world.

*—Nick Baran*

# A Frame of Reference

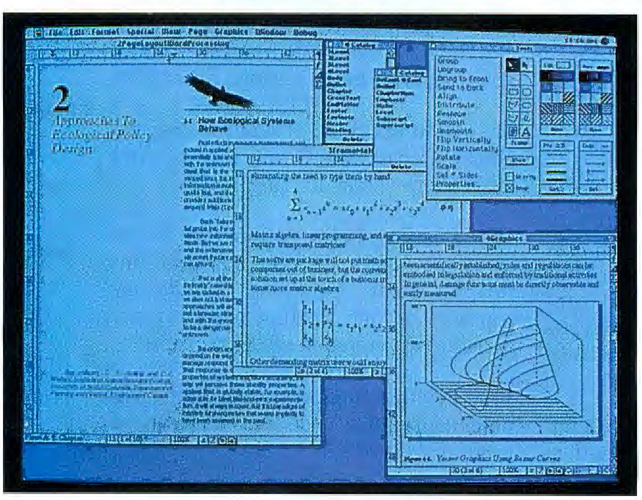
It seems that you can't turn around anymore without bumping into a new WYSIWYG this or DTP that. As much as these terms have been stretched of late, it's refreshing to see them applied to a product that lives up to its acronyms.

Technical publishing is the intended forte of Frame Technology's **FrameMaker 2.0/Mac**, and it is uniquely equipped for the task. This software, once available exclusively on Unix workstations, has migrated to the Macintosh.

FrameMaker is named for its central design element, the frame. These are rubber-banded into position on a blank page and are subsequently filled with headlines, body text, bit-mapped graphics, or drawings. It's possible, however, that you may never stretch your own frame; FrameMaker includes a host of predefined styles, covering everything from simple memos to books.

The FrameMaker 2.0 screen is a study in excellent user interface design. FrameMaker uses pull-downs, but it places most of the repetitive operations a simple mouse-click away. Icons for zooming, next/previous page, font and paragraph style, and other common functions surround the document window. Several of these, like the style icons, pop up dialog boxes or selection lists that can remain on-screen for subsequent use.

Technical documents are unique in their complexity. A single work may include headlines, numbered sections, outlines, text boxes, drawings, tables, bit-mapped images, and equations in addition to the body text. FrameMaker not only handles these (and considerably more), but does them with style. Clicking an icon brings up a selection list of paragraph styles. Each one has a name, or tag, associated with it. Clicking, say, "subsection" will automatically increment the subsection number, display it in a user-definable format, and let you type that subsection's title. Each style sheet has its own set of paragraph tags, and adding new ones is child's play.



ASCII text can be imported, along with Microsoft Word and MacWrite documents, but you can dump your word processor once FrameMaker hits the scene. Not only does it provide advanced hyphenation, spelling checking, and kerning, but it justifies, paginates, and flows text around graphics objects as you type.

FrameMaker 2.0's availability on the Apple Macintosh could convince non-believers that the Mac actually is capable of being a serious workstation after all. FrameMaker is publishing for people who make their living at it. ■

*—Tom Yager*

**THE FACTS**

**FrameMaker 2.0/Mac**
$995

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1010 Rincon Cir.
San Jose, CA 95131
(408) 433-3311
**Inquiry 1014.**

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***For Europe Circle 221 on Reader Service Card***

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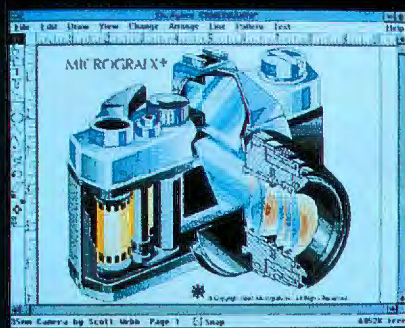
# WINDOWS SHOPPING:

Now that we've had a chance to work with the first crop of Windows 3.0–compatible applications, we are convinced that Windows has finally come of age. Programs look, feel, and perform better than ever before. Don't underestimate the importance of Windows' stylish new appearance. Nowadays, operating systems have to dress for success. The graphical-user-interface fashion industry has become a big business; even Unix is making itself over for the 1990s. People respond powerfully to Windows 3.0's carefully designed look, and that will fuel the demand for 3.0-compatible software.

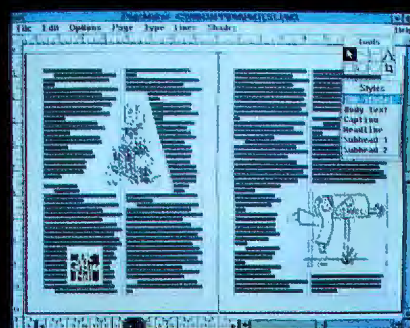
The changes are not just skin-deep, though. Newly incarnated as a protected-mode operating system, Windows compares favorably with OS/2 in certain respects—notably, memory management.

Considered singly, not all applications get a huge performance boost from 3.0's new memory manager. Many Windows programs got by fairly well under Windows 2.11 with the help of expanded memory. For example, the BYTE PageMaker benchmark runs only slightly faster under 3.0 (using 2 megabytes of extended memory) than under 2.11 (using 2 MB of expanded memory). But what happens when you run, say, Micrografx's Designer at the same time?

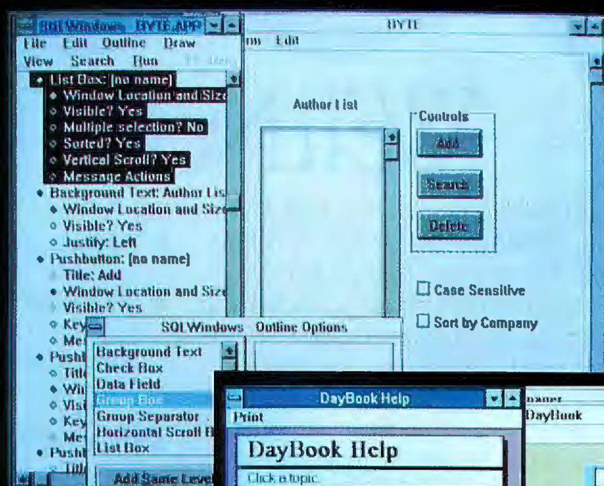
Under Windows 2.11, some programs, like PageMaker, relied on Windows' use of expanded memory (to swap code segments); others, like Designer, used the memory themselves to store data. Unfortunately, the two strategies conflicted. To give Designer access to expanded memory, you had to disable Windows' use



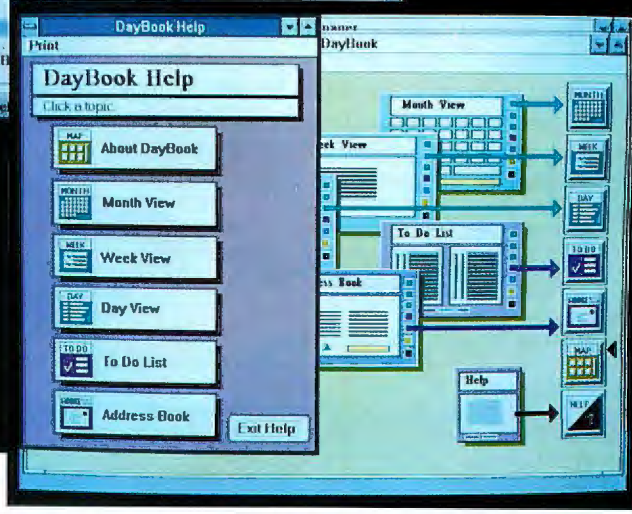
Designer 3.0



PageMaker 3.01

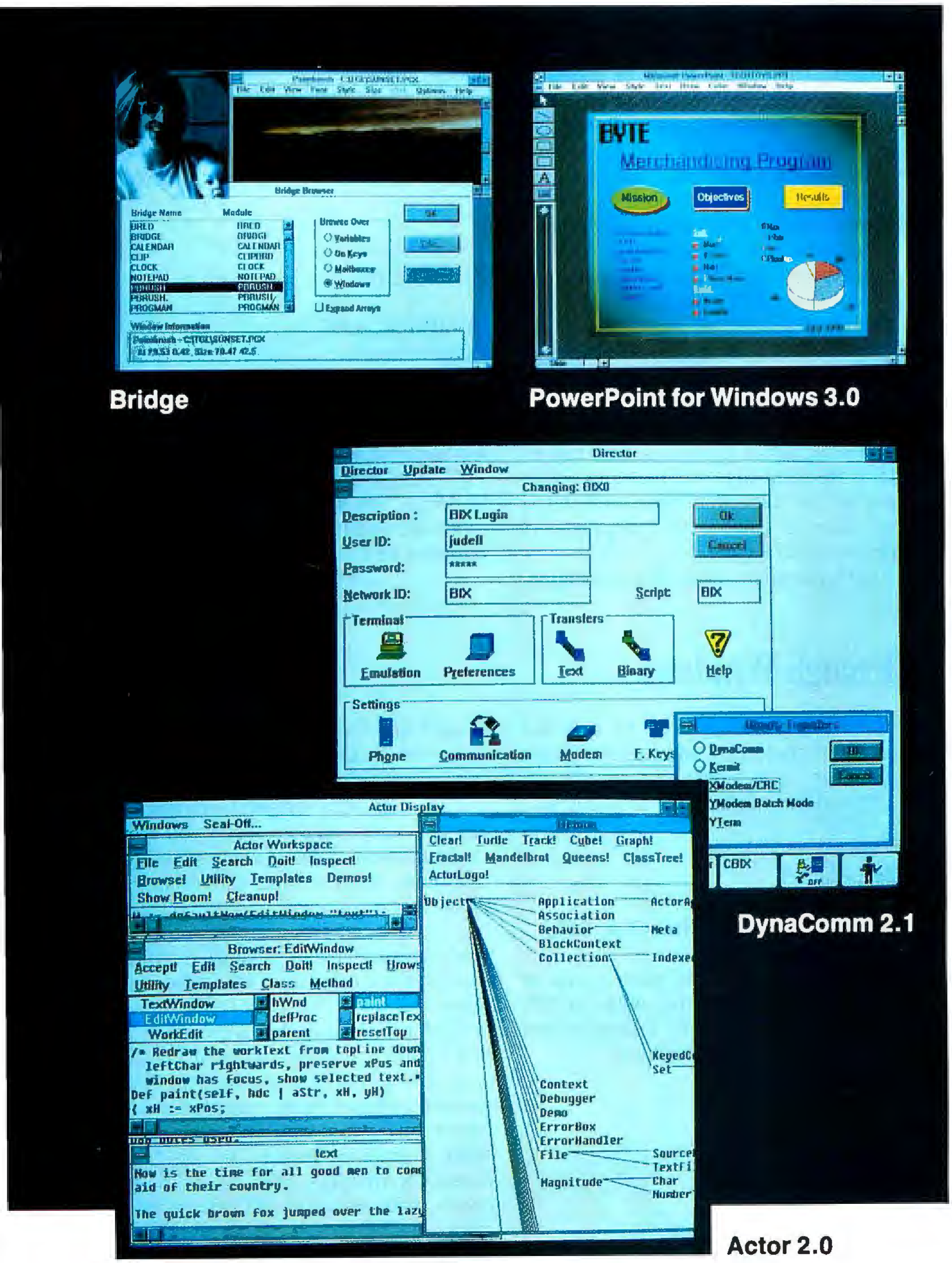


SQLWindows



ToolBook

# 3.0 Applications Take Shape




**Bridge**

**PowerPoint for Windows 3.0**

**DynaComm 2.1**

**Actor 2.0**

of it—and that crippled PageMaker's performance.

Windows 3.0 unifies memory management; developers and users can now awaken from the long nightmare that was EMS. No more compromises and configuration trade-offs—if your machine has extended memory, Windows (and its applications) will just use it. As a result, 3.0 makes multitasking serious applications practical. The effect on productivity can be dramatic.

The programs that we review this month demonstrate the breadth of uses to which Windows can be put: desktop publishing, object-oriented programming, hypermedia, telecommunications, presentation graphics, and networked database management. Of the applications we considered, some are entirely new, some have been ported to Windows, and most are 3.0-compatible versions of existing programs.

Conversion to protected mode does not appear to be a major obstacle; as a result, 3.0 seems likely to inherit the existing body of Windows software in short order. Perhaps more important, a rich collection of software development tools—tailored to different levels of interest and expertise—supports Windows 3.0. That has been one of the keys to the long-standing popularity of DOS, and it certainly bodes well for mass acceptance of Windows.

This month and next, we'll explore the strengths (and weaknesses) of Windows 3.0 in a series of short product reviews. We can't cover all the applications, and that is a telling sign. Windows has achieved critical mass; it's here to stay.

*—Jon Udell*

*continued*

# ToolBook: An Application Construction Set for Windows

If, as many people suggest, Windows makes the IBM AT look like the Apple Macintosh, then where is the Windows version of the Mac's popular HyperCard software? A number of companies have recognized the opportunity and have labored to bring a hypertext-style program to the Windows 3.0 environment. Asymetrix is one company with a Windows 3.0 version of a HyperCard-like product. I looked at an early version of its **ToolBook** and found it similar to HyperCard, but different—and, in some ways, better.

ToolBook functions more or less as a software construction set for fairly sophisticated graphics applications—what Asymetrix calls *books*. Most users will probably use ToolBook to create prototype applications or to generate training materials. ToolBook makes it easy to create a multipage electronic training book, where readers can quickly skip around from page to page by clicking on a button or "hot word."

One of the product's best features is its animation capability, which, although somewhat crude, allows you to generate training books that could never be presented on paper through traditional printing. For example, the animation could show trainees exactly how a tricky toner cartridge lifts out of a laser printer. ToolBook also has some database support, including the ability to create a simple flat-file database and to access dBASE files.

Building applications with ToolBook takes some getting used to, but it does let you create a fairly sophisticated book without ever writing a line of code. Yet you can write code when you need to, by accessing ToolBook's own OpenScript programming language, which has many object-oriented features. For example, you can have an information box suddenly appear every time the cursor goes over a certain object on the screen. You can also access other Windows applications through the DDE (dynamic data exchange) channels, or make use of the Windows DLLs (dynamic link libraries).

ToolBook has a bevy of interesting features and capabilities. But this large number of features may have an impact on performance. Certain books may require frequent disk accesses and consequently be somewhat slow. Asymetrix recommends a 386 with 2 megabytes of memory, and I agree.

Still, like many other Windows applications, ToolBook can be addictive. After using it awhile, several possible unusual applications occurred to me. One would be a police artist application, where witnesses to crimes could create a sketch of a criminal by simply pushing buttons to select various noses, eyes, lips, and so on.

As I mentioned before, comparisons with HyperCard come to mind. But HyperCard is free with the purchase of a Mac; ToolBook costs $395. Fortunately, Asymetrix says it will not charge a royalty for a run-time version of the package, so you can distribute your books for free to anyone who has Windows 3.0. If you need to create some eye-catching hypermedia and simple database applications, ToolBook seems to be worth the price.

*—Rich Malloy*

### THE FACTS

**ToolBook, $395**
Requirements:
IBM AT or compatible with at least 1 MB of memory and Windows 3.0.

Asymetrix Corp.
110 110th Ave. NE, Suite 717
Bellevue, WA 98004
(206) 462-0501
**Inquiry 857.**

# Making Points Powerfully Through Windows

PowerPoint for the Mac helped define the product category known as desktop presentation software. Products of this type let you develop slide shows, often by pulling together text, data, or charts from other applications, and then output them to the screen, to a printer or plotter, or to a slide service.

The new **PowerPoint for Windows 3.0** may set another standard. It offers an expanded set of features over its Mac ancestor, proving that a PC equipped with Windows 3.0 and the right add-ins can stand up to the Macintosh in the color presentation arena. Because of its intuitive graphical user interface and its WYSIWYG fonts and colors, PowerPoint could challenge character-based Lotus Freelance Plus and Software Publishing's Harvard Graphics. In addition, the supplied Bitstream fonts, clip art, and templates could give Micrografx Graph Plus a run for its money.

PowerPoint treats a set of slides as a single file. First you design the "master" slide, which sits behind all the others and can include a frame, a background color, a logo, and other original or imported text and image objects. Then you create the individual slides (in any order—you can move them around and even copy them from one show to another) by layering on text, charts, and graphics. If you're unsure how to get started, Microsoft supplies more than 40 sample templates.

Each presentation has a color scheme that includes background, text, and accent colors. After you select the background, PowerPoint suggests other colors that work well in combination. With a graphics board like the Video Seven VRAM VGA, you can get 256 real colors; with standard VGA there are 16 colors, and dithering creates the illusion

### THE FACTS

**PowerPoint for Windows 3.0, $495**
Requirements:
IBM AT or compatible with 2 MB of RAM; a hard disk drive with 16 MB available; Windows 3.0; a mouse; and EGA, VGA, or better graphics.

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
**Inquiry 858.**

*continued*

of more. The advantage of color schemes is that if you change them, all objects keyed to the scheme will be updated. By contrast, you have to change spot colors manually.

The PowerPoint icon bar is remarkably simple. There are tools to draw shapes (ovals, rectangles, and lines, but no polygons), a labeling tool, and a word processing tool. The word processor includes a spelling checker, and it can import outlines from Microsoft Word for Windows.

One feature new to the Windows version of PowerPoint is the Chart tool. This miniature version of Excel allows you to create a spreadsheet (original, or imported from Excel or Lotus 1-2-3) and a hot-linked chart with all the graph types available in Excel. The finished chart is then copied directly into a PowerPoint slide. This is one example of PowerPoint's excellent use of DDE (dynamic data exchange). The program can also link to other Windows applications through the clipboard.

Microsoft ships 400 vectored clip-art images with PowerPoint. For output, you can print to a black-and-white or color plotter or printer, including PostScript devices, or you can ship files to Genigraphics for 35mm slides. Besides the slides themselves, PowerPoint also produces notes for the presenter and handouts for the audience that include miniature representations of the slides.

Creating a slide show with PowerPoint is easy, fast, and fun. I found the program to be slow on a 286 system, so for best results I would recommend a 386 machine with a fair amount of memory. PowerPoint is strong in charting, word processing, file exchange, color support, and presentation, but it's a little weak in drawing tools and effects. Most likely, in an attempt to avoid the kitchen sink phenomenon, Microsoft is counting on an exchange of images between Windows applications to fill in where PowerPoint lacks power.

*—Andy Reinhardt*

# Building Stand-Alone SLQBase Applications

**SQLWindows** works hand-in-hand with Gupta Technologies' SQLBase, which is the first Structured Query Language server for the PC and still one of the leading contenders in its field. SQLBase runs on a dedicated DOS or OS/2 server and communicates over NetBIOS with DOS clients. You can develop character-mode client applications with Gupta's C application programming interface, or much more sophisticated graphical applications using SQLWindows. This slick 4GL (fourth-generation language) runs under Windows 3.0 and provides all the tools you need to build stand-alone Windows 3.0 applications that access SQLBase.

Two views share the screen when you are developing an application with SQLWindows. In the form window you draw, resize, and align user interface elements: menus, list boxes, data fields, scroll bars, and—particularly handy in the SQL environment—table windows. In the outline window, which automatically receives a structured-text representation of what you design in the form window, you build a protocol that mediates between users and the SQL engine.

It took me a couple of hours to do a simple program from scratch. I began with WINTALK, the Windows version of Gupta's interactive SQL command interpreter. Running WINTALK on the client, I imported a .DBF file into a server-resident SQL table. (Incidentally, the lengthy demonstration script that comes with WINTALK provides an excellent introduction to SQL.) Then I fired up SQLWindows, added a list box to the form window, and linked it to a column of my database. To forge that link I trapped and handled two messages. The first, sent to the program at start-up, triggered a connection to the server. The second, sent to the list box in response to a menu pick, activated a function (which I wrote in the SQLWindows application language) that issued a SQL query and then looped through the result set adding values to the list box.

**THE FACTS**

**SQLWindows, $1295**
**SQLBase for DOS, $1995**
**SQLBase for OS/2, $2495**
Requirements:
*Client:* IBM AT or compatible with 1 MB of RAM and a hard disk drive
*DOS server:* 1 MB of RAM
*OS/2 server:* 4 MB of RAM

Gupta Technologies
1020 Marsh Rd., Suite 210
Menlo Park, CA 94025
(415) 322-4100
**Inquiry 859.**

SQLWindows neatly encapsulates Windows' message-oriented architecture, which greatly simplifies the task of building an interface. Still, negotiating a clean exchange between Windows display objects and SQL result sets takes a lot of work, particularly for multiuser applications. Gupta documents how to maximize both concurrency and consistency; basically, you monitor a hidden row ID and lock a row only when its ID becomes invalid. That's easier said than done; Gupta plans to endow table windows with more intelligence in a release due out later this year.

Under DOS, a SQLBase application requires considerable RAM-resident support. On top of NetBIOS you have to run Gupta's router, which eats up an additional 165K bytes of RAM. (An alternate, high-loading router uses only 56K bytes.) Under Windows, the router runs as a DLL (dynamic link library).

With Windows 2.x, that configuration didn't leave very much room for your SQLWindows application, let alone other concurrent Windows tasks. But the Windows 3.0 version of SQLWindows really shines. Now, neither DOS nor Windows suffers. DOS only needs to provide basic network services. (For NetWare users, a forthcoming native IPX router will eliminate the need to load Novell's add-on NetBIOS.) Given some extended memory to work with, Windows provides SQL services effortlessly.

Gupta plans to offer SQLBase on the Sun SPARCStation later this year, and to adapt SQLWindows for use with other servers: OS/2 Extended Edition Data Manager, SQL Server, and Oracle. There's work to be done, but SQLWindows should go a long way toward making the Windows 3.0 client workstation a reality.

*—Jon Udell*

*continued*

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# PageMaker Revs Up under Windows 3.0

PageMaker is a healthy-size package; the executable file alone is over three quarters of a megabyte. Add your document file and a number of graphics files, and you're asking your PC to manipulate megabytes of data for every document. But PageMaker has always run in 640K bytes of conventional memory under Windows. True, it used more than that, but only by swapping code segments to and from expanded memory and the hard disk drive.

Windows 3.0 has done great things for **PageMaker 3.01**. Aldus's newest release takes good advantage of the Windows look and feel, as well as using the improved memory and task management to greatly improve performance. PageMaker still runs as one single task; it's just that the task is no longer hampered by the environment.

I ran PageMaker 3.01 under both Windows 3.0 and Windows/286 version 2.11 on a 33-MHz 386 with 4 MB of memory. Under Windows 3.0, flowing a 90K-byte document into 35 pages took about 35 seconds. The standard Windows/286 installation provides no expanded memory, using only extended memory as a SmartDrive cache. PageMaker and Windows were trying to juggle about 10 MB of data, and only pulled it off with constant disk swapping. Windows/286 took over 1½ minutes for the same job.

The next thing I tried was using Quarterdeck's QEMM to simulate 2 MB of expanded memory and letting Windows/286 use that for segment swapping. That cut the time down to within 2 seconds of the Windows 3.0 test. The moral of the story: With enough memory tricks, you can really open up Windows/286. With Windows 3.0, you don't need any tricks.

Don't forget about the OS/2 version of PageMaker. Under OS/2, PageMaker gets some added goodies. OS/2's multiple application threads give you more control over PageMaker's operation. Under any version of Windows, some operations, such as autoflow, cannot be interrupted except at specific times. But OS/2 PageMaker puts these operations into a separate execution thread and allows the user input thread to run concurrently. The result is a snappier feel and better ability to manage long operations.

Windows/286 made using long documents with PageMaker 3.0 a chore; with the 3.01 update, PageMaker under Windows 3.0 is a joy. Before PageMaker 3.01, getting that kind of performance boost would require switching over to OS/2—a pretty big step. PageMaker 3.01 and Windows 3.0 give you that boost and more, without sacrificing compatibility with your DOS and other Windows applications. And just wait—PageMaker 4.0 promises to be even better.

*—Howard Eglowstein*

### THE FACTS

**PageMaker 3.01, $795**
Requirements:
IBM PC with 2 MB of RAM.

Aldus Corp.
411 First Ave. S, Suite 200
Seattle, WA 98104
(206) 622-5500
**Inquiry 860.**

# Actor Sets a New Stage for OOP

**Actor** does for Windows what Digitalk's Smalltalk/V does for the Mac and for Presentation Manager: It brings the graphical-user-interface revolution full-circle. Object-oriented programming concepts underlie today's GUIs, but OOP tools haven't dominated the field of GUI programming. That irony may not persist much longer. Actor's interpreted methods execute briskly under Windows 3.0; access to extended memory will allow more ambitious Actor applications.

If you've used Smalltalk, you'll feel right at home in Actor's Browser, Inspector, and Debugger. I miss some of the conveniences of Smalltalk/V PM: Actor's class-hierarchy list doesn't expand and collapse, and methods and instance variables aren't as easy to cross-reference. But I prefer Actor's C-like syntax and its smooth integration with underlying application programming interfaces. Actor methods can call DOS, the Windows kernel, or Windows DLLs (dynamic link libraries) with practically no fuss at all.

Unlike Smalltalk/V, Actor couples closely with its native GUI. That cuts two ways: You lose portability, but you gain the chance to learn a lot about the innards of Windows. I've never got very far with the Windows Software Development Kit/Microsoft C combination, but with Actor, formerly daunting topics like logical fonts and text metrics are far more accessible. Of course, as with Smalltalk, you have to learn a lot about Actor's classes and methods to get anything done. OOP technology makes a powerful lever; the trick is in finding the fulcrum.

Actor doesn't gain as much from Windows 3.0 as you might think. The Windows/286 version of Actor 2.0, released earlier this year, added the ability to swap Actor's static memory (code) and dynamic memory (data) to disk. Although Windows 3.0's enhanced mode provides virtual memory, Actor continues to roll its own. There's really no choice: Virtual memory is only an option in Windows 3.0, not a standard feature as in Unix and OS/2. Of course, Actor now has more global heap to play with. And Windows 3.0's ability to run more Windows and DOS programs in a given amount of RAM makes Actor applications (like all 3.0-compatible Windows programs) more attractive.

Actor has always played to several audiences. Some developers use it to create prototype applications that ultimately get built using a compiled language; because it's much more powerful than simple menu-and-screen interface builders, you

*continued*

### THE FACTS

**Actor 2.0, $695**
Requirements:
IBM AT or compatible with a hard disk drive, 1 MB of RAM, and Windows 3.0.

The Whitewater Group
Technology Innovation Center
906 University Place
Evanston, IL 60201
(312) 491-2370
**Inquiry 861.**

can create highly functional prototypes. Others use it as an OOP laboratory for growing class libraries that they later transplant to C++. Still others deliver finished applications in Actor—typically of the client/server variety, in vertical markets. The large memory and protection that Windows 3.0 gives Actor applications will likely shift the balance in favor of Actor itself as a delivery system.

What does Actor still lack? Encapsulation of the communications and database services that mainstream Windows 3.0 client applications will require. As network and Structured Query Language (or object-oriented) database technologies mature, The Whitewater Group should evolve its class library to accommodate them. A well-connected Windows 3.0 workstation will not need a powerful file system or a sophisticated database: Unix, OS/2, or hosts can provide these amenities. But the Windows workstation will need graphical interfaces to such hosts, and Actor figures to be a key provider of these. *—Jon Udell*

## Windows 3.0 Paints a Rosier Picture for Designer

Products like **Designer 3.0**, the latest version of Micrografx's leading drawing program, prove that PCs will play an increasingly important role in professional graphics. Windows 3.0 isn't a cure-all for Designer, but it's a powerful tonic. Under Windows 2.11 you had to reserve expanded memory for Designer's exclusive use in order to manipulate complex images, and even then there were problems. For example, although Designer's import function could move graphics from a disk file straight into expanded memory, interapplication cut-and-paste operations were bound by the conventional memory available to the Windows clipboard. Windows 3.0's direct use of extended memory makes the promise of Macintosh-style interoperability finally real for applications like Designer.

Still, life isn't perfect. Although Designer 3.0 runs more briskly on my 20-MHz 286 machine under Windows 3.0 than under Windows 2.0, there's no getting around the fact that it takes quite a long time to render layered, vector-rich images to the screen. A math coprocessor would liven things up; so would a graphics coprocessor. Over the next year or so, two trends—the falling price of 34010-based display boards, and rising demand for serious PC-based imaging software—will inevitably intersect.

For hardware vendors, Windows 3.0 drivers are a high priority. At the moment, it's unclear how Windows' raster-oriented Graphics Device Interface can best utilize vector-oriented coprocessors. Designer 3.0's new outline fonts underscore the need for vector support: Screen redraws crawl when you add lots of outline text to a drawing. The need will grow much more pressing when Microsoft incorporates TrueType into Windows. Windows' fate as a production

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graphics platform—and by extension, the fate of applications like Designer—will depend on the effective utilization of advanced display hardware.

Designer 3.0 comes with two new accessories. Electronic SlideShow does on-screen presentations; it features PCX and TIFF color bit-map support, transition effects, and prerendering. The program's TeleGrafx Imaging Center Driver transmits via modem and phone lines to either of two service bureaus (more are to be added later) for conversion into 35mm slides, 4-inch by 5-inch transparencies, overhead foils, and full-color presentation prints.

Another bonus is a free clip-art library with more than 1700 professional-quality images. Other new features include the ability to trace color PCX and TIFF images and convert them to editable color vector images; clip-art preview (so you can see what a piece of clip art looks like before importing it); a Bézier curve drawing tool that allows setting and editing Bézier control points while drawing; enhanced color-separation controls; improved PostScript and Matrix (SCODL) film recorder drivers; and the ability to import the embedded TIFF portion of an Encapsulated PostScript file.

Micrografx advertises Designer as the "cure for Mac envy." Windows 3.0 adds considerable credence to that claim.

*—George Bond*

### THE FACTS

**Designer 3.0, $695**
Requirements:
IBM AT or compatible with 1 MB of RAM, a hard disk drive, an EGA or VGA graphics card, a graphics monitor, and a mouse or compatible pointing device.

Micrografx, Inc.
1303 Arapaho
Richardson, TX 75081
(800) 272-3729
**Inquiry 862.**

## Bridge over Troubled Waters

You've heard the refrain: "The graphical interface makes everything easy; all you do is point and click." And point, and click, and drag, and point, and click . . . after a while, ease-of-use starts to feel like tyranny. Enter **Bridge**, a graphical command language for Windows. Bridge batch files can launch Windows (or DOS) applications; select, resize, and move windows; control menus and dialog boxes; feed keystrokes to running programs; conduct DDE (dynamic data exchange) conversations with DDE-aware Windows applications; and manage message-oriented interprocess communication (IPC).

Here is a trivial but handy use of Bridge. When my PC boots and loads Windows, a Bridge batch file activates

*continued*

the clock (which my WIN.INI loads as an icon), resizes it, and moves it to the lower right-hand corner of my screen. Silly as it sounds, there's no straightforward way to do this on a Mac or in any of the Unix graphical user interfaces. Windows 3.0's own Macro Recorder, which can remember and play back sequences of mouse and keyboard events, isn't a real solution, either. What you really need is programmatic access to a GUI's message stream—the modern equivalent of standard input. Then you can begin to treat GUI-based applications as Unix-style software building blocks that fit together in complementary ways.

Advanced Bridge applications can combine off-the-shelf DOS and Windows software to create customized, job-specific workstations. For example, a financial system might feed numbers from a proprietary DOS-based analytical program directly into Excel. Two Bridge components facilitate such interactions: A TSR DOS supervisor monitors DOS sessions, enabling Bridge to send and react to keystrokes and capture screen data, and the Bridge message controller supports more-complex interactions.

Under Bridge control, DOS and Windows programs can converse locally or over a NetBIOS-compatible LAN, using mailboxes to coordinate activities. Of course, shrink-wrapped programs are basically black boxes. Bridge can supply them with inputs and take action based on their outputs, but they remain passive components. But an optional toolkit lets developers create Bridge-aware DOS and Windows programs that actively exploit Bridge's message-oriented IPC.

Softbridge has packed the Bridge batch language chock-full of the goodies that DOS's sorely lacks: arrays, parameterized subroutines, local variables, file I/O, modern control structures, and a rich set of supporting functions. You can parse a filename, query and set file attributes, read or write an array, insert an element into an array, look up an element in an array, and search, concatenate, or alter strings. With the Bridge browser you can monitor windows, variables, mailboxes, and hot keys.

As users exploit Windows 3.0 to run more concurrent applications, Bridge should come into its own. Ultimately, of course, applications ought to integrate tightly with operating-system-level IPC mechanisms; Unix and OS/2 will likely serve that goal better than the DOS/Windows hybrid. But for now, if you want programmatic control of character-based and graphical applications under Windows 3.0, you'll find Bridge as handy as a Swiss Army knife. *—Jon Udell*

### THE FACTS

**Bridge**
**developer's toolkit, $695**
**run-time version, $125**
Requirements:
IBM AT or compatible with a hard disk drive, 640K bytes of RAM, and Windows 3.0.

Softbridge Microsystems
125 Cambridge Park Dr.
Cambridge, MA 02140
(617) 576-2257
**Inquiry 863.**

## Telecommunications Under Windows 3.0

**DynaComm 2.1** is a telecommunications program that runs with Windows 3.0. It contains an extensive script language that provides a platform for building complex applications as well as simple log-in scripts. Its binary file transfer support is good, although ZMODEM is conspicuous by its absence. And it runs nicely in the background.

Windows 3.0 memory management works well with this program. When DynaComm 2.1 is loaded into a 286 machine with 640K bytes of main memory, 384K bytes of extended memory, and 1 megabyte of EMS 4.0, Windows 3.0 still has 532K bytes left for programs. DynaComm 2.0, on the same machine and using Windows/286, leaves only 271K bytes of memory for programs and 240K bytes of EMS. Windows 3.0 alone leaves 650K bytes of main memory for programs. With only Windows/286 loaded, 342K bytes of main memory and 320K bytes of EMS are left.

The ability to do file transfers in the background is a great asset. It lets you receive and send E-mail and conferencing system messages, or transfer program code or graphics, while doing other work; your computer is not out of general service during the transfer. DynaComm 2.1, running in the background, received a 20K-byte ASCII file in just over 5 minutes at 2400 bps over a packet-switching network. The same file transfer required almost 6½ minutes using Windows/286. Thus, a 200K-byte transfer would take about 15 minutes less with Windows 3.0.

The script language has the usual high-end telecommunications-program script language capabilities—conditional execution, parameter passing, local variables, subroutine execution, and so on. Its more advanced features include support for DDE (dynamic data exchange), dynamic reconfiguration of the graphical user interface, and event handling using WAIT and WHEN commands. These should make it easy to develop specialized interfaces for even very sophisticated and complex applications.

First-time programmers may find the language daunting; the price of its power is complexity. But users with general programming experience, even in other script languages or databases, should have few problems finding their way around this language. And over two dozen sample scripts are included.

The program can emulate eight terminals: ADD VP/60; CompuServe Vidtext; DEC VT52, VT100, and VT220; HP 700/94; IBM 3101; and TeleVideo 925/950. It supports NetBIOS, including AT&T ISN and UB NIU extensions, ComBIOS via interrupt 14H, and UB-NetCI. It can also be used on LANs. ■

*—George Bond*

### THE FACTS

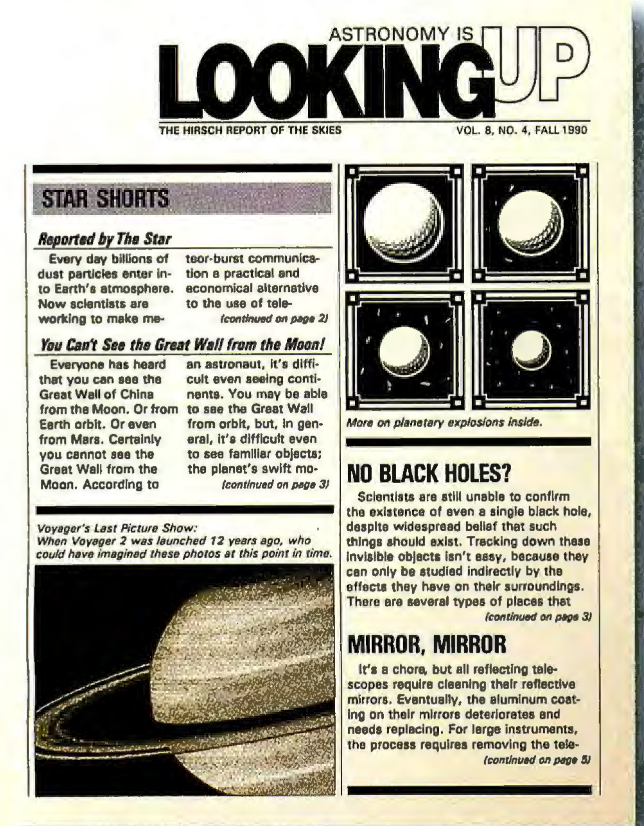
**DynaComm 2.1, $295**
Requirements:
IBM AT or compatible with a hard disk drive (400K bytes of free disk space is needed to install the application, 1 MB to install the entire DynaComm environment), 512K bytes of RAM (640K bytes recommended), and Windows 3.0.

Future Soft Engineering, Inc.
1001 South Dairy Ashford, Suite 203
Houston, TX 77077
(713) 496-9400
**Inquiry 864.**

# Other laser printers play with one standard dot size.

*Circle 113 on Reader Service Card*

# HP makes it a



ASTRONOMY IS LOOKING UP

THE HIRSCH REPORT OF THE SKIES — VOL. 8, NO. 4, FALL 1990

**STAR SHORTS**

***Reported by The Star***

Every day billions of dust particles enter into Earth's atmosphere. Now scientists are working to make meteor-burst communication a practical and economical alternative to the use of tele-

*(continued on page 2)*

***You Can't See the Great Wall from the Moon!***

Everyone has heard that you can see the Great Wall of China from the Moon. Or from Earth orbit. Or even from Mars. Certainly you cannot see the Great Wall from the Moon. According to an astronaut, it's difficult even seeing continents. You may be able to see the Great Wall from orbit, but, in general, it's difficult even to see familiar objects; the planet's swift mo-

*(continued on page 3)*

*Voyager's Last Picture Show:*
*When Voyager 2 was launched 12 years ago, who could have imagined these photos at this point in time.*

*More on planetary explosions inside.*

**NO BLACK HOLES?**

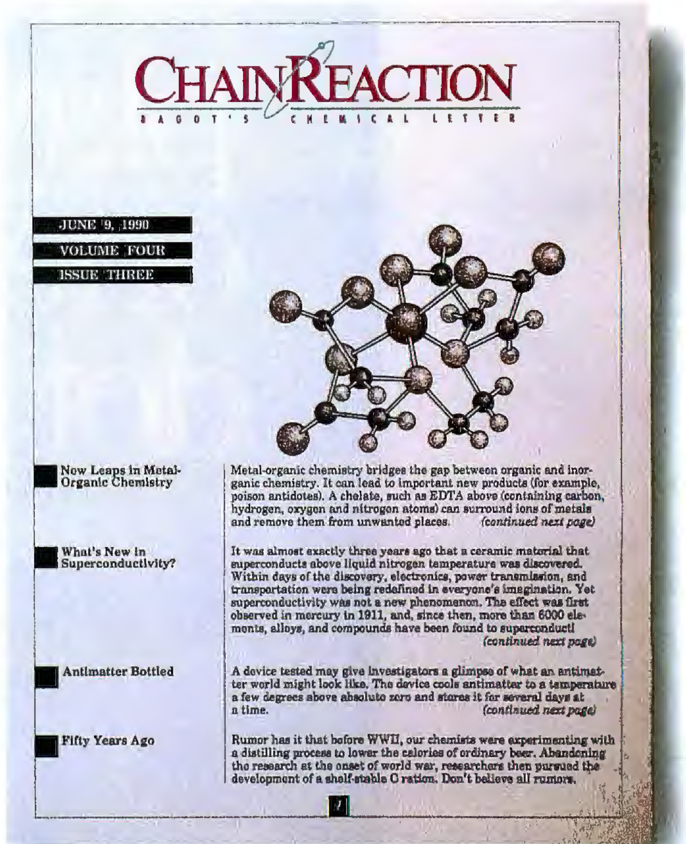
Scientists are still unable to confirm the existence of even a single black hole, despite widespread belief that such things should exist. Tracking down these invisible objects isn't easy, because they can only be studied indirectly by the effects they have on their surroundings. There are several types of places that

*(continued on page 3)*

**MIRROR, MIRROR**

It's a chore, but all reflecting telescopes require cleaning their reflective mirrors. Eventually, the aluminum coating on their mirrors deteriorates and needs replacing. For large instruments, the process requires removing the tele-

*(continued on page 5)*



CHAINREACTION

BAGOT'S CHEMICAL LETTER

JUNE 9, 1990
VOLUME FOUR
ISSUE THREE

**Now Leaps in Metal-Organic Chemistry**

Metal-organic chemistry bridges the gap between organic and inorganic chemistry. It can lead to important new products (for example, poison antidotes). A chelate, such as EDTA above (containing carbon, hydrogen, oxygen and nitrogen atoms) can surround ions of metals and remove them from unwanted places. *(continued next page)*

**What's New in Superconductivity?**

It was almost exactly three years ago that a ceramic material that superconducts above liquid nitrogen temperature was discovered. Within days of the discovery, electronics, power transmission, and transportation were being redefined in everyone's imagination. Yet superconductivity was not a new phenomenon. The effect was first observed in mercury in 1911, and, since then, more than 6000 elements, alloys, and compounds have been found to superconduct!

*(continued next page)*

**Antimatter Bottled**

A device tested may give investigators a glimpse of what an antimatter world might look like. The device cools antimatter to a temperature a few degrees above absolute zero and stores it for several days at a time. *(continued next page)*

**Fifty Years Ago**

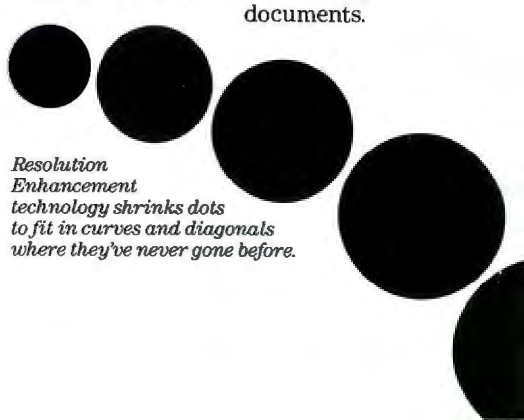
Rumor has it that before WWII, our chemists were experimenting with a distilling process to lower the calories of ordinary beer. Abandoning the research at the onset of world war, researchers then pursued the development of a shelf-stable C ration. Don't believe all rumors.

1

## Introducing the new HP LaserJet III printer with Resolution Enhancement technology.

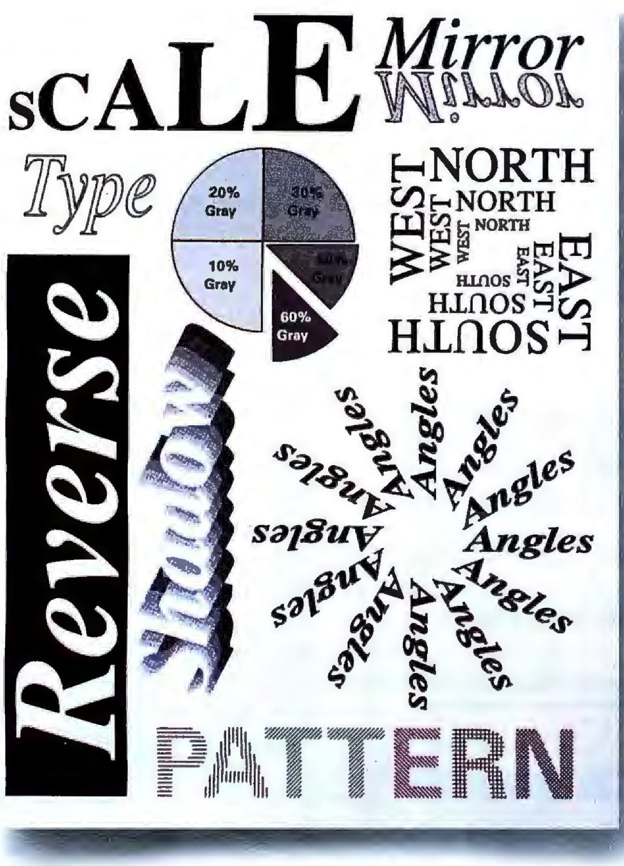
The rules have changed. Now the name of the game is Resolution Enhancement technology. You'll call it the best thing to happen to laser printing since the very first HP LaserJet printer. It gives you clearer resolution. Curves that really curve. And edges that are never jagged.

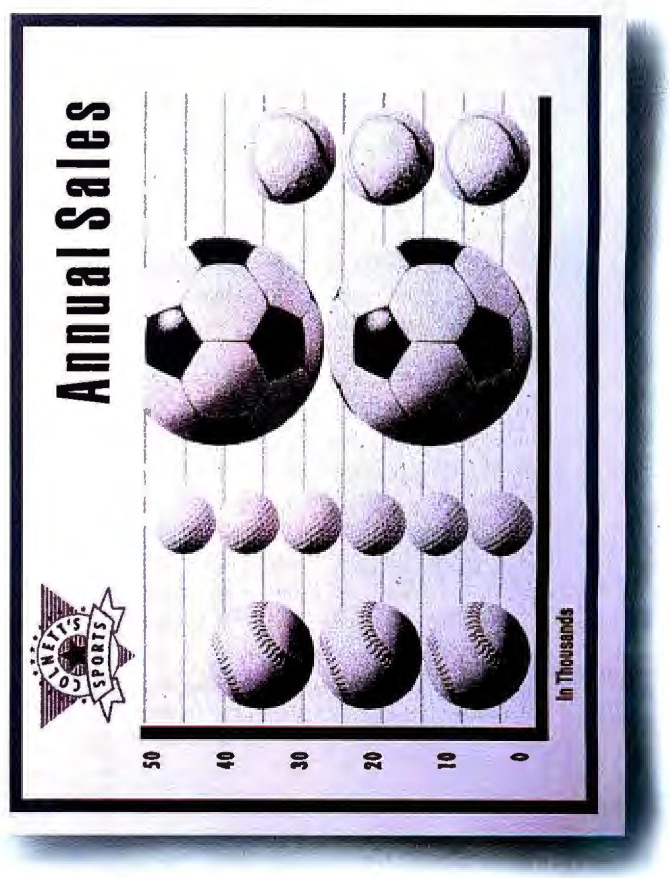
Instead of a "one-size-fits-all" dot, HP's built-in intelligence varies dot sizes. So they can fill areas where they could never go before. For clearer, more professional-looking documents.



*Resolution Enhancement technology shrinks dots to fit in curves and diagonals where they've never gone before.*

# whole new ball game.




But there's more than better print quality. 14 bit-mapped fonts and 8 internal scalable typefaces provide thousands of options. And enhancements to our PCL5 printer language, including our HP-GL/2 graphics language, let you print portrait and landscape on the same page. Reverse and angled type. Spirals. Even shaded text. You can also plug in Adobe PostScript® software.

For all its new features, the $2,395* list price of the HP LaserJet III is a good deal less than the HP LaserJet

Series II printer it replaces. With the same hardware compatibility, wide range of applications, 8 ppm print speed, and software compatibility, including WordPerfect 5.1 and WordStar® 6.0. And the same reliability as the rest of the HP printer family.

So call **1-800-752-0900, Ext. 1007.** Ask for our booklet on Resolution Enhancement technology and where to find your nearest authorized HP dealer. We'll put you in a whole new league.

## There is a better way.

hp HEWLETT PACKARD

*Suggested U.S. list price. WordStar is a U.S. registered trademark of WordStar International Incorporated. Adobe and PostScript are registered trademarks of Adobe Systems, Inc.

*Circle 114 on Reader Service Card*


## THE NEW SHARP JX-9500.

Sharp's new laser printer saves you three things everyone seems to be short of—money, time and space. It takes up no more room than two sheets of paper, yet it prints 6 pages per minute of crisp text and graphics, and holds 250 sheets in its internal paper tray. As small and inexpensive as it is, the JX-9500 is a real office workhorse.

It's also ready to grow. Add a second paper tray for a full 500 sheet capacity. Or an automatic envelope feeder that handles 40 envelopes without forcing you to take the paper out. There are *two* font card slots. And memory is expandable to 4.5MB with easy-to-install RAM cards.

**Room to grow.** *The JX-9500 with automatic envelope feeder and second paper tray.*

We could go on and on about our remarkable new laser printer. But we suggest you call 1-800-BE-SHARP, because, as you can see, space is tight.

**SHARP®**
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*Circle 318 on Reader Service Card*

# Notebook Newcomer

■ Michael Nadeau

Designing a state-of-the-art notebook computer is risky. To begin with, the competition is playing a constant game of leapfrog. A leading-edge product today could be obsolete next week. On top of that, cheap knock-off products from the Pacific Rim and a cutthroat sales climate make entry into this market tough.

In fact, unless you are a Compaq or a Toshiba, you'd have to be a little crazy to jump in. Yet, that is what a start-up venture, Airis Computer, has done. Its notebook PC is so loaded with features that it could maintain the leading edge for a significant period of time—at a price half that of the competition.

Airis hopes to challenge established small-PC makers with an innovative new machine

### Features, Features, Features

For $1895, the Airis VH-286 comes with most standard notebook PC features and several new ones. The standard configuration has a 12.5-MHz 286 CPU with a socket for an 80287 FPU. A 2½-inch 20-megabyte 23-millisecond hard disk drive from Conner Peripherals or PrairieTek is the sole mass storage device.

The VGA LCD video is an 11-inch, supertwist, backlit, black-on-white, 640- by 480-pixel screen with 16 levels of gray shading. A 2400-bps modem is built into the motherboard. Standard memory is 2 MB, upgradable to 4 MB using two 1-MB single in-line memory modules. A low-profile external floppy disk drive, powered from the computer, is a $150 option if you buy it with the system, $249 sold separately. Traveling Software's LapLink, standard on the hard disk drive, provides file transfer capability between the VH-286 and desktop PCs. MS-DOS 4.01 is the standard operating system.

The case measures about 10 inches long by 12 inches wide. The wedge shape is 2 inches thick at the back and about 1½ inches at the front. It is roughly the same size as a loose-leaf notebook. It weighs about 6½ pounds with batteries; the AC power pack weighs just under a pound and is smaller than most.

Standard ports include one RS-232C serial port, one parallel port, one RJ-11 connector for the built-in modem, an AC power connector, a floppy disk drive connector, and a PS/2 mouse port (which also supports an external keyboard). All are located at the rear. It does not have an external monitor port.

You have a choice of battery power—rechargeable nickel-cadmium batteries or 10 C-cell alkaline batteries. Airis had not yet determined battery life, but it estimates that the unit will run about 6 hours on nickel-cadmium batteries and perhaps as much as 12 hours on alkaline batteries. These impressive numbers are believable if you consider the extraordinary battery-saving features built into the VH-286.

Airis started with the battery-saving features found in most other notebook PCs—low-power components like the small hard disk drive, power-management utilities, and the strategic omission of a floppy disk drive. All major components automatically shut down when not in use, a feature found on systems like the Compaq LTE and Toshiba T1600. What's different is Airis's use of excess video RAM as an on-board disk cache

*continued*

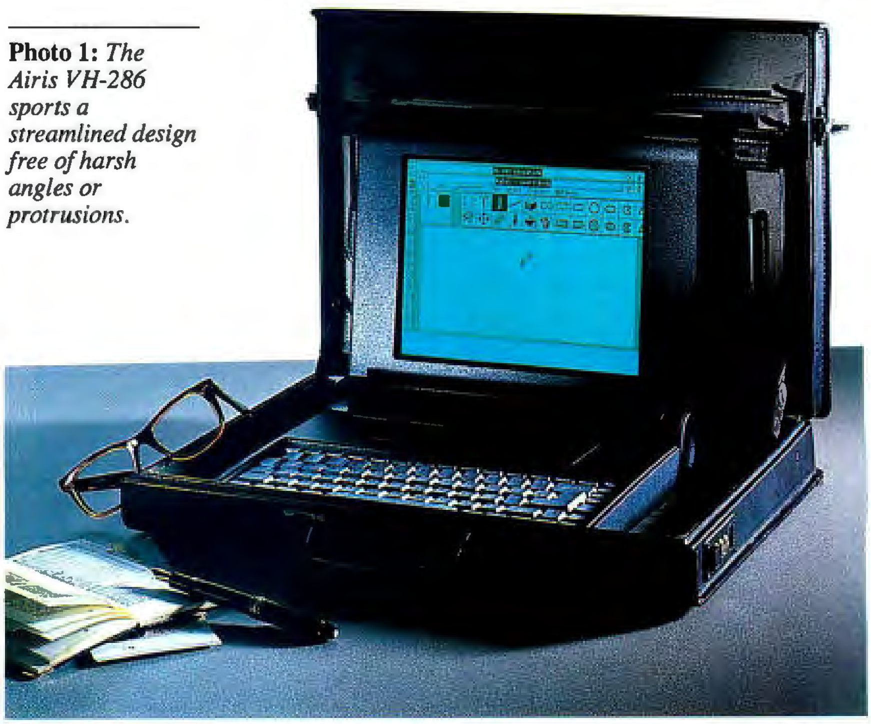

**Photo 1:** *The Airis VH-286 sports a streamlined design free of harsh angles or protrusions.*

and an efficient power-converter design.

To reduce the video RAM chip count from eight to four, the VH-286 designers opted for low-power pseudostatic RAM. But the configuration of these chips provided 512K bytes of video RAM; only 256K bytes were needed for video. The rest became the disk cache. Airis estimates that this cache (not yet implemented on the prototype I saw) achieves a 65 percent to 70 percent hit rate; thus, the system accesses the hard disk drive that much less, saving battery life.

A configuration utility allows you to set time-outs for component shutdowns. All system configurations can be set via the keyboard. A battery-watch utility monitors battery power. An auto-resume feature lets you return to an application at the point you turned off the computer. The feature maintains power to system RAM after you shut off the computer, so it "remembers" where it was.

One last unique feature is Airis's use of Intel's Flash EPROM technology in storing the BIOS. The Flash EPROM chip is soldered onto the motherboard, and it can be updated remotely by simply downloading new code over a phone line. Airis calls this feature TeleROM. Not only does this provide a convenient and inexpensive means for users to get BIOS updates, it reduces manufacturing and design costs by permitting on-the-fly changes to the BIOS code.



## Good-Looking, Too

The hardware is interesting, but perhaps the most striking feature of the VH-286 is its appearance. Its streamlined shape is free of sharp angles or protrusions. All the ports and external connections are covered by a contoured, hinged panel that, when opened all the way, raises the rear of the system for a steeper typing angle. The Joss Design Group, a well-known design house from Chicago, is the architect of the system's housing.

The unit has no front latch to release the clamshell-style display. Instead, a cam mechanism in the screen's hinge locks it shut. To open the display, you press a button on the side of the hinge. This button is flush with the case. The screen folds back a full 180 degrees and is held in place by friction.

Eliminating the front latches has two advantages. It gets rid of any external release mechanism and protruding latches, and it allows for a slightly smaller footprint by requiring less material around the keyboard.

The design has another, hidden advantage. All the components snap together, except for the keyboard assembly, which has two screws. This translates into significant cost savings in manufacturing.

Airis says it was aiming for a professional-looking design that business users would be comfortable with. Compared to some of the competition—the Zenith MinisPort comes to mind—it has met that goal.

## For Keyboard Fanatics

Airis is especially proud of its keyboard. The unit I saw, however, had only a prototype keyboard. The basic layout and feel, according to Airis, is similar to the final version, which is being developed by EECO/Maxi-Switch.

It is basically a standard, full-size, 82-key keyboard with some exceptions commonly found on small PCs. It has no separate numeric keypad, relying on an embedded one, and the function and some of the other nonalphanumeric keys are considerably smaller. Separate PageUp, PageDown, Home, and End keys are full size. No compromise was made on key travel or distance between key caps. The cursor control keys are full size and in the familiar inverted-T configuration, and the Enter key uses the larger backward-L shape. The Control, Shift, and Alt keys are where you'd expect them to be. Anyone moving from a standard desktop PC keyboard should have little trouble adjusting to the VH-286 keyboard.

The keyboard will have a couple of other uncommon features, as well, although they were not on the unit I saw. One is a keyboard remapping utility that lets you rearrange the key layout to your liking. The other is a "sticky key" feature that allows you to perform multiple-key sequences one-handed.

## Performance

Functionality is more important than raw power on a notebook PC, but the Airis holds its own in the power department, too (see the table). Preliminary BYTE benchmark scores give it an excellent 2.35 CPU index, higher than the Compaq SLT's 1.59 and those of most 80386SX systems we've tested. Airis claims zero-wait-state operation for the VH-286, and the CPU index shows it.

The disk I/O index is an adequate 1.38, but this should improve when the disk cache is fully implemented. The video index of 1.48 is a little above average for LCD-based laptops.

## Not Available in Stores

By pricing the VH-286 at under $2000, Airis has left little margin for profit. Therefore, it will sell the VH-286 only through direct sales; for most people, that means mail order. Assuming that Airis will provide good after-sale support à la Dell and other successful mail-order houses, this should not be a problem.

The VH-286 comes with a two-year parts-and-labor warranty—longer than many of its competitors. Since the system board uses mostly surface-mount technology, most repair service will be a simple matter of replacing entire components. Airis expects to have a one-week turnaround on repairs. Since each unit has a modem built in, the company can do remote diagnostics to try to resolve the problem over the phone.

**COMPANY INFORMATION**

**Airis Computer Corp.**
1824 North Besly Court
Chicago, IL 60622
(312) 384-5608
**Inquiry 990.**

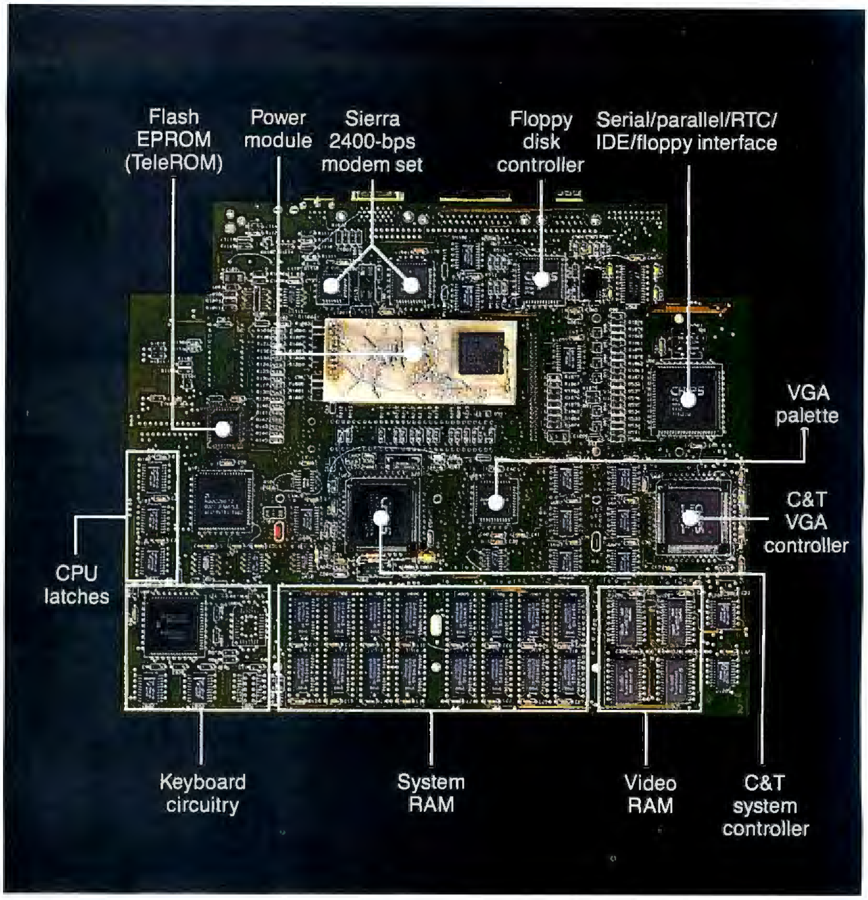


**Photo 2:** *The VH-286 motherboard makes extensive use of surface-mount technology. It has a number of wire jumpers, which should not appear on the final production units.*

**BYTE BENCHMARK RESULTS**

*The 2.35 CPU index is very fast for a 286-based laptop and is owing to the VH-286's zero-wait-state operation (N/A = not applicable).*

| | CPU | FPU | Disk I/O | Video |
|---|---|---|---|---|
| Airis VH-286 | 2.35 | N/A | 1.38 | 1.48 |
| Compaq SLT/286 | 1.59 | N/A | 1.77 | 1.43 |

Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT = 1.
For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

## Is It a Winner?

It's too early to predict the success of the Airis. If Airis can overcome the combined problems of a new company with a new product and deliver what it's promising, then both the company and the VH-286 will be worth keeping an eye on. I liked what I saw, and I don't see another vendor introducing a notebook PC with comparable features any time soon—certainly not for under $2000.

Airis hopes to tap into what it sees as an unfulfilled demand for a powerful, low-cost notebook PC. That demand exists; the question remains whether Airis has pushed the right buttons.

Some people will fault Airis for not including a floppy disk drive as standard. Many notebook PC users rely on floppies, but others, like me, prefer working from a hard disk drive whenever possible. Some users will feel uncomfortable buying direct.

Still, there's something very attractive about the Airis VH-286. Since the unit I saw was hardly finished, I'll wait until the final production units are available (sometime in early August) to make my final judgment. But the compromises Airis made in the design are quite reasonable. Most potential notebook PC buyers will be able to live comfortably with the trade-offs made in the VH-286. Good looks never hurt, either. ■

*Michael Nadeau is BYTE's managing editor of the BYTE Lab. You can reach him on BIX as "miken."*

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| 80 MB VGA Monochrome System | $7,899 |
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| 330 MB Super VGA Color System (800 x 600) | $9,599 |
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Prices listed include 4 MB of RAM. 100 MB hard drive configurations also available.

AD CODE 11EG0

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***Circle 77 on Reader Service Card***

# Laser Printers Get Personal

**The latest wave of Series II-compatible printers offers one feature that PostScript printers can't match: a price tag you can live with**

*Stanford Diehl and Stan Wszola*

The wait is over. The era of the personal laser printer is upon us. Only a few years ago, when laser printers came on the scene, they carried eye-popping price tags that sent shivers up many a consumer's spine. How times change.

Hewlett-Packard introduced the first LaserJet printer in May 1984, and it set the standard for performance. The introductions of the HP LaserJet Series II printer in March 1987, and the LaserJet Series III earlier this year, have further pushed the boundaries of price/performance.

All the Series II-compatible laser printers in this roundup have list prices of less than $3000; some sell for under $2000 (take a look at some street prices, and you'll be hooked). Yet they provide more sophisticated text and graphics processing than ever before. This range of performance has never been available at such a low cost.

In the BYTE Lab, we've cut through a forest of features to give you an objective analysis of each printer. Our laser benchmarks put each printer through a rigorous suite of performance and compatibility tests. Because each test is geared to a particular mix of applications, you can pick the right printer for your needs (see the text box "How to Use Our Laser Printer Test Results" on page 151).

## The Heart of the Beast

A curious form of schizophrenia exists among laser printers. Manufacturers tout feaures that are unique to their models, but when it comes to the printer engine itself, there's a marked similarity among the different brands. We examined 18 laser printers (see table 1), but they represent only six different printer engines: Canon, IBM, Kyocera Unison, Ricoh, Sharp, and TEC (Tokyo Electronics Corp.). Seven of the printers use the TEC engine, five use the Canon engine, three use the Sharp engine, and the others use different engines.

As expected, printers that use the same power plant have much in common. Each engine type boasts specific design and performance advantages—enough so that you should select an engine before picking a particular model.

One major difference among the different brands is whether the engine uses separate optical photo coupler and toner cartridges, as do the TEC, Sharp, Kyocera Unison, and Ricoh engines, or an integrated unit combining the OPC and toner in one, as do the Canon and IBM engines. (See the text box "Painting with Light" on page 142.)

Separate cartridges require maintenance more often. For example, the Epson EPL-6000 uses the TEC engine and requires a new toner cartridge every 1500 pages and a new OPC every 10,000 pages. A new toner cartridge is relatively inexpensive (a TEC toner cartridge lists for $29), but be prepared for a potential mess. You should quickly vacuum up any spilled toner, or it could migrate through the printer engine, ruining the printing and possibly damaging the engine. Another potential problem is that the OPC might be exposed to light during servicing; such exposure will reduce its ability to attract toner and degrade the quality of your printout.

Integrated cartridges, such as those for the Canon engine—which is used in the Brother, HP LaserJet, NEC, and Star Micronics printers—give you convenience at a price. With these cartridges, you can print 3500 to 4000 pages before the machine runs out of toner. It's a simple matter to open the printer, pull out the old cartridge, and insert a new one. But when you throw away the old cartridge, there may be plenty of life left in the OPC. (See the text box "To Refill or Not to Refill" on page 142.)

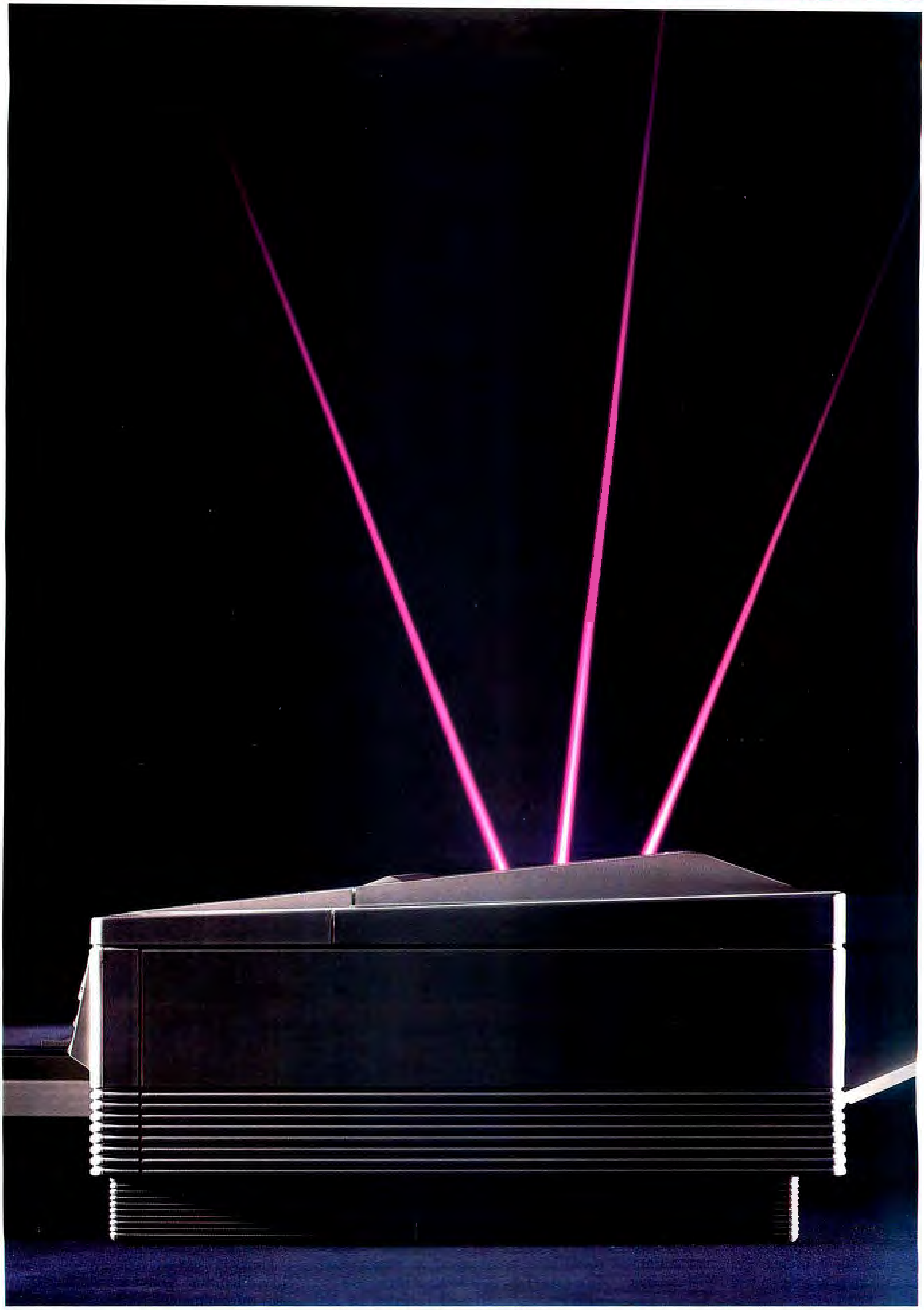
## Paper Handling

Laser printers can be very fussy about the type of paper they receive. Printer manufacturers recommend 16- to 34-pound paper with a smooth surface. Paper specifically made for use with laser printers or photocopiers is excellent. We used photocopier paper for our benchmark tests. Laser printer printouts cost between 2 and 3.4 cents per page. Typical dot-matrix printouts cost 1 cent per page or less. (See the text box "Your Mileage May Vary" on page 154.)

Be careful with preprinted forms or letterhead. When a page passes through the laser printer's fuser assembly, the paper is heated to 392 °F (200 °C) for a tenth of a second to fuse toner to paper. Some of the inks used in raised letterhead can melt and gum up the fuser rollers. Some colored papers scorch or discolor.

Feeding envelopes to a laser printer has always been a problem. You can manually feed the envelopes into any of these laser printers or use an optional envelope tray. Unfortunately, the trays are limited to 30 or 40 envelopes. Jams are a fact of life when you're doing envelopes, because they are thick and resist bending around the rollers and the OPCs inside the laser printers. Make sure that the adhesive used on the envelope flap and any

*continued*



PHOTOGRAPHY: PAUL AVIS © 1990

**LASER PRINTERS**

**Table 1:** *As the following comparisons show, many laser printers selling for less than $3000 don't force you to sacrifice speed or versatility. Most offer upgrade paths to at least 4.5 MB of memory and PostScript compatibility (●=yes; ○=no).*

| **Standard features** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | **Brother HL-8e** | **Dataproducts LZR 650** | **Desktop Systems EXO-2507** | **Epson EPL-6000** | **Facit P6060** | **HP LaserJet IIP** | **HP LaserJet III** | **IBM Laser-Printer 4019** |
| List price | $2895 | $1695 | $1995 | $1899 | $1595 | $1495 | $2395 | $2395 |
| Engine manufacturer | Canon | Sharp | TEC | TEC | TEC | Canon | Canon | IBM |
| Integrated or separate OPC/toner | Integrated | Separate | Separate | Separate | Separate | Integrated | Integrated | Integrated |
| Rated speed (pages per minute) | 8 | 6 | 6 | 6 | 6 | 4 | 8 | 10 |
| Operating noise level (dBa) | 50 | 50 | 52 | 52 | 52 | 47 | 42.9 | 50 |
| Engine life (pages) | 180,000 | 200,000 | 300,000 | 300,000 | 300,000 | Indefinite | Indefinite | Indefinite |
| Monthly duty cycle (pages) | 3000 | 3000 | 3000 | 3000 | 4000 | 2500 | 16,000 | 20,000 |
| Standard memory | 1 MB | 512K bytes | 512K bytes | 512K bytes | 512K bytes | 512K bytes | 1 MB | 512K bytes |
| Maximum memory | 3 MB | 4.5 MB | 4.5 MB | 4.5 MB | 4.5 MB | 4 MB | 5 MB | 4 MB |
| Interface (P=Centronics parallel) | P, RS-232C | P, RS-232C | P, RS-232C, RS-422 | P, RS-232C | P, RS-232C | P, RS-232C, RS-422 | P, RS-232C, RS-422 | P, RS-232C |
| Dimensions (D,W,H) (in inches) | 19 × 17.9 × 9.1 | 14.2 × 13.4 × 10.9 | 15.4 × 16.1 × 8.3 | 15.4 × 16.1 × 8.3 | 15.4 × 16.1 × 8.25 | 24.9 × 13.8 × 8 | 19 × 18 × 8.5 | 20.5 × 14.2 × 10.2 |
| Weight (lbs.) | 44 | 33.5 | 35.3 | 36 | 35.3 | 22 | 50 | 33.6 |
| Power consumption (watts) | 900 | 700 | 600 | 600 | 600 | 550 | 870 | 690 |
| Warranty | 1 year | 1 year | 1 year | 1 year | 1 year | 1 year | 1 year | 1 year |
| **Paper handling features** | | | | | | | | |
| Standard capacity tray | 200 | 250 | 150 | 150 | 150 | 50 | 200 | 200 |
| Maximum capacity (with optional tray) | 200 | 500 | 150 | 150 | 440 | 300 | 200 | 700 |
| Paper size handled | Letter, legal | Letter, legal, A4, B5 | Letter, legal, A4, B5 | Letter, legal, A4, exec. | Letter, A4, B5 | Letter, legal, A4, exec. | Letter, legal, A4, exec. | Letter, legal, A4, B5 |
| Prints envelopes | ● | ● | ● | ● | ● | ● | Optional | ● |
| Prints labels | ● | ● | ● | ● | ● | ● | ● | ● |
| Prints transparencies | ● | ● | ● | ● | ● | ● | ● | ● |
| Output orientation | Face down | Face up or down | Face down | Face up or down | Face up or down | Face up or down | Face up or down | Face down |
| Optional equipment | Paper trays | Paper, env. trays | Paper trays | Epson emul. | Paper, env. trays, font cart. | Paper trays, font cart. | Paper trays | Paper tray, font cart. |
| **Typographic features** | | | | | | | | |
| Resident typefaces | 5 | 4 | 6 | 3 | 3 | 2 | 4 | 5 |
| Font cartridge slots | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| Accepts HP font cartridges | ● | ○ | ● | ● | ● | ● | ● | ○ |
| ***Emulation*** | | | | | | | | |
| Epson FX | ● | ● | Optional | Optional | ○ | Optional | Optional | ○ |
| IBM Proprinter | ● | ● | Optional | ○ | Optional | Optional | Optional | ● |
| Diablo 630 | ● | ● | Optional | ○ | ○ | ○ | ○ | ○ |
| HP 7475 plotter | ● | ○ | Software | ○ | ○ | ○ | ● | ● |
| PostScript | ○ | ○ | Optional | Optional | ○ | Optional | Optional | ○ |

preprinted return address will not melt when passing through the fuser.

Printing transparencies and labels requires materials that are specifically designed for laser printers. Do not attempt to make substitutions. Both types of materials must be able to withstand the heat from the fuser.

## A Sure Cure for the Jaggies

One of the problems with trying to produce good-looking text and graphics on a laser printer are "jaggies," the stair-step effect on some curves and lines. Jaggies result from breaking up an image into a fine grid (i.e., 300 dots per inch). All the printers we examined function at 300 dpi. To get better quality and resolution, manufacturers could go to 600 dpi, but the cost for a more precise print engine and RAM for graphics would be prohibitive for most users.

Hewlett-Packard found a way around this dilemma. The LaserJet Series III uses the company's Resolution Enhance-

## LASER PRINTERS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Kyocera F-1000A** | **Mannesman Tally MT 906** | **NCR 6435** | **NEC Silentwriter 2** | **Packard Bell PB9500** | **PCPI Laser-Image 1030** | **Sharp JX-9500** | **Star Micronics LaserPrinter 8** | **TI microLaser** | **Toshiba PageLaser6** |
| $2895 | $2195 | $2395 | $2695 | $2195 | $2295 | $1795 | $2799 | $1799 | $1549 |
| Kyocera Unison | TEC | TEC | Canon | TEC | Ricoh | Sharp | Canon | Sharp | TEC |
| Separate | Separate | Separate | Integrated | Separate | Separate | Separate | Integrated | Separate | Separate |
| 10 | 6 | 6 | 8 | 6 | 6 | 6 | 8 | 6 | 6 |
| 55 | 52 | 52 | 50 | 52 | 52 | 50 | 53 | 50 | 52 |
| Indefinite | 300,000 | 300,000 | 300,000 | 300,000 | 180,000 | 300,000 | 300,000 | 180,000 | 300,000 |
| 10,000 | 4000 | 5000 | 5000 | 4000 | 3000 | 3000 | 3000 | 3000 | 4000 |
| 512K bytes | 512K bytes | 512K bytes | 1 MB | 1.5 MB | 512K bytes | 512K bytes | 1 MB | 512K bytes | 512K bytes |
| 1.5 MB | 4.5 MB | 4.5 MB | 5 MB | 4.5 MB | 5 MB | 4.5 MB | 5 MB | 4.5 MB | 4.5 MB |
| P, RS-232C | P, RS-232C | P, RS-232C, RS-422 | P, RS-232C, AIM | P, RS-232C, RS-422 | P, RS-232C | P, RS-232C | P, RS-232C | AppleTalk, P, RS-232C, RS-422 | P, RS-232C |
| 17.7 × 16.9 × 12.6 | 15.4 × 16.1 × 8.3 | 15.4 × 35.4 × 8.3 | 17.3 × 24.5 × 11.4 | 15.4 × 16.1 × 8.3 | 16.4 × 15.9 × 8.2 | 14.2 × 13.4 × 10.5 | 19.4 × 17.9 × 8.6 | 14.2 × 13.4 × 10.9 | 15.4 × 16.1 × 8.3 |
| 57.3 | 35 | 36 | 49 | 35.3 | 36 | 33.5 | 45 | 33.5 | 35 |
| 950 | 600 | 1000 | 870 | 600 | 1000 | 700 | 600 | 700 | 600 |
| 90 days | 1 year | 90 days | 1 year or 60,000 pages | 1 year | 90 days | 1 year | 1 year | 1 year | 1 year |
| 250 | 150 | 150 | 200 | 150 | 150 | 250 | 200 | 250 | 150 |
| 250 | 400 | 150 | 200 | 150 | 400 | 500 | 200 | 500 | 150 |
| Letter | Letter, legal, A4, B5 | Letter, legal, A4, A5, B4 | Letter, legal | Letter, legal, A4, B5 | Letter, legal, A4, A5 | Letter, legal, A4, B5 | Letter, legal, A4, B5 | Letter, legal, A4, B5 | Letter, legal, A4, B5 |
| ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Face down | Face up or down | Face up or down | Face up or down | Face up or down | Face up or down | Face up or down | Face up or down | Face up ord down | Face down |
| Paper trays | Paper trays, printer emul. | Font cart., printer emul. | Paper trays, font cart. | Font cart., printer emul. | Paper trays, font cart. | Paper trays, font cart. | Paper trays, font cart. | Paper and env. trays, font cart., printer emul., serial board | Paper trays |
| 6 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 4 |
| 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| ○ | ○ | ● | ○ | ● | ○ | ○ | ○ | ○ | ● |
| ● | Optional | Opt. cart. | ○ | Optional | ● | ● | ● | Optional | ○ |
| ○ | Optional | Opt. cart. | ○ | Optional | ● | ● | ● | ○ | ● |
| ● | ○ | ● | ○ | Optional | ● | ● | ● | Optional | ○ |
| ○ | ○ | Opt. cart. | ○ | ○ | ● | ○ | ○ | ○ | ○ |
| PreScribe language | Optional | ○ | ○ | ○ | Optional | ○ | Opt. board | Optional | ○ |

ment (RE) technology to improve the visual quality of its output. RE smoothes edges and produces sharper points and line intersections (see figure 1). It does this by adjusting the size and position of the individual dots in relation to each other. The print engine is still limited to 300 dpi, but text and graphics look slightly sharper.

Hewlett-Packard incorporated the RE circuitry into an application-specific IC in the controller electronics. The circuitry intercepts and stores a 6-dot-high by 2560-dot-wide section of the page. It examines the relative position of each dot to its 49 neighbors. The circuitry uses pattern recognition to identify any problem areas, and then it uses pulse-width modulation to control the laser beam. RE adjusts dot positions in a horizontal line by controlling the on/off timing of the laser beam; the technology adjusts the dot size by controlling the beam's intensity.

*continued*

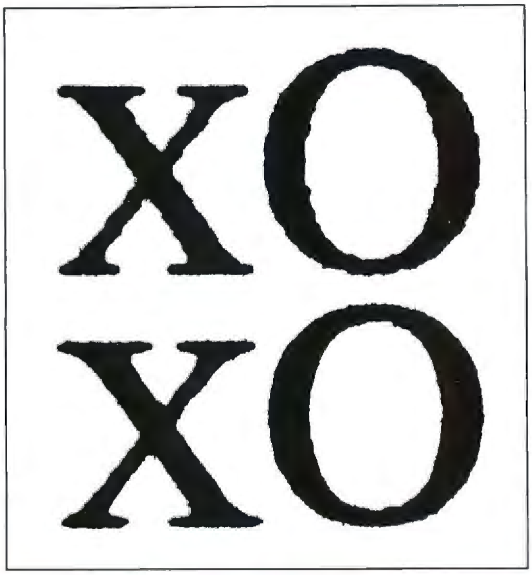



**Figure 1:** *Hewlett-Packard's Resolution Enhancement (RE) technology smoothes out jagged curves. The sample output at top was printed on a LaserJet Series III with RE disabled. The bottom output is from the same printer with RE turned on. Both samples are enlarged 800 percent.*

## Painting with Light

A laser printer engine emulates photocopier technology. But where a copier uses a bright light, laser printers use a low-power, solid-state laser.

A multisided, rotating mirror reflects the laser beam to project an image onto an electrically charged, photosensitive drum (also called an optical photo coupler, or OPC). As it sweeps across the rotating drum, the laser beam rapidly flickers on and off to paint the individual dots of the 300-dot-per-inch image. The charged drum attracts the toner to the areas that have been painted by the laser beam.

As a page of paper passes through the printer, it also receives an electrical charge. When the paper rolls against the drum, the toner image is transferred to the paper. The paper then passes through the fuser assembly, and it's there that heat and pressure melt the toner to make a permanent image on the paper. The paper then passes through the output rollers and lands in the output tray.

## To Refill or Not to Refill

An entire industry has sprung up to refill used Canon toner cartridges. Refilled cartridges, on average, cost half the price of new cartridges. The drawback is that you may not know how many times a cartridge has been refilled. It could be recycled until the optical photo coupler (OPC) develops defects that begin to show in the printout.

Refillable, integrated cartridges are now available. For example, Pelikan sells integrated cartridges with four toner refills, good for 12,000 pages. They can be substituted for some of the older Canon cartridges. (Pelikan is based in Derry, PA, at (800) 288-6637.)

But most laser printer manufacturers discourage the use of refilled cartridges. Manufacturers claim that their cartridges are not built for reuse; seals on a reused cartridge could fail from heat stress and spread toner throughout the printer engine. Also, the OPC has only a limited life if you want the maximum quality in your printout. Reusing a cartridge could void your warranty.

We concur with these warnings. But if you must refill your cartridges, follow these precautions. Deal with a reputable company, mark your cartridges, and insist that you receive only your cartridges back. That's the only way to assure that your cartridge hasn't been refilled more than four times.

The RE circuitry's print quality improvement is subtle. With normal-size text in business correspondence, you wouldn't see an obvious difference between the older Series II and the new Series III. Only when we viewed the output with an eight-power loupe did we detect any differences (see figure 2 for a comparison of representative output from each of the engines we tested).

### Port of Call

Because laser printers are relatively expensive compared to other forms of printer technology, many buyers use them on LANs or with printer-sharing devices. Most laser printers offer the option of different types of serial and parallel port connections.

Standard Centronics parallel ports let you position your printer up to 15 feet away from your computer. This distance also applies to any manual or electronic switching boxes, or other printer-sharing devices. An RS-232C serial connection allows for longer cable runs, up to 50 feet long. Another serial connector option is the RS-422A; this allows a higher data throughput and cable runs of up to 4000 feet. If you are using a Mac, several laser printers offer optional AppleTalk connectors with a maximum cable run of 1000 to 3000 feet, depending on your Mac's AppleTalk configuration.

We don't recommend manual switch boxes for laser printers. To switch to another host computer safely, you must switch all the lines simultaneously. Manual switches, depending on their design, make connections sequentially. This means that some data and ground lines may be left unconnected for a fraction of a second, which can damage the interfacing chips in the laser printer's controller electronics.

The NEC Silentwriter 2 offers the unusual feature of permitting two host computers to share the printer by connecting one host to the parallel port and the other host to the serial port. The printer can automatically handle data from both ports.

### Fun with Fonts

A laser printer accepts three kinds of fonts: resident, or internal fonts; cartridge fonts; and downloadable, or "soft" fonts. Internal fonts come packaged with the printer; they are permanently stored in the printer's ROM. Cartridge fonts are ROM fonts that you buy separately. The cartridge, or "font card," plugs into a port on your printer. Soft fonts reside on a hard disk and are

*continued*

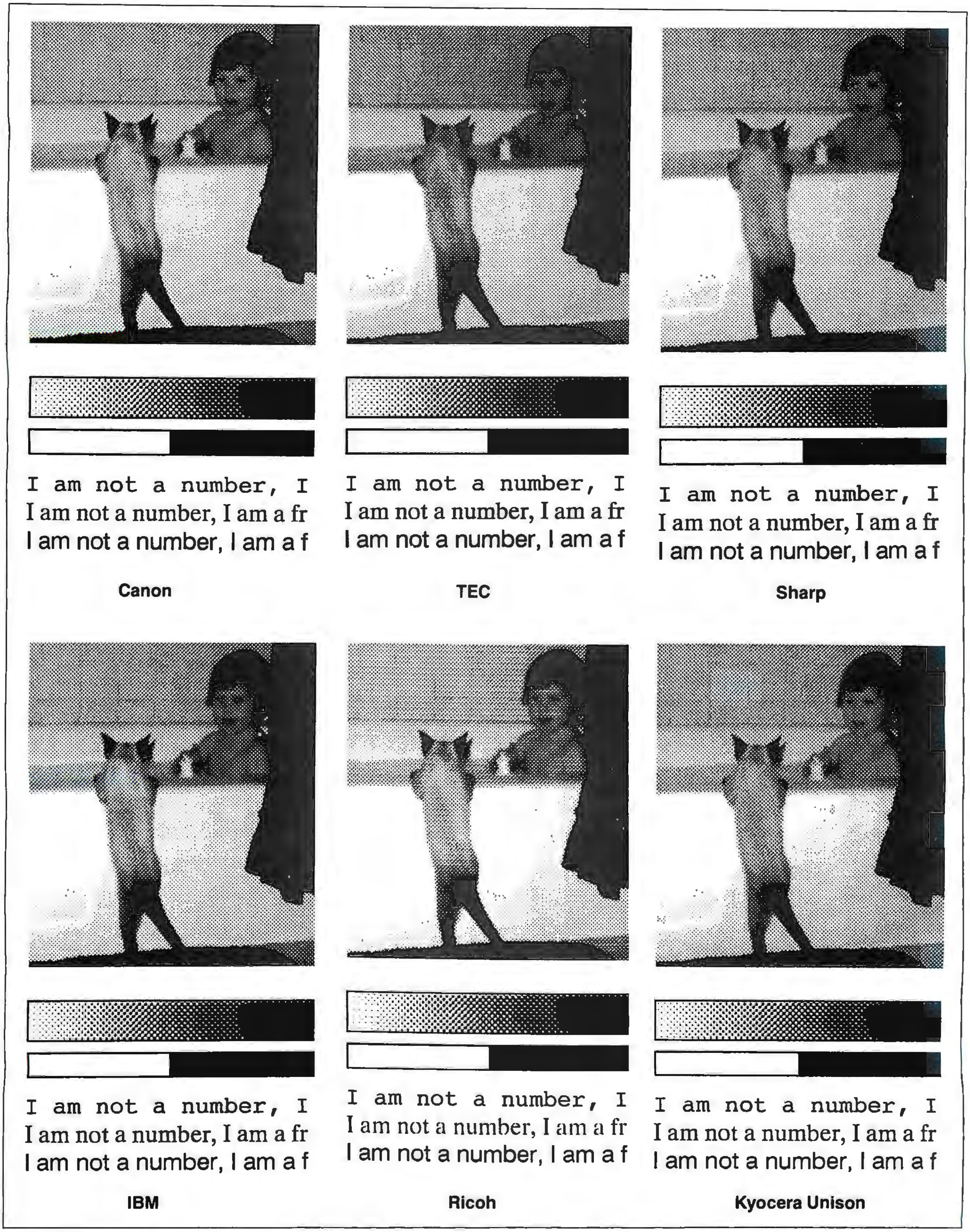



**Figure 2:** *A sample printout from each printer engine covered in this product focus. The engines varied little in print quality, although the Ricoh engine's output lacked the sharpness of the other five samples.*

downloaded to the printer's RAM when needed.

For most needs, the internal fonts are barely sufficient. Most users will also want the fonts available in their word processor program, and they will invest in software fonts or font cartridges. If you're doing desktop publishing, trying to match previously used fonts, or trying to achieve a specific "look," then a good selection of optional fonts becomes important.

Many manufacturers inflate the number of fonts available in their laser printers by counting every font and then multiplying by portrait- and landscape-mode options, the different sizes for each font, and font sets for every printer emulation. For example, by counting portrait and landscape modes and other variables, Kyocera Unison claims 79 fonts for its F-1000A laser printer, although only six different typefaces are represented. For a fair comparison, you should count only the specific type styles available internally in each laser printer.

Some printers do not accept HP font cartridges, opting for their own font cartridges or cards. Such a policy can lock you into a vendor's product line. If you get the fonts you need up front, you'll be all right.

Soft fonts are readily available from commercial sources and from BBSes. All 18 printers that we reviewed will accept HP soft fonts, since they are all HP Printer Control Language (PCL) compatible. Soft fonts may seem like a dream until you start using them. You will soon notice them stealing precious RAM from your printer as well as consuming gobs of space on your hard disk drive.

### Buyer Beware

While all these printers tout software compatibility with the original Series II, that doesn't make them clones. Considerable hardware differences exist even when printers have the same engine. Keep that in mind when you buy, especially if you use mail-order sources. Make sure your source also sells toner and other supplies. Consider what upgrades you expect to make. Some vendors, for instance, are shipping PostScript boards now, while others may never give you PostScript compatibility.

Even if vendors can meet your future needs, you will pay a premium if you are isolated from other sources. You can't count on a flurry of third-party development for printers out of the mainstream. The HP printers attract many third-party hardware and software developers, and

*continued*

the IBM LaserPrinter, if it catches on, will also spawn third-party support.

For many of these printers, you will have to rely on the vendor for hardware upgrades, font cards, and even printer expendables like toner. So make sure that your future needs are available now or, at the very least, in the works.

### That Physical Presence

The dimensions that we list in table 1 describe the printers as they come out of the shipping box. In full regalia, with paper trays extended and any optional paper cartridges installed, these printers can have a very large footprint. Before you select a spot on your desk for that printer, make sure you know how much room is required. And remember that laser printers are air-cooled machines that require some breathing room to function properly. Do not position them flush against a wall.

All 18 laser printers produced approximately 42 to 55 adjusted decibels of noise while operating. Their sounds range from a low-pitched hum to a whine, both of which we found acceptable; this is, of course, a matter of personal preference. The average 24-pin printer, by comparison, produces from 63 to 75 dBa of noise with a higher pitch.

### A Lapse in Memory

Finally, don't short-sell memory—the more, the better. Four of these printers double the usual installed memory to 1 megabyte. The Packard Bell PB9500 includes 1.5 MB standard. In these graphical days, 512K bytes of memory probably won't suffice. Since a laser printer must process a full page before printing it, there aren't many ways around a memory shortage. If you want to print a full-page, 300-dpi graphic, and your printer stocks only 512K bytes of RAM, you'll have to generate a smaller graphic or settle for 150 dpi. Also, be wary of maximum memory limitations. As your print jobs become more complex, your memory requirements will increase. The Brother HL-8e can take only 3 MB of memory, while the Kyocera Unison F-1000A is restricted to 1.5 MB. Your print jobs may fit within 512K bytes for now, but if you ever require more than 1.5 MB, you'll have no upgrade path.

Once you start using software fonts, your memory requirements skyrocket. To keep downloaded fonts in the printer memory, you'll need a minimum of 2 MB. If you are planning on doing desktop publishing, you should stock a healthy supply of RAM right from the beginning.

**HP LaserJet III**

### Canon Cadre

The original HP LaserJet Series II contained the venerable Canon engine. It was a good choice. The printers with Canon engines—the HP LaserJet Series III, the Brother HL-8e, the NEC Silentwriter 2, and the Star Micronics LaserPrinter 8—closely resemble the LaserJet Series II. They are big and heavy, and rugged and dependable. These five printers will take up a lot of desk space. They are not as lean and streamlined as some of the other models, but they are built to last. Even their paper trays have a more rugged feel about them, sliding snugly into the front of the printer. These printers will probably hold up better than most in a multiuser environment.

The printers with Canon engines also offer greater convenience to the user. We found them much easier to install and maintain than the other printers. You simply slip the cartridge under the hood, and you're ready to print. As usual, greater convenience translates into greater cost. Generally, the Canon printers cost a bit more. On top of that, you'll pay more for the expendable cartridges. When the toner is spent, you can either throw out the entire cartridge, drum, and toner or take your chances refilling it, a practice that both we and HP discourage.

All the Canon models performed within a predicted range, with the Brother HL-8e posting the best overall numbers (see table 2). However, the Canon models did not significantly outperform our baseline machine, the HP LaserJet Series II. We also found little difference in the quality of the printouts. Even the LaserJet Series III, with its RE technology, did not stand out from the crowd.

Given the uncanny similarity of the Canon-engine printers, the HP models remain obvious choices. They're cheap, compatible by definition, and sure to be

*continued*

# We put 25 font cartridges in one because the perfect printer is just a dream.


Let's face it. There hasn't been a printer built that has all the fonts you need. Which is why we created 25 Cartridges in One!

It has fonts from 25 Hewlett-Packard cartridges, saving you hundreds of dollars. You get 172 fonts and symbol sets such as Prestige Elite, Tms Rmn style and Helv style types. And our 3.6 pt AFS typeface so you can print full Lotus and Excel worksheets. Plus 69 international fonts.

Just plug 25 Cartridges in One! into your LaserJet*. It's compatible with virtually all major word processing software. And even works with our Headlines in a Cartridge product offering 14-48 pt fonts.

25 Cartridges in One! can help make your dream of the perfect printer a reality. To learn more, call or write: Pacific Data Products, 9125 Rehco Rd., San Diego, CA 92121, **(619) 552-0880.** Fax (619) 552-0889.

**PACIFIC**
DATA PRODUCTS

*Versions of 25 Cartridges in One! are compatible with HP LaserJet Series II, IIP, IID and III.



*Circle 193 on Reader Service Card (DEALERS: 194)*

supported. In fact, if you like the convenience and ruggedness of the Canon engine, you might even keep a keen eye open for a good used Series II. A proven workhorse, the HP LaserJet Series II has stood up well over time. (For a review of the HP LaserJet IIP, a $1495 laser printer built on a similar Canon engine, see "The LaserJet IIP: Inexpensive, Not Cheap," February BYTE.)

Mannesman Tally MT 906

## All in One Basket

TEC manufactures the most common engine in this printer roundup. The TEC engine has one big advantage over the Canon engine: separate toner. When a TEC printer runs out, you replace only the toner cartridge—a significant savings over the long haul. Also, we found that the printers with TEC engines—the Desktop Printer EXO-2507, the Epson EPL-6000, the Facit P6060, the Mannesman Tally MT 906, the NCR 6435, the Packard Bell PB9500, and the Toshiba PageLaser6—were generally cheaper than models with the Canon engine or those with proprietary engines.

The TEC models print at a rated speed of 6 pages per minute, slower than the average Canon printer at 8 ppm. Because the TEC engine comes in a wider variety of models, components are not always interchangeable. We could easily transfer a Canon cartridge from one Canon engine to the next. This was less true with the TEC engines.

Canon cartridges are readily available from many sources. If you choose a model that accepts the same cartridge as that of the Series II, you will never have to worry about finding the right replacement. But you'd better make sure that the expendable supplies will be available for your particular TEC engine through mail order and other avenues.

We found that the TEC models did not handle paper as well as those that used the Canon engine. The paper trays were more fragile and did not slide into the printer as smoothly. The trays have tabs protruding from each side. These tabs fit into slots on the side of the printer and snap into place. We could not easily detect a good solid click when the tray was properly seated. In addition, the trays extend out from the side of the printer, adding to its footprint. We also noted more paper jams using these trays.

One pleasant surprise among the printers packing TEC engines was the Mannesman Tally MT 906. It proves that a printer need not be saddled with the performance limitations of its engine. While the first-page-output test times were consistent for all the TEC printers, the MT 906 performed the short memo test a good half-minute faster than any of the other TEC models. On the text-and-graphics test, the MT 906 showed just how significant powerful processing can be. It ran the test a full *13 minutes* faster than the nearest TEC competitor. The other TEC models posted an average graphics throughput of 3800 bytes per second or so. The MT 906, meanwhile, screeched by them all at a dizzying rate of 15,594 bytes per second. If you like the TEC engine, you'll look long and hard to beat the MT 906.

TI microLaser

## A Fitting Footprint

The laser printers designed around the Sharp print engine are wonderfully compact, with footprints any desk jockey would love. We tested three of them: the Dataproducts LZR 650, the Sharp JX-9500, and the Texas Instruments microLaser. They all have paper trays conveniently tucked into a shelf at the bottom of the printer. The trays slide all the way into the printer, so you need not consider a protruding paper tray when clearing desk space for your printer. Again, parts are not interchangeable from one Sharp engine to another. We tried to place the

*continued*

**BY THE NUMBERS**

**Table 2:** *Benchmark test results in seconds except graphics throughput, which is in bytes per second for the laser printers to generate text, combined text and graphics, and HPGL files (N/A = not applicable).*

| Printer | First page | Short memo | Text-and-graphics | Graphics throughput | Long document | HPGL |
|---|---|---|---|---|---|---|
| Brother HL-8e | 19 | 290 | 575 | 9962 | 1152 | 705 |
| Dataproducts LZR 650 | 19 | 395 | 1555 | 3065 | 1238 | N/A |
| Desktop Printer EXO-2507 | 24 | 421 | 1298 | 3856 | 1371 | 800 |
| Epson EPL-6000 | 26 | 425 | 1310 | 3736 | 1492 | N/A |
| Facit P6060 | 24 | 423 | 1298 | 3815 | 1467 | N/A |
| HP LaserJet Series II | 20 | 316 | 724 | 8341 | 1034 | N/A |
| HP LaserJet Series III | 19 | 307 | 619 | 9693 | 1017 | 459 |
| IBM LaserPrinter 4019 | 21 | 313 | 829 | 11,208 | 844 | 669 |
| Kyocera Unison F-1000A | 17 | 290 | 807 | 5517 | 1300 | N/A |
| Mannesman Tally MT 906 | 25 | 382 | 473 | 15,594 | 1298 | N/A |
| NCR 6435 | 24 | 432 | 1369 | 3482 | 1749 | N/A |
| NEC Silentwriter 2 | 21 | 339 | 721 | 12,809 | 968 | N/A |
| Packard Bell PB9500 | 25 | 425 | 1298 | 3815 | 1467 | N/A |
| PCPI LaserImage 1030 | 24 | 410 | 1035 | 2134 | 1498 | 291 |
| Sharp JX-9500 | 18 | 336 | 1138 | 4269 | 1252 | N/A |
| Star Micronics LaserPrinter 8 | 20 | 315 | 641 | 8539 | 1022 | N/A |
| TI microLaser | 17 | 293 | 981 | 10,549 | 1195 | N/A |
| Toshiba PageLaser6 | 24 | 423 | 1276 | 3815 | 1498 | N/A |

# Experts Recommend A Super IQ.

*"I especially recommend the all-inclusive font cartridge from IQ Engineering that has a ton of fonts all on the same cartridge."*
John Dvorak

*"...IQ's cartridges surpass everything else on the market."*

PC MAGAZINE EDITORS' CHOICE
Super Cartridge 2
June 13, 1989

PC MAGAZINE BEST OF 1989
Edward Mendelson
Printer Fonts Super Cartridge 2
January 16, 1990

*"...a half-dozen competitors, including Hewlett-Packard, have tried to catch up. None has even come close."*

*"...the best thing to happen to LaserJet owners since they bought their printer."*

PC MAGAZINE BEST OF 1988
Gus Venditto
Printer Fonts Super Cartridge 1
January 17, 1989

*"The Super Cartridge 2 may well be the last cartridge you will ever buy."*
Andrew Seybold's Outlook

**Your Laser Printer Needs A Super IQ.** The IQ Engineering Super Cartridge 2 adds value to the HP LaserJet IIP, quality to the HP LaserJet Series II and speed to HP LaserJet III printers.

**Your Best Deal On A IIP.** You know that for less than a thousand dollars, you can have your own laser printer. But it has only three fonts, Courier, Courier, and something like Courier. Add a Super Cartridge 2 and get 17 typefaces in every size your software allows—from 4 to 30 points! Smart money says there's no better buy.

**Quality Fonts For The Series II.** Your series II printer is not obsolete, if you recycle with a Super Cartridge 2. You'll get every size of Tms Rmn and Helv in common use. Each font is designed for optimum resolution without need for enhancement algorithms. Chances are, a smart upgrade is all you need.

**Speed For The LaserJet III.** Why give up speed to get all the fonts you need? The Super Cartridge 2 snaps into the HP LaserJet III printer to deliver every ordinary font at full hardware speed and highest resolution. Try a test—you'll see the difference. Nobody's slow with a Super IQ.

Our 17-page guide reveals everything you need to know about font accessories. There's a Super Cartridge for every HP LaserJet printer and many compatibles, priced from $399 to $799. And compatibility with all the software programs you'd expect (including WordPerfect and many others).

**Ask Us Today.** We'll explain how we got the experts to agree. (Even the infamous John Dvorak). And we'll help you find a dealer with a Super IQ. So every printer will be as smart as it should be. Before you buy a font cartridge, listen to what the critics say about IQ Engineering.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*(1-800-765-3668)*
*Canada: 1-800-663-6157*

IQ ENGINEERING

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Hong Kong: 5-8400336 • Malaysia: 3-2482900 • Australia: (02) 819-6811 • New Zealand: 4-4990967 • U.S.A.: (408) 733-1161



*Circle 125 on Reader Service Card (DEALERS: 126)*

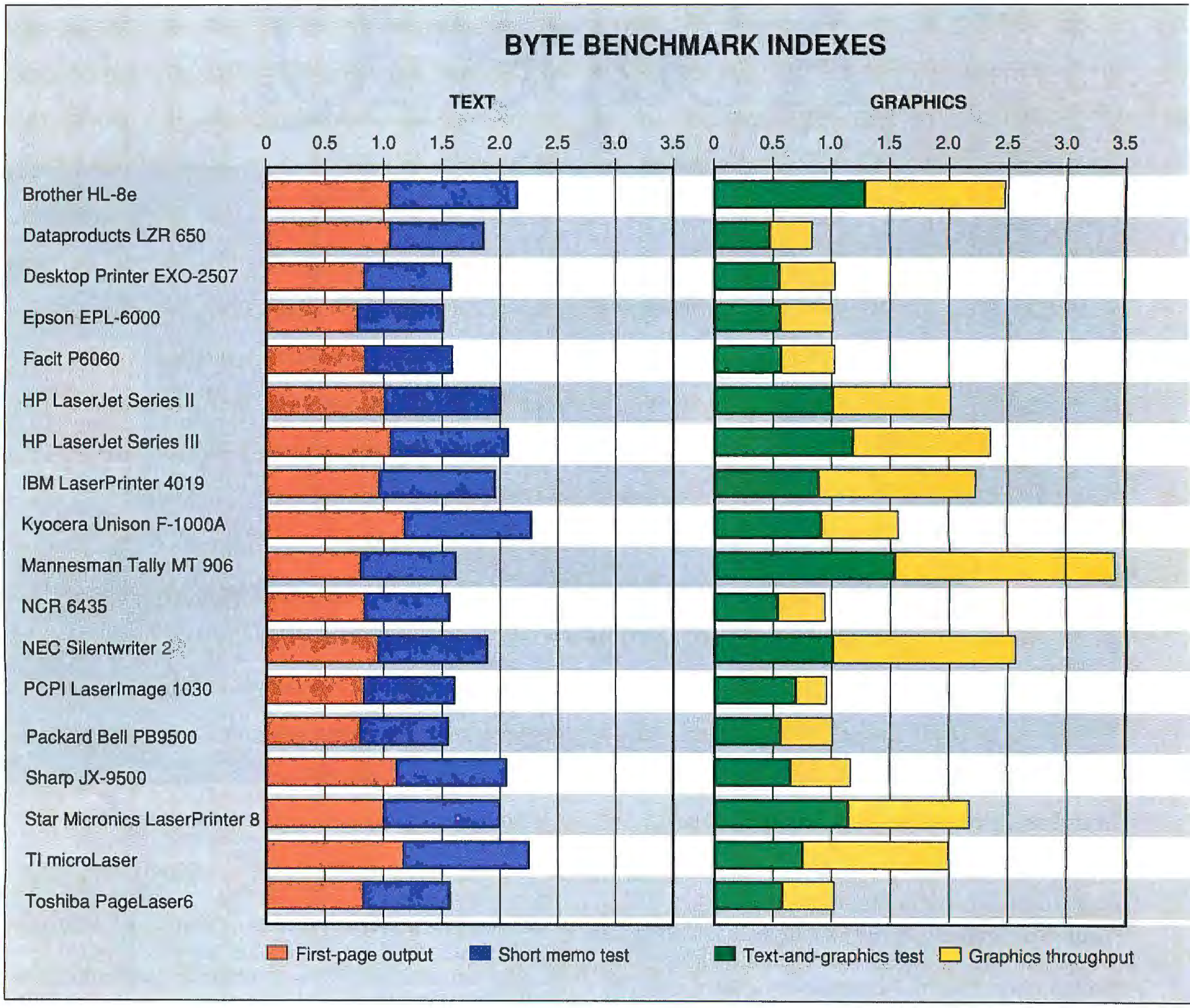


**Figure 3:** *The Text Index combines two tests, the first-page output test and the short memo test. Use this index if your applications tend to be small, textual print jobs (e.g., memos, letters, and simple spreadsheets). The Graphics Index combines the text-and-graphics test and the graphics throughput test. Use this index if your applications include heavy-duty graphical elements—newsletters, flyers, complex spreadsheets, and scanned images. Use the Long Document Index if your print jobs tend to be many pages of pure text. In all cases, long bars indicate superior performance.*

TI drum and toner into the JX-9500, but the printer would not accept them.

The Sharp models are inexpensive, and they perform a bit faster than the average TEC engine, despite sharing the same 6-ppm rating. The TI microLaser was the top performer of the printers with Sharp engines. Unfortunately, the microLaser did not pass our HP-PCL compatibility test. An escape sequence within our PCL file included a space. Hewlett-Packard considers this a bad programming practice, but all the other printers, including the Series II, ignored the space. The microLaser choked on the extra space and would not properly respond to the command. An engineer from TI acknowledged the problem and said a new set of ROMs will fix it.

Ironically, the microLaser suffers from being too compatible. It adheres to the PCL standard more closely than the LaserJet Series II does. The microLaser printed all our other documents without a hitch. It's a fine printer. Don't be dissuaded by the compatibility quirk; it will probably be fixed by the time you read this.

**IBM LaserPrinter 4019**


# How to Use Our Laser Printer Test Results

The commandment we preach for every purchasing decision—Know Thy Application—is especially valid when evaluating laser printers. Once you decide how you're going to use your printer, check our benchmark tests to determine the right model for you.

You can't simply pick a printer with the highest page-per-minute rating and expect the fastest output. That may be true for pure text, but once you include graphics, the engine speed becomes less consequential. The fastest graphics printer usually boasts the richest processing power. The bulk of time passes when the printer processes and downloads the graphic, while a page of text prints as fast as the engine allows. A mixture of print jobs might favor a third printer with an optimal complement of features and speed.

All our tests were designed for a Hewlett-Packard LaserJet Series II-compatible printer with 512K bytes of RAM. We ran a total of seven tests on 17 printers plus the original Series II, our baseline machine. We printed each test document from the DOS command line using the `copy /b filename lpt1:` syntax. The graphs are indexed to a LaserJet Series II, so the longest bars reveal superior performance.

In the Text Index (see figure 3), we combined the first-page output test and the short memo test. If your shop runs a lot of small documents, pay particular attention to the Text Index. We also included some minor graphics (e.g., scanned letterhead). The first-page output test times how long it takes to generate a single page from command-line input to page ejection. The short memo test includes a single-page textual spreadsheet, a two-page memo, two letters with scanned letterhead, and 10 one-page memos. We timed each document separately. After one document was processed and ejected, we suspended timing until the printer's motor wound down. Then we sent the next document.

If you do heavy-duty graphics—newsletters, flyers, page layout—then you should focus on the text-and-graphics test and the graphics throughput (figure 3) results. The text-and-graphics test printed a complex PageMaker letterhead, a Quattro Pro spreadsheet with embedded graphics, an Amí Professional report with numerous fonts and embedded .PCX files, a flyer with a scanned photograph, and an eight-page BYTEWEEK. The graphics throughput test tracked a byte-per-second rate for producing a three-quarter-page, 300-dot-per-inch graphic.

The long-document test (figure 3) generated 125 pages of text. The text includes a variety of fonts that were downloaded before the test began, to simulate a shop that will download a group of soft fonts at the start of the day.

The HPGL test (figure 4) includes plot files from both AutoCAD and Vellum CAD. The test exercises a wide range of HPGL (Hewlett-Packard Graphics Language) commands. The HP Printer Control Language test samples a typical range of PCL commands. All the printers except the Texas Instruments microLaser (which had a minor problem; see the text) passed the compatibility tests without a hitch.

## An Engine Like No Other

Two of the printers employ proprietary engines. *IBM*, as usual, went its own way with the LaserPrinter 4019, which uses an engine that boasts a full 10-ppm rating. The faster engine boosted the 4019's performance on the long-document test above all the others. There's a catch, though. Our model kept jamming paper. Obviously, this will slow down your print jobs considerably. At one point, the 4019 absolutely mutilated a piece of paper, leaving shreds of it in the paper path. It took us some time to pick the pieces of paper out from under the fuser.

Like the printers with Sharp engines, the 4019 carries its paper tray in a shelf at the bottom of the unit. It protrudes only slightly, adding little to the printer's footprint. Like the units with Canon engines, the 4019 has an integrated cartridge, so you throw the drum out with the toner. We didn't like the way the IBM's cartridge fits into the printer. It hangs loose instead of fitting snugly into its slot. As you close the printer, the cartridge absorbs the impact first—before the printer's lid snaps shut. And don't forget: When it comes to buying new cartridges, you'll be at the mercy of IBM.

A proprietary engine also drives the Kyocera Unison F-1000A. The printer has a hopper on top for the toner. Though convenient, this setup can be messy. Unlike all the other printers, the F-1000A requires that you pour the toner into the hopper, remove the toner container, and close the lid. This exposes you directly to black dust. You must also consider the pitfalls of going with a unique engine. When we were benchmarking the F-1000A, the

*continued*

## COMPANY INFORMATION

**Brother International Corp.**
(Brother HL-8e)
200 Cottontail Lane
Somerset, NJ 08875
(201) 981-0300
**Inquiry 1071.**

**Dataproducts Corp.**
(Dataproducts LZR 650)
6200 Canoga Ave.
Woodland Hills, CA 91367
(818) 887-8000
**Inquiry 1072.**

**Desktop Systems, Inc.**
(Desktop Printer EXO-2507)
48431 Milmont Dr.
Fremont, CA 94538
(415) 683-4725
**Inquiry 1073.**

**Epson America, Inc.**
(Epson EPL-6000)
2780 Lomita Ave.
Torrance, CA 90505
(800) 922-8911
(213) 539-9140
**Inquiry 1074.**

**Facit, Inc.**
(Facit P6060)
400 Commercial St.
Manchester, NH 03108
(800) 733-2248
(603) 647-2700
**Inquiry 1075.**

**Hewlett-Packard Peripherals Group**
(HP LaserJet Series II, Series III)
19310 Pruneridge Ave.
Cupertino, CA 95014
(800) 752-0900
**Inquiry 1076.**

**IBM Corp.**
(IBM LaserPrinter 4019)
101 Paragon Dr.
Montvale, NJ 07645
(800) 426-2468
**Inquiry 1077.**

**Kyocera Unison, Inc.**
(Kyocera Unison F-1000A)
1321 Harbor Bay Pkwy.
Alameda, CA 94501
(415) 748-6680
**Inquiry 1078.**

**Mannesman Tally Corp.**
(Mannesman Tally MT 906)
8301 South 180th St.
Kent, WA 98032
(800) 843-1347
(206) 251-5524
**Inquiry 1079.**

**NCR Corp.**
**Peripheral Products Division–Wichita**
(NCR 6435)
3718 North Rock Rd.
Wichita, KS 67226
(316) 636-8570
**Inquiry 1080.**

**NEC Technologies, Inc.**
(NEC Silentwriter 2)
1414 Massachusetts Ave.
Boxborough, MA 01719
(508) 264-8000
**Inquiry 1081.**

**Packard Bell**
(Packard Bell PB9500)
9425 Canoga Ave.
Chatsworth, CA 91311
(818) 773-4400
**Inquiry 1082.**

**Personal Computer Products**
(PCPI LaserImage 1030)
11590 West Bernardo Court, Suite 100
San Diego, CA 92127
(619) 485-8411
**Inquiry 1083.**

**Sharp Electronics Corp.**
**Systems Division**
(Sharp JX-9500)
Sharp Plaza
Mahwah, NJ 07430
(201) 529-9500
**Inquiry 1084.**

**Star Micronics America, Inc.**
(Star Micronics LaserPrinter 8)
420 Lexington Ave., Suite 2702
New York, NY 10170
(800) 447-4700
**Inquiry 1085.**

**Texas Instruments, Inc.**
(TI microLaser)
P.O. Box 202230
Austin, TX 78720
(800) 527-3500
**Inquiry 1086.**

**Toshiba America Information Systems, Inc.**
**Computer Systems Division**
(Toshiba PageLaser6)
9740 Irvine Blvd.
Irvine, CA 92718
(800) 334-3445
**Inquiry 1087.**

printouts emerged faded and washed-out. We immediately suspected bad toner. Unfortunately, none of the other printers could loan its toner to the F-1000A. We had to go back to the vendor directly to obtain new toner, which fixed the problem.

The F-1000A matches the IBM Laser-Printer 4019's 10-ppm rating, but its results on the long-document test (see figure 3) did not corroborate a superior engine speed. The engine did seem extremely well built, however, and the paper tray was the best of the bunch.

Only one printer carried a Ricoh engine: the PCPI LaserImage 1030. The Ricoh design includes separate toner, a 6-ppm rating, and an awkward paper tray. Also, the output quality was inferior to that of the other printers, although the printer shined when producing plots.

### The Laser Equation

The Text Index (see figure 3) tests raw engine speed as well as the time that it takes to dump the page to the output tray. There were some telling results. The Kyocera Unison F-1000A ranked at the top of the Text Index, which is not surprising, given its 10-ppm engine rating. But that same engine did not perform as well as expected on other tests. The other 10-ppm engine, the one in the IBM LaserPrinter 4019, excelled, too. The printers with Canon engines—particularly the Brother HL-8e, the HP LaserJet Series II and III, the NEC Silentwriter 2, and the Star Micronics LaserPrinter 8—also showed off their high 8-ppm rating.

Surprisingly, the printers with Sharp engines—the Sharp JX-9500, the Dataproducts LZR 650, and the TI microLaser—consistently outperformed those with TEC engines, even though both engine types have a 6-ppm speed rating. Our tests tag the Sharp engine as a superior performer. The three Sharp engines even give the higher-rated engines a run for their money. The microLaser led the charge of the Sharp engines, with

*continued*

## Your Mileage May Vary

How long can you expect your new laser printer to last? Like any complicated machine, a laser printer has a limited duty cycle. You can run these printers only so hard for so long before they overheat and break down. Engine designers assume that you won't use the printer continuously; there will be time for the printer to cool down. Most manufacturers rate their printers for a duty cycle of 3000 pages per month. That may seem small, but it is reasonable if you do some math.

Assuming that the laser printer is used in an office whose employees work an 8-hour day and approximately 20 working days per month, you would have to print 18¾ pages every hour to achieve the duty cycle.

Many manufacturers also rate their printers with a life span in total number of pages printed. The typical life span runs 300,000 pages, although IBM and Hewlett-Packard claim an indefinite period, assuming proper maintenance.

If you divide the 300,000-page life span by the 3000-page duty cycle, you get 100 months, or eight years and four months. Some manufacturers conservatively give their printers a five-year life span. Theoretically, with the current speed of development in laser printer technology, that old laser printer would be relegated to mundane printing tasks or the obsolete equipment room before it would wear out.

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a result rivaling the 10-ppm F-1000A's.

In the Graphics Index tests (see figure 3), processing power prevailed over raw engine speed. The Mannesman Tally MT 906 leaves the other printers in the dust. This is especially noteworthy given the lackluster performance of the other TEC engines. For heavy-duty graphics and professional layout applications, the MT 906 is a clear winner.

The Brother HL-8e, LaserJet Series III, IBM LaserPrinter, NEC Silentwriter 2, Star Micronics LaserPrinter 8, and TI microLaser also performed well on the graphics tests. As we negotiated the full suite of tests, the Brother HL-8e emerged as a solid performer across the board. Apart from the MT 906, the printers with the TEC engine posted remarkably similar scores. Evidently, only Mannesman Tally has enhanced the processing power of the standard TEC model.

If you have a lot of long text documents to generate, the top performers on the Long Document Index (see figure 3) should appeal to you. We suspended timing on paper changes and jams, which will slow you down more than a sluggish engine. Our top performer, the 10-ppm IBM LaserPrinter 4019, did suffer from occasional paper jams, somewhat tainting its impressive time. The Kyocera Unison F-1000A, while performing sufficiently, did not do justice to its 10-ppm rating. The leaders in the other tests rose to the top here as well: the Brother HL-8e, the LaserJet Series II and III, the NEC Silentwriter 2, the Star Micronics LaserPrinter 8, and the TI microLaser.

### The HPGL Subplot

Five of these printers can produce plots from an HPGL (Hewlett-Packard Graphics Language) file. Three of them offer ROM-based HPGL emulation, while a fourth packages a software HPGL emulator. The HP LaserJet Series III, driven by Hewlett-Packard's PCL 5, incorporates HPGL commands into its command set. The Series III output, though fast and legible, resembles a drawing more than a plot. The Desktop Printer EXO-2507 emulated HPGL with included software. As expected, the output was slow. And remember: Any of these printers could do the same trick with the right software package.

The IBM LaserPrinter 4019 and the Brother HL-8e produced fine HPGL plots, but both were almost as slow as the software emulator. If you need a laser printer to do a lot of draft plotting, consider the PCPI LaserImage 1030. In the lab, the PCPI's plot samples were consistently chosen as having the best output. Also, it absolutely blazed through the HPGL benchmark (see figure 4), easily beating all the other HPGL printers.

*continued*

*Engineered for the office. Designed for people.*


# Due to space limitations, we can't show you all the awards our 1124 and 1180 printers have won.

What can we say? Of course, we're proud. But we've always been proud of our 1124 and 1180 Dot Matrix Printers — even before they started winning all these awards. Who wouldn't? They just make so much sense. Each one, for example, has multiple paper paths. Load it from the bottom or rear. And put it wherever you want. Each one has an EZ Set™ Panel. As well as a staggering 3400 print combinations possible from a wide variety of fonts, sizes and enhancements. And each one comes with a 2-year limited warranty on parts and labor. (See your dealer for details.)

Panasonic® 1124 and 1180 Dot Matrix Printers. They're everyone else's choice. Shouldn't they be yours, too?

*Printers, Peripherals, Computers, Copiers*
*Typewriters and Facsimiles*

**Panasonic**
Office Automation OA

***Circle 195 on Reader Service Card***

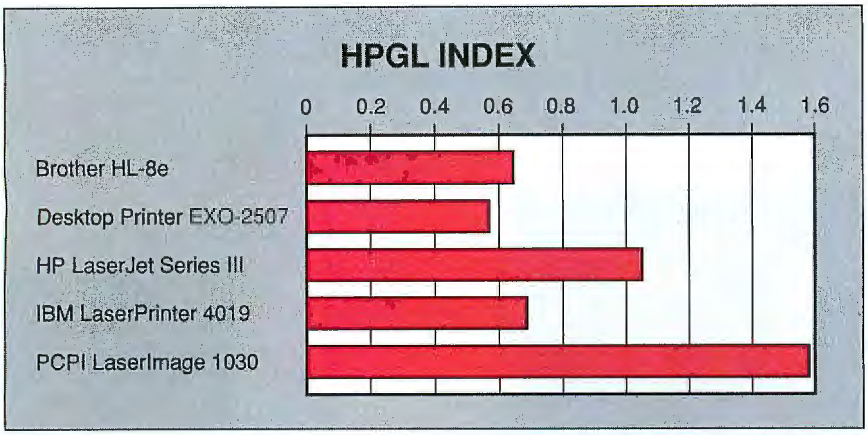


**Figure 4:** *The HPGL Index. Three of the printers support the Hewlett-Packard Graphics Language internally. A fourth, the Desktop Printer EXO-2507, packages software emulation. The LaserJet Series III, driven by HP's latest incarnation of its Printer Control Language (PCL 5), incorporates HPGL commands into its command set. The index is based on the Series III results. Long bars indicate superior performance. The PCPI LaserImage 1030 produced the sharpest plots in record time.*

**The Best of the Laser Line**

In the end, it's awfully hard not to pick an HP printer. Even the old Series II performed admirably on our tests. All the LaserJets are rugged, dependable, and supported like no other printer in the world—and they have a proven track record. The Series III includes 1 MB of RAM, an extended command set (PCL 5), and enhanced resolution—for a surprisingly low list price of $2395. The HP choice may not be too daring, but it's money in the bank.

Mannesman Tally packed some impressive processing power inside the MT 906. If your jobs demand a lot of graphics processing, a fast engine will only be wasted. You'll do better to find a fast processor, and you can't do much better than the MT 906. It also proved rugged for daily print jobs in the lab.

If you're looking for a truly personal laser printer, consider those printers that are based on the Sharp engine. They have an attractive price (all three are under $2000), an exquisitely small footprint, and a compact design destined for a cramped desktop. Of these, we liked the TI microLaser the best.

Most of us thought it would be a long time before laser printer prices dropped. But the wait is already over. Keep an eye out for low street prices. Sooner or later, you'll find a deal you can't refuse. ■

*Stanford Diehl and Stan Wszola are testing editors/engineers for the BYTE Lab. They can be contacted on BIX as "sdiehl" and "stan," respectively.*



 Circle 316 on Reader Service Card

# "So, this punk comes up to me and says, 'Is there anything you won't do for a buck?' And I say, 'Sure. I won't plug in my PC without a Proxima product to protect it.'"


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"When people tell me I take foolish risks, I say to them: 'At least I assess the risks, and I always take steps to protect myself. Do you?'

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*Whether you're operating a home computer or a technical workstation, there's a state-of-the-art Proxima ProLine to match your needs.*

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# PostScript® laser printers used to be expensive, large and shared by the entire office.

# Until now.

# microLaser™ from Texas Instruments: the affordable PostScript printer you can call your own.

Finally, for less than $3,000, you can have a PostScript laser printer right at your desk. TI introduces its new microLaser, with the features you want — now and in the future.

## Small size. Lots of value.

At only 13.4 inches wide and 14.2 inches deep, microLaser may be the small kid on the block, but it packs plenty of punch. This printer takes full advantage of the advanced software that runs on your PC. That's because it uses the Adobe® PostScript printer language and is compatible with the HP LaserJet® Series II — allowing you to switch between them easily. With that kind of flexibility, the six-page-per-minute microLaser is ideal for word processing, spreadsheet and desktop publishing applications.


Because microLaser features the PostScript language, you can print fonts in a variety of typestyles and sizes. Plus, you can print them tall-ways, long-ways, all kinds of ways. You can even print complex pages of integrated text and graphics.

## Capabilities that grow as your needs grow.

One of the best things about microLaser is that you only buy what you need. So if you're not ready for PostScript language, you can buy the standard microLaser for less than $2,000 and add PostScript software and other powerful features later.

You can upgrade microLaser without tools or technicians by simply adding upgrade boards. These boards include up to four 1Mb increments of memory, serial and AppleTalk® interfaces and a PostScript interpreter. All you have to do to get additional fonts or emulations is plug optional microCartridges into two credit card-size slots.

## Superior paper handling.

Part of what makes microLaser a truly personal desktop laser printer that takes up so little room is its paper drawer, which slides *inside*. Because microLaser holds *250 sheets* standard (it holds 500 when you add an optional paper drawer), you spend less time refilling paper and more time creating superb-looking documents.

### New! PostScript printing just got *more* affordable — now only $2,499*

How do you enter the world of PostScript with its high-quality scalable fonts, integrated text and graphics, and broad software support? Buy TI's new microLaser PS17 — the laser printer that offers you more scalable fonts and other features, proving that great things come in small packages.

At just half the footprint of the HP LaserJet III, microLaser PS17 not only offers 17 scalable fonts (LaserJet III offers eight), they're *PostScript* fonts — the industry's standard for high quality. That means more than 4,000 software programs take advantage of microLaser's PostScript font capabilities.

Plus, microLaser PS17 offers the same superior paper handling as other microLaser models, is easily upgradeable and comes at a desktop price.

Why would you consider anything else?

Call TI at 1-800-527-3500 to find out more!

The printer also handles a variety of paper sizes and types — from letter, legal and executive to transparencies, labels and envelopes. For those times when you're facing a large mail merge task, just plug in an optional envelope feeder to easily alternate between letters and envelopes.

## Your own PostScript printer is a call away.

To find out more about how you can have affordable PostScript printing right at your own desk, call TI today.

**1-800-527-3500.**

TEXAS INSTRUMENTS



*Standard microLaser is HP LaserJet II-compatible, prints six pages per minute and comes with .5 Mb of RAM. microLaser PS17 and PS35 have the same features as the standard microLaser, plus an Adobe PostScript interpreter with 17 or 35 typefaces and an extra 1 Mb of RAM.* microLaser is a trademark of Texas Instruments Incorporated. Adobe and PostScript are registered trademarks of Adobe Systems, Inc. LaserJet is a registered trademark of Hewlett-Packard, Inc. AppleTalk and Macintosh are registered trademarks of Apple Computer, Inc. *TI suggested list price for microLaser model PS17.

***Circle 282 on Reader Service Card***

SYSTEM

Corey Sandler

REVIEW

# The New 486s: Are Faster FPUs Enough?

*The Spear Super 486/25U (left) and the Dyna Micro AIR486-C shine in floating-point-intensive applications.*

For several years I commuted into Boston in a beat-up econocar with the pickup of a septuagenarian sloth. When I treated myself to a high-powered, state-of-the-art sports car, my driving time in Boston's infamous traffic did not change. But the new car sure looked good sitting there in its parking space, and every once in a while, I found a place to put the pedal to the metal....

That is also the story with the first round of 25-MHz i486-based computers, including the Spear Super 486/25U and the Dyna Micro AIR486-C. These machines are real screamers compared to a run-of-the-mill 286 system, but in much of today's traffic they are generally just equal to—or worse than—top-end 386s. Most of the potential horsepower of the i486 processor is held hostage by the speed of the CPU clock, the speed of the buses, and the capabilities of today's software.

But these two i486-based systems really shine in performing floating-point-intensive applications, turning in BYTE FPU benchmark indexes that are nearly double the 15.66 index of the ALR FlexCache 33/386 that was used for comparison. These scores are attributable to the integration of a math coprocessor within the i486 chip.

In raw throughput, the 25-MHz i486 performs about 11 million instructions per second, versus about 8 MIPS for a 33-MHz 386 machine. You'll best realize this power in applications such as file server, specialized CAD/CAM, and engineering. In most stand-alone tasks, you'll have a harder time seeing the differences between 25-MHz 486s and 33-MHz 386s. But success in the marketplace for the i486 should bring true 32-bit applications and utilities that will move systems along briskly (see the text box "The i486 at a Glance" on page 163).

## Spear: A Thicket of Cables

The Spear Super 486/25U is an Extended Industry Standard Architecture-bus computer built around a Mylex MBE486 motherboard with a Phoenix BIOS. The test unit did not take advantage of the EISA bus, using AT-compatible cards and disk drives.

Enclosed in a sturdy tower case, the computer includes three disk drive bays accessible from the front and a tight-fitting internal cage that could accommodate two slim hard disk drives. It includes eight available slots, capable of automatically sensing 32-bit EISA peripherals and 16- or 8-bit ISA devices. Memory chips reside on the motherboard; our test unit came with 8 megabytes of 80-nanosecond DRAM.

**Spear Super 486/25U**

**Company**
Spear Technology Holding Co.
968 Hanson Court
Milpitas, CA 95035
(408) 946-6498

**Components**
Processor: 25-MHz Intel i486
Memory: 8 MB of 80-ns DRAM; 128K bytes of BIOS ROM
**Mass storage:** 5¼-inch 1.2-MB Teac floppy disk drive; 3½-inch 1.44-MB Toshiba floppy disk drive; 85-MB 18-ms Imprimis ESDI hard disk drive
**Display:** Eversync MON-300 14-inch multisync monitor; MaxLogic MX-677 VGA card (800- by 600-pixel resolution)
**I/O interfaces:** Two serial ports; one parallel port; eight EISA slots, capable of accepting 8-, 16- or 32-bit peripherals

**Price**
System as reviewed: $7960

**Inquiry 852.**

**Dyna Micro AIR486-C**

**Company**
Dyna Micro, Inc.
30 West Montague Expy.
San Jose, CA 95134
(408) 943-0100

**Components**
Processor: 25-MHz Intel i486; socket for 25-MHz Weitek WTL4167 math coprocessor
Memory: 4 MB of 70-ns DRAM (expandable to a maximum of 16 MB); 128K bytes of BIOS ROM
**Mass storage:** 5¼-inch 1.2-MB Teac floppy disk drive; 3½-inch 1.44-MB Teac floppy disk drive; 170-MB 17-ms MiniScribe ESDI hard disk drive; Western Digital 1007 ESDI disk drive controller
**Display:** Mitsubishi Diamond Scan AUM-1381A 14-inch multisync monitor; MaxLogic MX-677 VGA card; Orchid Technology ProDesigner VGA card
**I/O interfaces:** One parallel port; 9-pin and 25-pin serial ports; game port; one dedicated 32-bit memory card slot; seven 8-/16-bit peripheral slots; DTK 286 Courier I/O II Card

**Price**
System as reviewed: $6995

**Inquiry 853.**

I found the innards of the Spear Super 486/25U rather sloppily assembled. When the computer arrived, it would not recognize the presence of a hard disk drive. I eventually discovered that the cable to the supplied hard disk drive controller had worked its way out of its connector during shipping—a common enough problem and not necessarily the manufacturer's fault. However, a veritable thicket of unmarked cables and power wires wander back and forth under the covers. I had to reach inside and sort them out for myself.

When I called Spear for some advice on the disk drive problem, I learned that the single technician was unavailable at that moment. When I called back, I received courteous—but incorrect—advice to perform a low-level format on the hard disk drive. I found the problem myself by counting and tracing the confusing jumble of cables.

I also had a surprise the first time I pressed the reset button on the front bezel of the machine. The button popped right through the opening and ended up dangling inside the computer. The connector to the LED that indicates disk drive activity was also very loosely attached, and the bolts holding the swing-out support legs on the bottom of the tower were loose. All of these are minor, fixable faults for the experienced computer user. For the less adventurous owner, however, each of the problems could have required a call to technical support or a visit from a repairman.

I tested the Super 486/25U with a range of standard applications software and found no compatibility problems. The machine performed like an ordinary 386. My test suite included WordPerfect 5.1, Lotus 1-2-3 release 3.0, and DOS 3.3. BYTE benchmarks also test compatibility and scores with programs including XyWrite III Plus, Microsoft Word 4.0, Aldus PageMaker, Lotus 1-2-3 release 2.01, Microsoft Excel 2.0, dBASE III Plus, and several CAD programs. The BYTE Lab didn't note any problems.

## Video Vagaries

I did run across an unusual problem, apparently not limited to the Spear machine; it involves the i486 processor, the EISA bus, and certain 16-bit peripherals. I tested a prerelease version of a CompuAdd high-resolution 16-bit VGA card based on Tseng Laboratories chips. The display adapter produced Super VGA images and provided downward compatibility with other graphics modes. Unfortunately, video benchmark scores were disappointingly slow. With the help of CompuAdd and Tseng engineers, I discovered that I had run into an obscure bug apparently related to the design of BIOS or programmable array logic chips on the Mylex motherboard in the Super 486/25U. It treats some—but not all—16-bit peripherals like lowly 8-bit devices. Thus, the speedy Super 486/25U acted like a lunky turbo XT with this particular video card. In the Dyna Micro AIR486-C, the card performed at its top speed and without any problem.

Spear uses a DTC 6280 ESDI controller, manufactured by Data Technology, a division of Qume. The board can control one or two ESDI hard disk drives and one or two floppy disk drives. You can disable the floppy disk drive control section of the card with a jumper if necessary. Spear included in the test machine an 85-MB 18-millisecond Imprimis ESDI hard disk drive, which performed as expected. The standard keyboard is a 101-key soft-touch Key Tronic. The Enter key is a smallish rectangle.

Spear provides a thrown-together collection of manuals, including a Phoenix 386 and 386SX BIOS User Guide, which was adequate, if not exactly appropriate, for the i486 BIOS under the covers.

The tower case was of sturdy construction and included a set of braces at the bottom to prevent its tipping over. I found it difficult, though, to access the internal disk drive bays. Also, the general quality of the plastics and metal was a bit on the crude side. Spear provides a one-year repair-at-manufacturer warranty.

The basic desktop system, including 1 MB of memory, one floppy disk drive, an ESDI or SCSI controller, one parallel and two serial ports, and a 101-key keyboard, sells for $4999. The system as tested, including the 85-MB hard disk

*continued*

# Spear Super 486/25U, Dyna Micro AIR486-C

## APPLICATION-LEVEL PERFORMANCE

Dyna Micro AIR486-C 27.5*

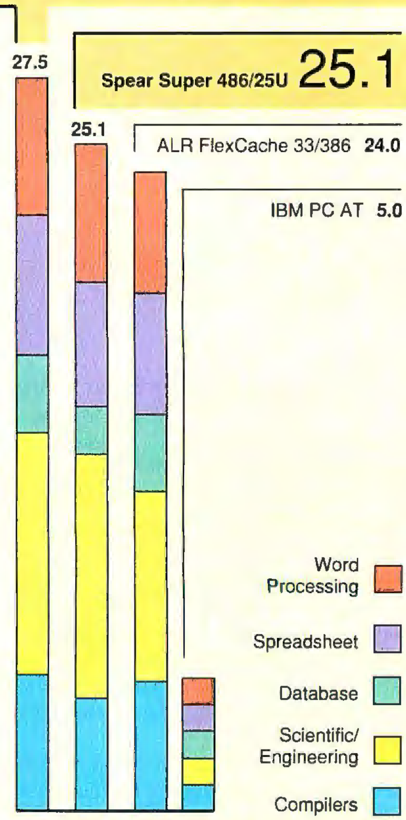
| WORD PROCESSING | Spear | Dyna |
|---|---|---|
| **XyWrite III + 3.52** | **Med./Large** | **Med./Large** |
| Load (large) | :11 | :11 |
| Word count | :01/:06 | :01/:06 |
| Search/replace | :03/:12 | :03/:12 |
| End of document | :01/:07 | :01/:07 |
| Block move | :07/:07 | :07/:07 |
| Spelling check | :03/:08 | :03/:18 |
| **Microsoft Word 4.0** | | |
| Forward delete | :10 | :11 |
| **Aldus PageMaker 1.0a** | | |
| Load document | :06 | :05 |
| Change/bold | :13 | :14 |
| Align right | :10 | :09 |
| Cut 10 pages | :09 | :09 |
| Place graphic | :02 | :02 |
| Print to file | :42 | 1:02 |
| **Index:** | **5.22** | **5.14** |

| SPREADSHEET | Spear | Dyna |
|---|---|---|
| **Lotus 1-2-3 2.01** | | |
| Block copy | :01 | :01 |
| Recalc | :01 | :01 |
| Load Monte Carlo | :08 | :05 |
| Recalc Monte Carlo | :02 | :02 |
| Load rlarge3 | :03 | :01 |
| Recalc rlarge3 | :01 | :01 |
| Recalc Goal-seek | :01 | :01 |
| **Microsoft Excel 2.0** | | |
| Fill right | :03 | :03 |
| Undo fill | :54 | :54 |
| Recalc | :01 | :01 |
| Load rlarge3 | :13 | :11 |
| Recalc rlarge3 | :01 | :01 |
| **Index:** | **4.67** | **5.30** |

| DATABASE | Spear | Dyna |
|---|---|---|
| **dBASE III + 1.1** | | |
| Copy | :51 | :36 |
| Index | :19 | :05 |
| List | 1:04 | :44 |
| Append | 1:27 | 1:28 |
| Delete | :02 | :02 |
| Pack | 1:08 | 1:07 |
| Count | :16 | :03 |
| Sort | 1:10 | :48 |
| **Index:** | **1.75** | **2.92** |

| SCIENTIFIC/ ENGINEERING | Spear | Dyna |
|---|---|---|
| **AutoCAD 2.52** | | |
| Load SoftWest | :20 | :21 |
| Regen SoftWest | :13 | :15 |
| Load StPauls | :05 | :05 |
| Regen StPauls | :03 | :02 |
| Hide/redraw | 3:45 | 3:42 |
| **STATA 1.5** | | |
| Graphics | :10 | :14 |
| ANOVA | :06 | :05 |
| **MathCAD 2.0** | | |
| IFS 800 pts. | :05 | :06 |
| FFT/IFFT 1024 pts. | :05 | :05 |
| **Index:** | **9.18** | **9.07** |

| COMPILERS | Spear | Dyna |
|---|---|---|
| **Microsoft C 5.0** | | |
| XLisp compile | 1:59 | 2:03 |
| **Turbo Pascal 4.0** | | |
| Pascal S compile | :03 | :02 |
| **Index:** | **4.25** | **5.11** |




*Cumulative applications index. Graphs are based on indexes at left and show relative performance.

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT = 1.

## LOW-LEVEL PERFORMANCE[1]

Dyna Micro AIR486-C

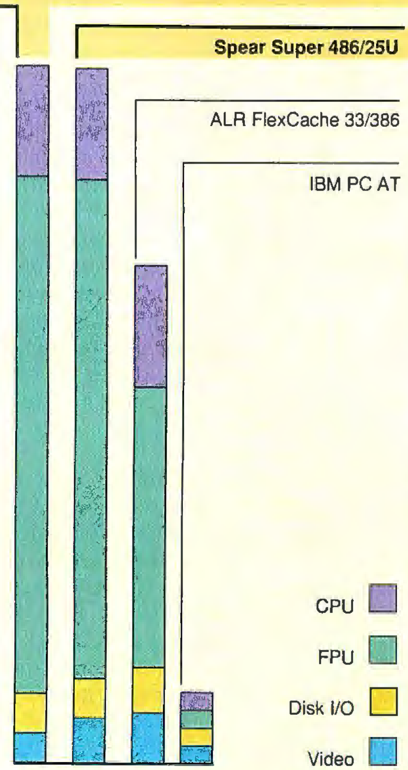
| CPU | Spear | Dyna |
|---|---|---|
| **Matrix** | 1.76 | 1.73 |
| **String Move** | | |
| Byte-wide | 22.41 | 20.78 |
| Word-wide: | | |
| Odd-bnd. | 16.53 | 17.06 |
| Even-bnd. | 11.61 | 12.28 |
| Doubleword-wide: | | |
| Odd-bnd. | 12.85 | 13.52 |
| Even-bnd. | 6.26 | 8.05 |
| **Sieve** | 7.63 | 7.62 |
| **Sort** | 5.77 | 5.77 |
| **Index:** | **6.20** | **6.21** |

| FLOATING POINT[2] | Spear | Dyna |
|---|---|---|
| **Math** | 1.69 | 1.64 |
| Error | | |
| **Sine($x$)** | 0.66 | 0.63 |
| Error | | |
| **$e^x$** | 0.67 | 0.65 |
| Error | | |
| **Index:** | **27.78** | **28.79** |

| DISK I/O | Spear | Dyna |
|---|---|---|
| **Hard Seek[3]** | | |
| Outer track | 3.31 | 3.32 |
| Inner track | 3.33 | 3.35 |
| Half platter | 6.63 | 5.00 |
| Full platter | 8.35 | 9.94 |
| Average | 5.41 | 5.40 |
| **DOS Seek** | | |
| 1-sector | 7.57 | 8.67 |
| 32-sector | 18.41 | 17.93 |
| **File I/O[4]** | | |
| Seek | 0.09 | 0.18 |
| Read | 0.87 | 0.52 |
| Write | 0.75 | 0.91 |
| **1-megabyte** | | |
| Write | 2.97 | 3.04 |
| Read | 4.39 | 2.89 |
| **Index:** | **2.21** | **2.19** |

| VIDEO | Spear | Dyna |
|---|---|---|
| **Text** | | |
| Mode 0 | 3.73 | 5.55 |
| Mode 1 | 3.72 | 5.55 |
| Mode 2 | 3.66 | 5.42 |
| Mode 3 | 3.66 | 5.40 |
| Mode 7 | N/A | N/A |
| **Graphics** | | |
| CGA: | | |
| Mode 4 | 1.45 | 2.42 |
| Mode 5 | 1.45 | 2.40 |
| Mode 6 | 1.54 | 2.49 |
| EGA: | | |
| Mode 13 | 3.17 | 4.27 |
| Mode 14 | 3.41 | 4.56 |
| Mode 15 | N/A | N/A |
| Mode 16 | 3.38 | 4.54 |
| VGA: | | |
| Mode 18 | 3.54 | 4.78 |
| Mode 19 | 1.58 | 2.58 |
| Hercules | N/A | N/A |
| **Index:** | **2.56** | **1.75** |

| CONVENTIONAL BENCHMARKS | Spear | Dyna |
|---|---|---|
| LINPACK | 64.04 | 64.37 |
| Livermore Loops[5] (MFLOPS) | 0.68 | 0.68 |
| Dhrystone (MS C 5.0) (Dhry./sec.) | 13192 | 13192 |




N/A = Not applicable.

[1] All times are in seconds. Figures were generated using the 8088/8086 and 386 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 i486 at a Glance

Intel's i486 processor consists of one chip with three previously discrete components: a main processor, a math coprocessor, and a cache controller with 8K bytes of data cache. The company based the main processor on the 386's architecture, and the math coprocessor is compatible with the 80387DX chip.

Intel borrowed from RISC design to streamline the 386's instruction set for the i486, which maintains downward compatibility with earlier 80xx6 software. The chip contains 1.2 million transistors, more than four times as many as the 386. The purpose of the RAM cache is to reduce the number of idle (wait) states the processor must expend when engaged in repetitive data retrievals. When the CPU requests data, it looks first in the i486's 8K bytes of internal RAM. Static cache RAM can respond in as little as 25 nanoseconds, compared to a 70- to 100-ns response for DRAM. The i486 can also transfer 32 bits of data in one clock cycle, called burst mode—twice the speed of the 386.

According to Intel, the integrated FPU should yield better performance than a 386 chip mated with a separate 80387 coprocessor because of an improved interface and the shorter distance between the elements of the processor.

drive, a VGA controller, and a monitor, sells for $7960 in a tower configuration.

### Dyna Micro: More Polish

The Dyna Micro AIR486-C is a considerably more finished product. Inside the standard desktop case was a model of neatness and organization. Connecting cables were nicely dressed and placed, boards were tightly tied down, and the general level of fit and finish was high.

The AT-bus AIR486-C reigned as the speed champion of the two systems tested, turning in a nearly identical score for CPU performance as the Super 486/25U but gaining a few points in the floating-point and application indexes.

The AIR486-C uses a standard 386-like architecture in a motherboard from AIR. One of the eight slots on the trim (9- by 13-inch) motherboard is given over to the exclusive use of a 32-bit memory board; the card in the test machine had four single in-line memory modules of 1 MB each installed, with room for a total of 16 MB. The remaining seven slots can hold 16- or 8-bit ISA cards.

For some users, one winning point for the AIR board is its socket for the Weitek WTL4167 math coprocessor, a supplement to the FPU on the i486 chip. The WTL4167 is a memory-mapped peripheral. To the i486 and its applications software, it appears to be a segment of memory. (The Spear Super 486/25U does not offer a Weitek socket.) According to Weitek, the chip could boost the floating-point performance by three to five times. But this chip, like the WTL3167 for 386s, is not compatible with instructions written for the Intel coprocessor. Applications must be written specifically to take advantage of the WTL4167's presence. According to Dyna Micro's technical support, several CAD programs and Novell NetWare 386 already support the

*If you absolutely want or need (not the same thing) the latest and greatest technology, these computers are worth considering.*

Weitek extensions to the i486 FPU.

The standard keyboard is a 101-key layout from Maxi-Switch. The soft-touch board includes a large reverse-lily-pad Enter key.

The AIR486-C passed all the tests I threw at it, including the CompuAdd VGA card and other peripheral devices. My software suite and the BYTE Lab tests turned up no anomalies. A test call to technical support produced a quick and accurate response.

The unit as tested, including a hard disk drive and VGA monitor, lists for a competitive $6995. A base unit without the drive or monitor lists for $4995. Dyna Micro, which sells its machines primarily through resellers, also offers the 486 as a tower unit for an additional $150. The company provides a one-year warranty on parts and labor, with service performed at the factory. On-site service contracts from Intel are available as an option. Also, Dyna Micro offers a money-back refund within 30 days of purchase, and an 85 percent credit or refund within 30 to 60 days of purchase, except for special-order items.

### Back to the Benchmarks

The CPU index of the BYTE benchmarks shows that both the Dyna Micro and Spear machines ran an impressive 6.2 times faster than BYTE's baseline 8-MHz AT. But neither machine could beat the 6.74 CPU index of the speedy 33-MHz ALR FlexCache 33/386.

The speed advantage of the i486's integral math coprocessor is obvious. On the floating-point tests, the 486s turned in scores nearly twice as fast as the FlexCache's and an amazing 28 times faster than the AT score.

Most significant for single users are the application results. Again, the FlexCache is the fastest of the lot in traditional tasks, although all the tested machines turned in very speedy results.

The bottom line is this: Both the Spear Super 486/25U and the Dyna Micro AIR486-C work well and prove that the era of the i486 is upon us. If you absolutely want or need (not the same thing) the latest and greatest technology, these computers are worth considering. My preference is the Dyna Micro AIR486-C.

If you are buying a machine for use as a server or for intensive CAD/CAM or engineering work, an i486 should be at the top of your shopping list. However, for many single users, the 25-MHz version of that chip doesn't offer significant improvement over a 33-MHz 386 costing several thousand dollars less. ■

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*Corey Sandler is president of Word Association, Inc., a consortium of high-tech authors based in Holliston, Massachusetts. He has written more than 20 books and is the former editor of several national computer magazines and newspapers. He can be reached on BIX c/o "editors."*


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This AT accelerator board replaces your 80286 with an 80386 clocked at 20 or 25 MHz. It is socketed for 8 Megabytes of 32 bit RAM, an 80387, Cyrix CX83D87, or Weitek 3167 and a 64K SRAM cache. The numeric performance of the Number Smasher 386/25 is a strong function of your application and the coprocessor you choose. The 25 MHz NDP Fortran-386 driven Whetstones are 2.1, 3.7 and 5.5 MegaWhetstones running on the 80387, CX83D87 and 3167.

**Number Smasher 486/25 Numeric Performance**

| | 486 | 4167 |
|---|---|---|
| Megawhetstones | 5.9 | 13.0 |
| Megawhetscales | 4.1 | 9.9 |



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Bill Catchings and Mark L. Van Name

REVIEW

# Power Servers

*The Zenith Z-386/33E (left) and the Storage Dimensions FileMaster II.*

Until recently, LAN servers were just big, fast PCs. System vendors didn't design machines specifically as file servers. No longer; today, vendor after vendor is announcing systems with special features aimed at the LAN server market.

We looked at two such systems, Storage Dimensions' FileMaster II and Zenith's Z-386/33E. You could use both systems as single-user DOS PCs, but they're clearly meant to be file servers, so that's how we tested them. They also offer similar performance, although they achieve that performance in very different ways.

The FileMaster II is a slightly modified Everex Step 386/33. (Everex markets the same basic machine as the StepServer.) Like all the Everex Step systems to date, the FileMaster II uses the standard AT bus and Everex's proprietary cache controller. But rather than a traditional PC modified-frequency-modulation or ESDI hard disk drive, the FileMaster II uses a SCSI disk subsystem.

The $11,599 base system comes with a 33-MHz 386 processor, a socket that can hold either a 33-MHz 80387 or a Weitek WTL3167 math coprocessor, 4 megabytes of memory, 64K bytes of static RAM (SRAM) cache, a 5¼-inch 1.2-MB Teac floppy disk drive, a 150-MB SCSI Maxtor hard disk drive, two serial ports, two parallel ports, a monochrome video adapter and monitor, MS-DOS 3.3, and a NetWare utilities disk. Our evaluation unit was the FileMaster II, which contains a second 150-MB hard disk drive and sells for $11,999.

Instead of the AT bus, the Zenith Z-386/33E has a 32-bit Extended Industry Standard Architecture (EISA) bus. The Z-386/33E's disk subsystem uses an ESDI drive, but with a new Zenith bus-master caching disk drive controller.

The $11,999 base system includes a 33-MHz 386 CPU, a socket for a 33-MHz 80387 math coprocessor, a socket for a Weitek WTL3167 math coprocessor, 4 MB of memory, 16K bytes of SRAM cache, a 3½-inch 1.44-MB floppy disk drive, a 150-MB ESDI hard disk drive, two serial ports, one parallel port, a VGA video adapter, MS-DOS 4.0 (3.30 on our unit), and Microsoft Windows/386 3.0. Our evaluation unit also included an optional Zenith ZCM1492 FTM (Flat Tension Mask) color monitor ($999) and an extra 4 MB of memory ($499 each), for a total price of $14,994.

To make the systems comparable, we'd need to replace the FTM monitor on the Zenith system with a ZVM1470 monochrome monitor ($299). Such a system would cost $12,298, $699 more than a FileMaster II.

## Performance

To see how these two systems would fare as file servers, we loaded them with vanilla copies of NetWare 386. We then copied 4.3 MB of files of all different sizes from LAN clients to the server and back. We tested each server with first one workstation and then four workstations running the test simultaneously. We timed the copying on our fastest client system, an ALR FlexCache 25386 with an 18-millisecond ESDI hard disk drive. Testing with only four workstations might not sound like much, but four workstations that are each sending over 4 MB of data back and forth over the network as fast as possible represents as much data movement as many more workstations doing the occasional disk accesses more typical of real work.

To help put these two servers in perspective, we also timed the test on the ALR system alone, copying to and from its hard disk drive. We also ran the tests on two other servers. To represent a low end typical of what many people are using today, we used a 16-MHz 386 Samsung system that had 4 MB of memory and a smart disk drive controller, and we ran NetWare 286 on it. As the keeper of the high-end flame, we used a Compaq Systempro that had two 33-MHz 386 CPUs, 12 MB of memory, and Compaq's Intelligent Drive Away disk subsystem, and we ran NetWare 386 on it.

We let the vendors supply the Ethernet board of their choice. Zenith furnished a Novell NE3200, which is a bus-master EISA board with its own 80186 processor. Storage Dimensions sent a CNet Technology CN100E board, a dumb 8-bit board compatible with Novell's NE1000. (In the Systempro we used the Novell NE3200; in the Samsung we used an 8-bit Western Digital WD8003.)

Storage Dimensions didn't have ready a final version of its NetWare 386 driver for the FileMaster II's SCSI disk drives (although NetWare 286 ran fine), so we had to use a beta version of that driver. We completed the NetWare 386 tests with that driver, but we had to halve the FileMaster II's bus speed to 8 MHz and add one wait state (with a jumper) to the disk drive controller. When the company finishes its NetWare 386 SCSI drivers, the FileMaster II's performance might improve—how much is anybody's guess.

The four servers performed as you would expect: The Systempro won, the Samsung brought up the rear, and the EISA-bus Z-386/33E beat the AT-bus FileMaster II (see the table on page 168). The FlexCache took 76 seconds to run the test on its own hard disk drive, so the

*continued*

**FileMaster II**

**Company**
Storage Dimensions
2145 Hamilton Ave.
San Jose, CA 95125
(408) 879-0300

**Components**
**Processor:** 33-MHz Intel 386 with a socket for a 33-MHz Intel 80387 or a 33-MHz Weitek WTL3167 math coprocessor
**Memory:** 4 MB of 80-ns DRAM; 64K-byte cache of 20-ns SRAM
**Mass storage:** 5¼-inch 1.2-MB Teac floppy disk drive; two 150-MB 14-ns full-height Maxtor SCSI hard disk drives
**Display:** Everex EverVision MN-100 monochrome monitor
**Keyboard:** 101-key modified IBM Enhanced AT keyboard layout
**I/O interfaces:** One 9-pin and one 25-pin serial port; two 25-pin parallel ports; six 16-bit and two 8-bit AT-style expansion slots

**Price**
System as reviewed: $11,999

**Inquiry 854.**

**Z-386/33E**

**Company**
Zenith Data Systems
1501 Feehanville Dr.
Mount Prospect, IL 60056
(800) 553-0331

**Components**
**Processor:** 33-MHz Intel 386 with a socket for a 33-MHz Intel 80387 and a socket for a 33-MHz Weitek WTL3167 math coprocessor
**Memory:** 8 MB of 80-ns DRAM; 16K-byte cache of 15-ns SRAM
**Mass storage:** 3½-inch 1.44-MB Sony floppy disk drive; 150-MB 16-ms half-height Imprimis ESDI hard disk drive
**Display:** Zenith FTM color VGA monitor
**Keyboard:** 101-key modified IBM Enhanced AT keyboard layout
**I/O interfaces:** Two 9-pin serial ports; one 25-pin parallel port; six 32-bit EISA expansion slots

**Price**
System as reviewed: $14,994

**Inquiry 855.**

### FILE SERVER THROUGHPUT TEST

*Our file server test reads and writes a group of files of varying sizes totaling 4.3 MB to each server. The baseline is the time to run the same test on our ALR FlexCache 25386's local hard disk drive. Server performance degrades as loading increases, but the Z-386/33E proved slightly more robust than the FileMaster II. Times for the Samsung and Systempro aren't directly comparable; we include them as reference points only. (All times in seconds.)*

| System | One user | Four users | % degradation |
|---|---|---|---|
| ALR baseline server | 76 | N/A | N/A |
| Samsung | 120 | 242 | 102 |
| Storage Dimensions FileMaster II | 80 | 113 | 41 |
| Zenith Z-386/33E | 73 | 99 | 36 |
| Compaq Systempro | 63 | 76 | 21 |

N/A = Not applicable.

Zenith and Systempro servers actually gave better file transfer performance over a LAN than the FlexCache on its own ESDI hard disk drive. With all four workstations running the test, all the servers slowed down, but they stayed in the same order. While the Z-386/33E beat the FileMaster II, the margin of victory was not great on either test: about 9 percent on the single-workstation test, and about 14 percent on the four-workstation run.

Perhaps a more interesting result, however, is the percentage by which the performance of these two servers degraded from the one-workstation test to the four-workstation test. The FileMaster II got 41 percent slower, while the Z-386/33E slowed by 36 percent. Based largely on the disk architectures of these two systems, we expect that this gap would widen with more users.

These tests do not necessarily represent file transfer activity in a specific real-world application. They do, however, provide a general reference point for overall performance differences.

The BYTE benchmarks for the Z-386/33E and the FileMaster II show that, as a single-user system, neither machine is outstanding. The Z-386/33E still beats the FileMaster II on the overall application index (20.4 versus 17.3), but both of them lose to the 33-MHz FlexCache.

## Moving the Bytes

The keys to these systems' strong server performances are their disk subsystems. While Zenith's EISA Mass-Storage Controller consumes only one slot, it's actually three boards linked by stand-offs and edge connectors. The combination sports over 200 chips, including the Intel NG82355 Bus Master Interface Chip application-specific integrated circuit (ASIC). The controller can act as an EISA bus master, so it can take control of the system's bus to speed DMA transfers and avoid tying up the CPU. It also has a 1-MB cache that came in four 256K-byte single in-line memory modules, each of which contained two 256K-byte DRAM chips. You can expand that cache to 4 MB with 1-MB SIMMs.

This controller can support up to four ESDI hard disk drives and up to seven SCSI hard disk drives, as well as up to two floppy disk drives. Based on a controller by Data Technology, the board also has some Zenith-proprietary modifications for *position-sensing*, a technique that lets the controller know how close each drive's heads are to the desired disk data, information that lets the controller minimize head movement. The card was clearly new, with about 30 wires running all over the three boards. A Zenith spokesperson said that the firm plans to come out with a new version of the controller that fits on two boards and eliminates these wires. Our Z-386/33E's hard disk drive was a half-height Imprimis 150-MB ESDI drive with a 16-ms average access time, but Zenith uses similar drives from other vendors as well.

Compared to the Z-386/33E's EISA bus and caching disk drive controller, the FileMaster II seemed almost mundane. Its SCSI controller was an 8-bit card on the system's AT bus. That bus, unlike the bus in normal Everex Step 386/33 systems, can run at 16.5 MHz, but otherwise it's a standard AT bus. The hard disk drive was a full-height, 150-MB 14-ms drive from Maxtor, Storage Dimensions' parent company.

## CPU and Memory

Aside from the bus and disk drive controllers, these two systems aren't all that different. The FileMaster II supports its 33-MHz 386 CPU with the standard Everex proprietary cache system, which grows as you add memory. The memory

*continued*

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# Zenith Z-386/33E, SD FileMaster II

## APPLICATION-LEVEL PERFORMANCE

| WORD PROCESSING | Zenith | SD |
|---|---|---|
| **XyWrite III+ 3.52** | **Med./Large** | **Med./Large** |
| Load (large) | :10 | :11 |
| Word count | :01/:10 | :01/:09 |
| Search/replace | :03/:12 | :02/:12 |
| End of document | :01/:08 | :01/:07 |
| Block move | :08/:08 | :02/:02 |
| Spelling check | :04/:28 | :04/:28 |
| **Microsoft Word 4.0** | | |
| Forward delete | :08 | :10 |
| **Aldus PageMaker 1.0a** | | |
| Load document | :07 | :07 |
| Change/bold | :13 | :14 |
| Align right | :10 | :11 |
| Cut 10 pages | :09 | :11 |
| Place graphic | :02 | :03 |
| Print to file | :57 | 1:09 |
| **Index:** | **4.73** | **5.32** |

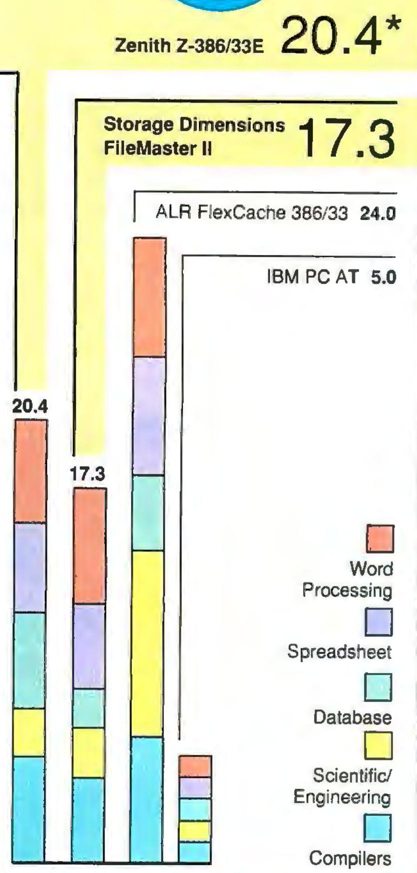
| SPREADSHEET | Zenith | SD |
|---|---|---|
| **Lotus 1-2-3 2.01** | | |
| Block copy | :02 | :02 |
| Recalc | :01 | :01 |
| Load Monte Carlo | :08 | :14 |
| Recalc Monte Carlo | :03 | :03 |
| Load rlarge3 | :02 | :04 |
| Recalc rlarge3 | :01 | :01 |
| Recalc Goal-seek | :02 | :02 |
| **Microsoft Excel 2.0** | | |
| Fill right | :03 | :03 |
| Undo fill | 1:07 | :52 |
| Recalc | :01 | :01 |
| Load rlarge3 | :12 | :14 |
| Recalc rlarge3 | :01 | :01 |
| **Index:** | **4.17** | **3.93** |

| DATABASE | Zenith | SD |
|---|---|---|
| **dBASE III+ 1.1** | | |
| Copy | :18 | :43 |
| Index | :06 | :18 |
| List | :29 | :56 |
| Append | :39 | 1:33 |
| Delete | :01 | :02 |
| Pack | :28 | 1:13 |
| Count | :04 | :16 |
| Sort | :39 | 1:09 |
| **Index:** | **4.38** | **1.80** |

| SCIENTIFIC/ENGINEERING | Zenith | SD |
|---|---|---|
| **AutoCAD 2.52** | | |
| Load SoftWest | 1:04 | 1:03 |
| Regen SoftWest | :58 | :55 |
| Load StPauls | :18 | :20 |
| Regen StPauls | :16 | :16 |
| Hide/redraw | 13:15 | 13:12 |
| **STATA 1.5** | | |
| Graphics | :28 | :24 |
| ANOVA | :16 | :16 |
| **MathCAD 2.0** | | |
| IFS 800 pts. | :31 | :30 |
| FFT/IFFT 1024 pts. | :38 | :36 |
| **Index:** | **2.23** | **2.28** |

| COMPILERS | Zenith | SD |
|---|---|---|
| **Microsoft C 5.0** | | |
| XLisp compile | 1:56 | 2:17 |
| **Turbo Pascal 4.0** | | |
| Pascal S compile | :02 | :03 |
| **Index:** | **4.91** | **3.96** |

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.




*Cumulative application index. Graphs are based on indexes at left and show relative performance.

## LOW-LEVEL PERFORMANCE[1]

| CPU | Zenith | SD |
|---|---|---|
| **Matrix** | 2.00 | 1.97 |
| **String Move** | | |
| Byte-wide | 22.72 | 12.05 |
| Word-wide: | | |
| Odd-bnd. | 17.06 | 15.05 |
| Even-bnd. | 11.35 | 6.04 |
| Doubleword-wide: | | |
| Odd-bnd. | 12.16 | 12.03 |
| Even-bnd. | 5.71 | 3.02 |
| **Sieve** | 10.43 | 10.43 |
| **Sort** | 8.22 | 7.91 |
| **Index:** | **5.41** | **6.88** |

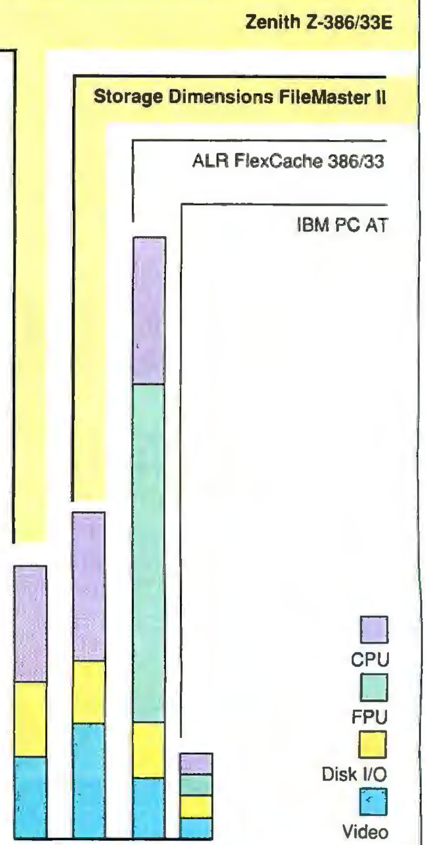
| FLOATING POINT[2] | Zenith | SD |
|---|---|---|
| **Math** | N/A | N/A |
| Error | | |
| **Sine(*x*)** | N/A | N/A |
| Error | | |
| **$e^x$** | N/A | N/A |
| Error | | |
| **Index:** | **N/A** | **N/A** |

| DISK I/O | Zenith | SD |
|---|---|---|
| **Hard Seek[3]** | | |
| Outer track | N/A | N/A |
| Inner track | N/A | N/A |
| Half platter | N/A | N/A |
| Full platter | N/A | N/A |
| Average | N/A | N/A |
| **DOS Seek** | | |
| 1-sector | N/A | N/A |
| 32-sector | N/A | N/A |
| **File I/O[4]** | | |
| Seek | 0.07 | 0.02 |
| Read | 0.19 | 0.90 |
| Write | 0.60 | 0.86 |
| **1-megabyte** | | |
| Write | 3.42 | 2.84 |
| Read | 2.88 | 4.19 |
| **Index:** | **3.46** | **2.92** |

| VIDEO | Zenith | SD |
|---|---|---|
| **Text** | | |
| Mode 0 | 2.48 | N/A |
| Mode 1 | 2.47 | N/A |
| Mode 2 | 1.98 | N/A |
| Mode 3 | 1.92 | N/A |
| Mode 7 | N/A | 2.28 |
| **Graphics** | | |
| CGA: | | |
| Mode 4 | 1.05 | N/A |
| Mode 5 | 1.04 | N/A |
| Mode 6 | 0.99 | N/A |
| EGA: | | |
| Mode 13 | 2.64 | N/A |
| Mode 14 | 2.58 | N/A |
| Mode 15 | N/A | N/A |
| Mode 16 | 2.54 | N/A |
| VGA: | | |
| Mode 18 | 2.64 | N/A |
| Mode 19 | 0.94 | N/A |
| Hercules | N/A | 0.88 |
| **Index:** | **3.85** | **5.42** |

| CONVENTIONAL BENCHMARKS | Zenith | SD |
|---|---|---|
| LINPACK | 929.94 | 918.02 |
| Livermore Loops[5] (MFLOPS) | 0.0227 | 0.0230 |
| Dhrystone (MS C 5.0) (Dhry./sec.) | 10845 | 11520 |

SD = Storage Dimensions.
N/A = Not applicable. Seek times were omitted in the low-level disk tests due to inaccuracies associated with SCSI devices.
[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.

is interleaved to further improve performance. Memory comes in small boards that connect like SIMMs. Each board holds 4 MB in 36 1-megabit 80-nanosecond chips, and accompanying each one is a cache card of the same size. Each cache card contains 64K bytes of 20-ns SRAM. Memory upgrades come in similar pairs. You can have up to four such pairs in the system, for a maximum of 16 MB and a total cache of 256K bytes.

The rest of the 12- by 14-inch motherboard is relatively boring, with few surface-mounted ICs and ASICs. One notable ASIC is the Chips & Technologies 82C206 Integrated Peripheral Controller, which is common in AT-bus systems.

The Z-386/33E's slightly smaller motherboard uses numerous surface-mounted ICs. It has few ASICs, although four are notable: two from Zenith and two from Intel (an NG82357 integrated system peripherals chip and an NG82358 EISA bus controller).

The Z-386/33E also eschews a standard cache controller in favor of a proprietary Zenith cache system that has 16K bytes of 15-ns SRAM in a special card slot. A 64K-byte version of that cache is also available. Eight SIMM slots hold the memory, which can come in 1- or 4-MB SIMMs of 80-ns chips. The first four slots can handle only 1-MB SIMMs, so the maximum system memory is 20 MB.

## Expansion

The Z-386/33E also has plenty of room to add disk drives. Its single half-height hard disk drive and the floppy disk drive leave one full-height and two half-height bays open. The system starts with a lot of EISA expansion slots (six), but the disk drive controller, VGA card, and LAN adapter fill three of those slots, so only three are open.

The FileMaster II has less drive expansion room but more open slots. The standard system's floppy disk drive and full-height hard disk drive leave only one full-height bay open. There are, however, eight expansion slots—six 16-bit and two 8-bit. The video, disk, I/O, and LAN cards fill four, leaving four free.

## The Incidentals

Except for support, the rest of these two systems is almost incidental. They have similar 101-key keyboards that follow the IBM Enhanced AT keyboard layout. Documentation on both systems was adequate, although Zenith's was generally more thorough.

Service, on the other hand, is important, especially for a network server. The FileMaster II comes with a one-year on-site service contract with General Electric. Zenith offers either one year of carry-in service from your dealer or three months of on-site service from its Zenith Data Systems Service Network.

It's not easy to choose between these systems. Each will boost your network performance, but the Z-386/33E offers slightly better performance and less degradation under load. We're a little leery of the many last-minute changes to the Zenith system's motherboard and hard disk drive controller, but we experienced no problems with the machine. Forced to choose between the two systems, we'd go with the Zenith Z-386/33E, but it would be a close call. ■

*Bill Catchings and Mark L. Van Name are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "wbc3" and "mvanname," respectively.*

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Ben Smith

REVIEW

# Personal Iris: The Dream Maker

*The Silicon Graphics Personal Iris Turbo workstation. I created the BYTE logo shown on-screen as a 3-D object. The Iris can set the logo in motion, recalculating and redrawing every polygon in real time.*

**Personal Iris Model 4D/25 Turbo**

**Company**
Silicon Graphics Computer Systems
2011 North Shoreline Blvd.
P.O. Box 7311
Mountain View, CA 94039
(415) 960-1980

**Components**
**Processor:** 20-MHz MIPS R3000 RISC processor; R3010 FPU
**Memory:** 8-MB RAM; 96K-byte cache
**Mass storage:** 380-MB SCSI hard disk drive; 150-MB cartridge tape drive
**Display:** 19-inch, 1280- by 1024-pixel; 16.7 million (24 bits) simultaneously displayable colors
**Keyboard:** 101-key IBM AT style
**I/O interfaces:** Two serial ports; one parallel port; SCSI port; Ethernet port; video and audio ports

**Software**
Irix (Unix System V release 3.2); WorkSpace environment manager; 4-Sight windowing system; X Window System version 11; NeWS graphical environment; Alias QuickModel and QuickPaint; Wavefront Personal Visualizer; a host of 2-D and 3-D graphical demos and source code

**Price**
System as reviewed: $32,500

**Inquiry 856.**

Any designer, whether an architect, engineer, planner, or graphic artist, needs to visualize a design while creating it. Rare individuals in this group can generate solid models in their minds. The mental models are so real for these people that they can rotate them, move into them, and investigate the details. But, unfortunately, these imaginings are not easily communicated to others. Wouldn't it be wonderful to display the models on a computer with as much detail and flexibility as in the mind?

That is just what the Silicon Graphics Personal Iris workstations are designed to do, and the new Turbo model does it very fast. It does it so well, in fact, that IBM has selected the same graphics hardware for use in its RISC System/6000 high-end workstations.

## Thoughtful Package

Inside its simply designed chocolate-brown case, the Personal Iris Model 4D/25 sports a 20-MHz MIPS R3000 processor with the accompanying FPU. Add to that a 32K-byte data cache and a 64K-byte instruction cache, and you have a serious number cruncher. Feed those numbers into the famous Silicon Graphics specialized display-processing pipeline with the Turbo Graphics option, and you have a machine that can produce real-time animation of solid objects. All this power is contained in a squat tower, with concealment panels to hide the cables in the back and the floppy disk drives and tape drives in the front.

Disk and cartridge tape drives slide in and out of the chassis without tools, so changing system drives is no more difficult than changing tape cartridges. Similarly, changing the electronics assembly requires no expertise or tools: Slide off a plastic panel and remove one screw. The entire circuit cage lifts right out. The system upgrade kits we received included instructions for user installation, all the necessary tools (like a screwdriver for removing that one screw), and grounding straps to protect electronic components while you handle them.

The standard input devices are an AT-style keyboard and an optical mouse. You can add an optional digitizing tablet and a three-dimensional input control called a SpaceBall. The system has two serial ports, a parallel port, an Ethernet port, a SCSI port, and an array of special-purpose connectors for video-recording equipment.

## Will It Run DOS?

Despite its size and shape, this machine is far from a PC. It *will* emulate MS-

DOS, but even the most complex DOS program would seem wimpy compared to any native Iris application.

The underlying operating system, Irix, is, as you might guess, an enhanced Unix. All your standard System V release 3.2 utilities and libraries are there, along with some BSD enhancements for interprocess communications and networking. Silicon Graphics has added a rich window manager, along with graphics and window programming libraries. You can also use X Window System, NeWS, and PHIGS graphics. All these window and graphics systems run under the supervision of the Irix window manager. Therefore, if you click on a PostScript file, the Iris creates an appropriate window in which to view it.

## Getting It All on Paper

No one can fault Silicon Graphics for failing to adequately document its system and software. There are 21 binders in all, but some of them hold two or three submanuals. Of these, several are devoted to Irix and are mostly reprints of traditional AT&T and Berkeley documentation. Several more cover the graphics extensions and the mountain of demonstration, executable, and source code shipped with the Iris. The overall quality and readability of the documentation is up to normal Unix standards, and the binder labels and section tabs make it somewhat easier to spot your topic of interest from among the thousands of pages.

Four user's manuals—those covering the bundled applications from Alias Research and Wavefront, and Silicon Graphics' own Personal Iris User's Guide—stand apart from the rest. Using them together, you can quickly become familiar with the Iris and its capabilities, without having to open any of the other 20 binders. Each has a "getting started" section, and this group of documents is custom-made for impatient users who can't wait to set their teapots to spinning. On-line manuals round out the set. These include virtually all reference pages, except for demonstration programs and the bundled applications.

## Performance

The Iris Model 4D/25 that I reviewed had 8 megabytes of RAM, 96K bytes of cache memory, a 380-MB SCSI hard disk drive, and an internal tape drive. CPU, disk, and floating-point performance, as tested by the BYTE Unix benchmarks, make the system competitive with other workstations in its price range.

continued

## Silicon Graphics Personal Iris Turbo

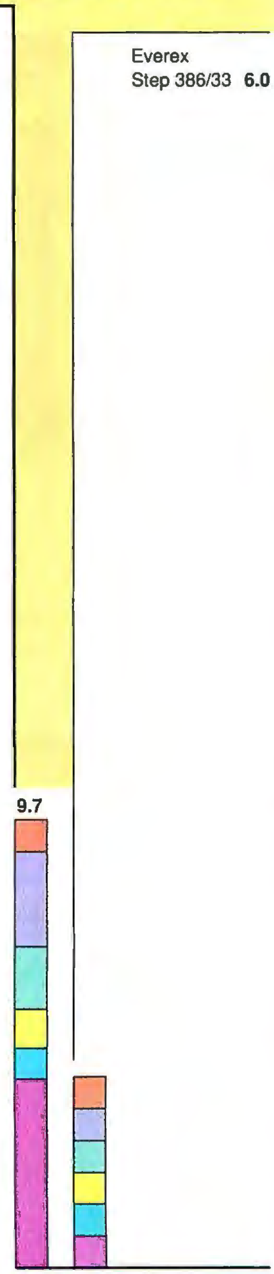
Silicon Graphics Personal Iris Turbo 9.7*

### HIGH-LEVEL PERFORMANCE

| | Iris Time | Iris Index | Everex Time |
|---|---|---|---|
| C Compiler | 2.18 | 0.95 | 2.08 |
| DC Arithmetic | 0.21 | 3.00 | 0.63 |
| Tower of Hanoi (17-disk problem) | 0.30 | 1.87 | 0.56 |
| **System Loading**[1] | | | |
| 1 concurrent background process | 3.31 | 1.23 | 4.06 |
| 2 concurrent background processes | 4.00 | 1.45 | 5.80 |
| 4 concurrent background processes | 7.19 | 1.34 | 9.60 |
| 8 concurrent background processes | 11.50 | 1.50 | 17.30 |

### LOW-LEVEL PERFORMANCE

| | Iris Time | Iris Index | Everex Time |
|---|---|---|---|
| **Dhrystone 2** (without registers; Dhry./sec.) | 13454 | 0.97 | 13847 |
| **Arithmetic** (10,000 iterations) | | | |
| Arithmetic overhead | 0.20 | 3.60 | 0.72 |
| Register | 2.90 | 1.01 | 2.92 |
| Short | 2.92 | 1.21 | 3.52 |
| Integer | 2.90 | 1.08 | 3.12 |
| Long | 2.90 | 1.08 | 3.12 |
| Floating Point | 2.02 | 5.90 | 11.92 |
| Double | 1.70 | 7.78 | 13.22 |
| **Throughput** | | | |
| System call overhead (5 x 4000 calls) | 0.62 | 1.77 | 1.10 |
| Pipe throughput (read and write 2048- × 512-byte blocks) | 0.45 | 2.04 | 0.92 |
| Pipe-based context switching (2 × 500 switches) | 0.21 | 3.00 | 0.63 |
| Process creation (100 forks) | 0.55 | 2.24 | 1.23 |
| Excel throughput (100 execs) | 0.82 | 4.18 | 3.43 |
| **Filesystem throughput** (1600 1024-byte blocks in Kbytes/sec.) | | | |
| Read | 564 | | |
| Write | 564 | | |
| Copy | 330 | | |




* Cumulative index is formed by summing the indexed performance results for C Compiler, DC Arithmetic, Tower of Hanoi, System Loading (with eight concurrent background processes), Dhrystone 2, and Floating Point tests.

[1] System loading performed using Bourne shell scripts and Unix utilities.

**Note:** All results are in seconds, unless otherwise specified. Indexes show relative performance. For all indexes, an Everex Step 386/33 running Xenix 2.3.1 = 1.

C Compiler
DC Arithmetic
Tower of Hanoi
System Loading
Dhrystone 2
Floating Point

For a description of all the benchmarks, see "The BYTE Unix Benchmarks," March BYTE.

The benchmarks don't measure the most impressive aspect of the Personal Iris: its graphics performance. According to Silicon Graphics, the 4D/25 Turbo will manipulate 200,000 3-D vectors in a second, or 20,000 polygons per second. These numbers have little meaning out of context, so consider the model in photo 1. Iris renders this model, with over 1000 3-D polygons, smooth shading, and multiple light sources, so quickly that it simulates smooth motion by redrawing the entire model in a slightly different position several times a second.

**Photo 1:** *As rendered here, the Silicon Graphics logo contains roughly 1400 polygons. With solid surfaces, remote and local lighting, calculations of spectral characteristics of surface, and full color rendering, this object can rotate and move in real time. The animation is smooth and convincingly real.*

## Put On a Simple Face

The Irix operating system comes with its own window manager, icon-based file manager, and editor, as well as several handy graphics applications, including Alias's QuickModel and QuickPaint and a robust renderer from Wavefront, the Personal Visualizer.

The Irix window system is partly embedded in the operating system instead of built on top of it like Motif. The window manager, 4-Sight, is good compared to what was available a few years ago, but it seems a little archaic when compared to Motif and Open Look. Repositioning overlapping windows, for instance, can turn areas of the screen to mush for several seconds until the window manager cleans things up. Selecting options from cascaded menus requires a delicate hand on the mouse, because there is no way to freeze a menu on the screen while you move to the next level. You must keep the mouse button pressed while you carefully maneuver through the hierarchy of menus.

The icon-based file manager operations are intuitive. As with many other systems, double-clicking on a file icon starts up the application program associated with the icon. Dragging an icon to the dumpster gets the associated file out of the way. Dragging an icon from one directory window (or folder) to another moves the file.

The Irix file manager also manages the WorkSpace, a virtual directory to which you can drag file icons. Instead of moving the file from the directory to the WorkSpace (the action associated with dragging an icon from one directory window to another), the file manager creates a virtual link of the file between the directory and the WorkSpace. I'm familiar with the structure of the Unix file system, and I had trouble understanding how the WorkSpace worked. It may be a gentle approach to file management for those unfamiliar with the subject, but sooner or later they will have to learn the way things are done for real.

The window-based editor, Jot, is probably all that any nonprogrammer will ever need for editing; it is easy to use and has enough features to continue to satisfy users even after they learn its basic capabilities.

QuickModel and QuickPaint are also easy to learn. You can use QuickModel to create 3-D models, and QuickPaint to create 2-D paintings. Then you can use the output from these programs as elements for Wavefront's Personal Visualizer, the full-featured rendering application. QuickModel is an excellent way to become familiar with the 3-D capabilities of the Iris. You can build complex models by creating and manipulating wire frames in three orthographic views and a simultaneous perspective view.

QuickModel gives you basic solid forms—a box, a sphere, and a cone—with which to build. You take each of these shapes as needed and mold them to create your model. You can also generate surfaces by extending and rotating Bézier curves. You can manipulate your perspective viewpoint as you work on the shape. At any point during the design, you can render the model with flat or smooth (Gouraud) shading, color, and local lights, and you can rotate it and zoom in on it for a close inspection (see photo 2).

The documentation provided by Alias and Wavefront for their applications is very good, as far as it goes. These programs are not demos in the conventional sense of the word, but they are running advertisements for higher-level products

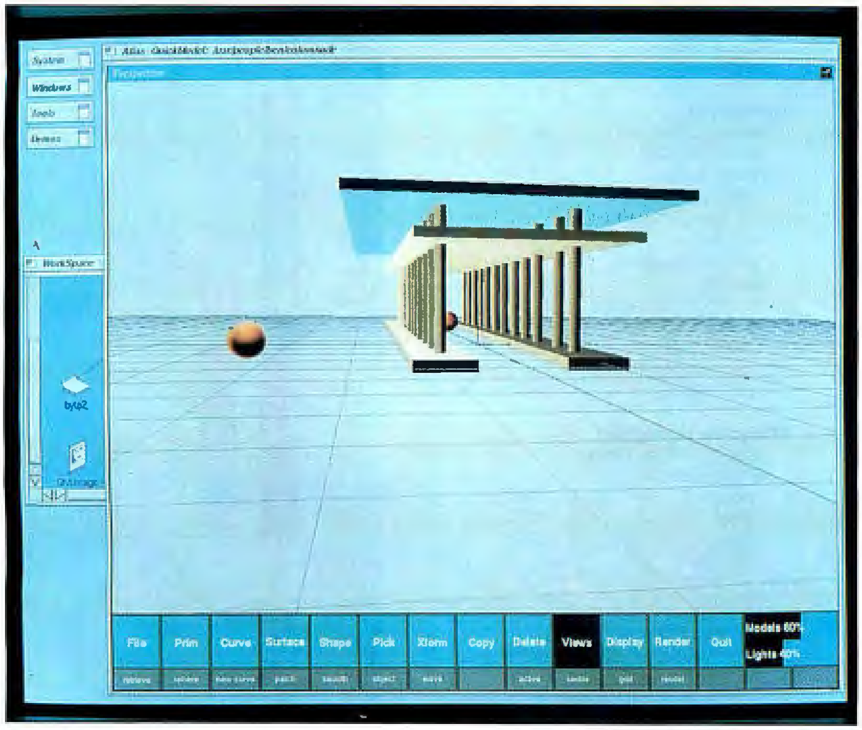



**Photo 2:** *QuickModel allows you to create models with additive 3-D geometric forms in orthographic views. You can then view them in perspective and export your views to Wavefront's Personal Visualizer, a full rendering program.*

Neon Sculpture by
Lili Lakich
Los Angeles, California

Seagate's Technology

# THE FINE ART OF DISC DRIVES

To the naked eye, disc drives haven't changed much in the past few years. While the visible aspects have remained the same, the parts you can't see have improved dramatically. What used to be megabytes are now gigabytes. And Seagate is at the forefront of this technological revolution.

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As a result of these and other technological improvements, Seagate now offers drives from 20 MB to 2.5 GB in the widest range of form factors and interfaces imaginable, for almost every conceivable application. And we're not through yet.

Like the artist who spends years perfecting his craft, Seagate has spent the past decade mastering the fine art of disc drives. To get a first-hand look at the state-of-the-art, contact your authorized Seagate distributor, or call Seagate directly: 800-468-DISC, or 408-438-6550.

Seagate

offered by both companies. I'm always pleased when a hardware vendor includes free software of any kind, and Silicon Graphics distinguishes itself by providing tons of it.

### The BYTE Logo Project

To better understand the graphics hardware and the software libraries that facilitate its use, I wrote a C program to generate the solid-form BYTE logo shown in the photo on page 174. You can rotate or translate the object or your viewpoint using the mouse. You can even send the model into a tumbling spin.

The logo model is generated from four tables of 2-D data points. Each table describes the edges of a single letter in the word "BYTE." Two rather lengthy and boring functions use these tables differently to describe the polygons that make the faces of the logo and the polygons that make the edges.

The largest part of the time needed for the project was spent in mathematically describing the model, roughly 230 polygons (I did it by hand, without any CAD tools—not recommended). When I was working on the solid model, the power of the Personal Iris became supremely obvious. But the level of the Irix graphics libraries requires you to know your 3-D analytic geometry. You must describe each polygon *and* its unit normal vector for the Iris to properly calculate the lighting of the polygon's surface. This is a nontrivial problem and remains the responsibility of the programmer. But once you have solved it, the Iris will do all the work of rendering as you rotate and move your viewpoint. Adding mouse control and menus was simple, but again, I had to write all the high-level work of turning mouse and menu operations into program-flow changes and 3-D motion.

During the course of the project, I found that the Irix window-based symbolic debugger, edge, was easy to use and that the Silicon Graphics technical-support people are friendly, knowledgeable, and responsive.

The BYTE logo project took about 40 hours of study and programming. Mind you, most of this time was spent at the low end of the learning curve. To finish another similar project would take only about 10 hours. All in all, I enjoyed programming the Iris, but I would have liked a few more convenience routines to handle more common functions.

Most people will find that there really isn't a need to do any programming for the Iris, since there are plenty of application programs. According to the Silicon Graphics directory of software products, more than 400 commercial applications are available for its machines.

There are 21 different professional animation packages that run on these machines, making the Iris the machine of choice for that kind of work. There are seven packages for building design; dozens for mechanical engineering, aerodynamics and fluid dynamics, and automation; and a host of applications for graphics modeling. The list also includes an assortment of databases, spreadsheets, and editors.

### Who Will Buy

Silicon Graphics workstations are already established as the most cost-effective, production-quality, computer-animation workstations. They are also very affordable for applications such as visualization of data from medical scanning equipment (e.g., CAT scans).

Without question, anyone who wants to do 3-D rendering could profit from a Silicon Graphics Personal Iris Turbo system, but, clearly, not everyone can afford one. A minimal Personal Iris 12.5-MHz system with a 14-inch (1024- by 768-pixel) monitor costs $13,500. This configuration will display only 256 colors out of a palette of 16.7 million. The minimum configuration does not include a hard disk drive; $2000 buys you a 200-MB drive. The drive includes the operating system and all the graphics utilities.

The machine I reviewed had the minimum 8 MB of system memory (out of a possible 32 MB), but it had the 20-MHz processor, the full Super Graphics options that deliver 24-color bit planes (16.7 million colors), 24 z-buffer planes, and eight system planes (see "3-D Graphics: From Alpha to Z-Buffer" on page 271). It also had a 380-MB hard disk drive and a 150-MB quarter-inch SCSI tape drive. The total value of the review system is $32,500. For graphics options, this is the top of the Personal Iris line but the low end of the Silicon Graphics family. Slip the disk drive from the review machine into a $13,000 model, and you can do the same things, but without the same performance or range of colors.

The Personal Iris 4D/25 places real graphics power in the hands of the people who need it most. Designers, engineers, artists, and other dreamers will find this system a willing bridge between the drawings of the mind and the finished product. ■

*Ben Smith is a BYTE technical editor. You can reach him on BIX as "ben_smith."*


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### PCBRAND 286/20 ______ $899

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Norton SI 23.0 Landmark™ Speed 26.7MHz,
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2 Serial and 1 Parallel Ports

**Standard System Features:***

- 80286-12, 80286-16, 80286-20 operating at 12 MHz, 16MHz, or 20MHz w/Zero Wait
- 512K RAM expandable to 8MB on the System board using 256K or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1:1 Interleaved Hard/Floppy Drive Controller, 1Mb/Second disk transfer rates on all 40Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- 2 Serial & 1 Parallel ports on std-configurations
- High Capacity System Power supply
- Real Time Clock/Calendar with 5 Year Battery
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- Built-in System Board LIM 4.0EMS hardware
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- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/6 Disk Drive bays

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|---|---|---|---|---|
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| Mono | $1049 | $1149 | $1329 | $1469 |
| VGA-Mono | $1229 | $1329 | $1509 | $1649 |
| VGA-Color | $1459 | $1559 | $1739 | $1879 |
| SVGA/Color | $1569 | $1669 | $1849 | $1989 |

**PC BRAND 286/16**
w/512k, Hard Disk Drive, Monitor & Video Card

| Hard Drives: Mb/Ms | 20/40 | 40/19 | 71/25 | 110/17 |
|---|---|---|---|---|
| No Video | $1079 | $1179 | $1359 | $1499 |
| Mono | $1199 | $1299 | $1479 | $1619 |
| VGA-Mono | $1379 | $1479 | $1659 | $1799 |
| VGA-Color | $1609 | $1709 | $1889 | $2029 |
| SVGA/Color | $1719 | $1819 | $1999 | $2139 |

**PC BRAND 286/20**
w/512k, Hard Disk Drive, Monitor & Video Card

| Hard Drives: Mb/Ms | 20/40 | 40/19 | 71/25 | 110/17 |
|---|---|---|---|---|
| No Video | $1229 | $1329 | $1509 | $1649 |
| Mono | $1349 | $1449 | $1629 | $1769 |
| VGA-Mono | $1529 | $1629 | $1809 | $1949 |
| VGA-Color | $1759 | $1859 | $2039 | $2179 |
| SVGA/Color | $1869 | $1969 | $2149 | $2289 |

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***-Personal Computing, Best Bargain Systems, Dec, 1989***

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***-Computer Buyer's Guide, Cover Story, Oct, 1989***

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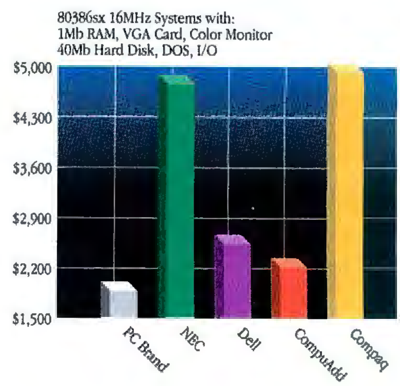
**Standard System Features:**

- 80386SX Processor Operating at 16MHz delivering 18MHz Effective Throughput
- 512K RAM expandable to 8MB on the System board using 256K and/or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1:1 Interleaved Hard/Floppy Drive controllers, 1 Mb/Second disk transfer rates on all 40 Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- 2 Serial & 1Parallel ports on std-configurations
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387SX Co-Processor Support
- AMI BIOS with full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatibility
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/6 Disk Drive bays (Shown in optional Mini Size Tower ® Case)

**Options:**

- Low profile Slim Line Case w/3 Disk bays
- Mini Size desk top Tower ® Case w/4 Disk Drive bays (as pictured above)
- VGA or CGA Plasma Portable Case
- Factory Installed RAM Upgrades
- Custom configurations w/Name Brand peripherals of your choice

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| Hard Drives: Mb/Ms | 20/40 | 40/19 | 71/25 | 110/17 |
|---|---|---|---|---|
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| Mono | $1349 | $1449 | $1629 | $1769 |
| VGA-Mono | $1529 | $1629 | $1809 | $1949 |
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*-Computer Shopper, Cover Story November, 1988*

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***-PC Magazine, 25MHz 386 PC's, Feb. 14, 1989***

**PC BRAND 386/20 _____ $1349**

20 MHz Clock, Zero Wait Operation, Norton SI 23.0 Landmark Speed26.1MHz, 1024K RAM, 1.2MB or 1.44MB Drive, 101-Keyboard, 2 Serial and 1 Parallel Ports

**PC BRAND 386/25 ____ $1499**

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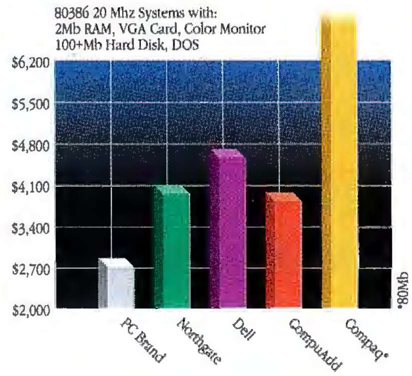
***- PC Magazine, 25MHz 386 PC's February 14, 1989***




**Standard System Features:**

- True 20MHz or 25MHzZ Intel 80386 CPU Operating with Zero Wait States
- 1024K RAM standard expandable to 16MB using 256K and/or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1:1 Interleaving Hard Drive/Floppy Drive controllers, 1Mb/Second disk transfer rates on all 40Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- 2 serial & 1 parallel ports on std-configurations
- High Capacity 200Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80287, 80387, or Weitek Co-Processor Support
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| Hard Drives: Mb/Ms | 40/19 | 71/25 | 110/17 | 200/19 |
|---|---|---|---|---|
| No Video | $1779 | $1959 | $2099 | $2549 |
| Mono | $1899 | $2079 | $2219 | $2669 |
| VGA-Mono | $2079 | $2259 | $2399 | $2849 |
| VGA-Color | $2309 | $2489 | $2629 | $3079 |
| SVGA/Color | $2419 | $2599 | $2739 | $3189 |

**PC BRAND 386/25**

with Hard Disk Drive, Monitor & Video Card

| Hard Drives: Mb/Ms | 40/19 | 71/25 | 110/17 | 200/19 |
|---|---|---|---|---|
| No Video | $1929 | $2109 | $2249 | $2699 |
| Mono | $2049 | $2229 | $2369 | $2819 |
| VGA-Mono | $2229 | $2409 | $2549 | $2999 |
| VGA-Color | $2459 | $2639 | $2779 | $3229 |
| SVGA/Color | $2569 | $2749 | $2889 | $3339 |

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***InfoWorld, Product Review, January 8, 1990***

## InfoWorld 386/33 Review Scores:

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***-PC Magazine, 33MHz 386 PC's, October 31, 1989***

"...great value. *Period*. ...excellent price performance ratio; high quality."

***-Computer Buyers Guide, Product Review, February, 1990***

**Standard System Features:**

- True 33 MHz INTEL 80386-33 CPU operating w/Zero Wait States with 58.7 MHz Throughput
- Intel 82385-33 Cache Processor with 32K 25NS Static RAM Standard
- 1024K RAM Standard Expandable to 16MB
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- 1:1 Interleaving Hard Drive/Floppy Drive Controllers, 1 Mb/Second disk transfer rates on all 40Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- I/O Ports-2 serial,1 parallel
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387 or Weitek Co-Processor support
- Phoenix BIOS with Full MS/DOS, 0S/2, XENIX, UNIX, NOVELL, 3COM compatibility
- EMS and Disk Cache in ROM
- 8 Slot motherboard design
- Medium foot print case w/6 Disk Drive bays

**Options:**

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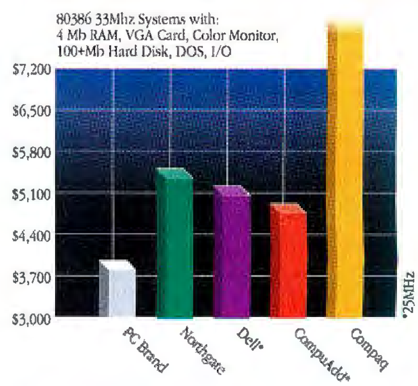


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| Hard Drives: Mb/Ms | 40/19 | 71/25 | 110/17 | 200/19 |
|---|---|---|---|---|
| No Video | $2679 | $2859 | $2999 | $3449 |
| Mono | $2799 | $2979 | $3119 | $3569 |
| VGA-Mono | $2979 | $3159 | $3299 | $3749 |
| VGA-Color | $3209 | $3389 | $3529 | $3979 |
| SVGA/Color | $3319 | $3499 | $3639 | $4089 |

*Turn the page for Portables & Peripherals*

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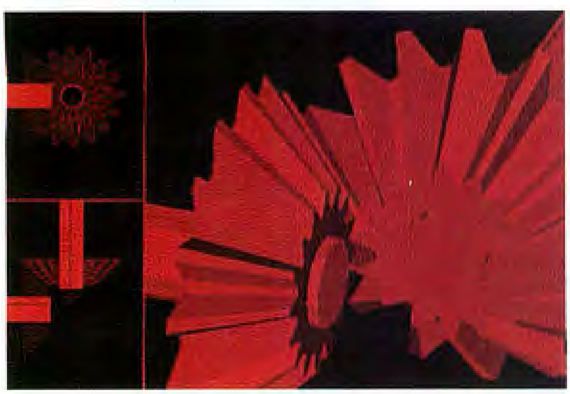

*Actual VGA PLASMA Screen Image*

**Standard System Features:**
- All performance and compatibility features as in desktops featured on previous pages
- 16 Grey Scale 640x480 VGA or 4 Grey Scale 640x400 CGA/Mono Graphics Plasma Display

**Standard Features Continued:**
- 3 Accessible Drive Bays for (2) 5.25" and (1) 3.5" Units
- 2 Available Peripheral Card Slots
- Simultaneous internal & external displays
- 200 Watt Auto Voltage Switching Power Supply

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**VGA Gas Plasma Portables**

| Drives Mb/Ms | 1 Floppy | 40/19 | 110/17 | 200/19 |
|---|---|---|---|---|
| 286/12 | $2595 | $2995 | $3395 | $3960 |
| 286/20 | $2795 | $3195 | $3595 | $4160 |
| 386/SX-16 | $2895 | $3295 | $3695 | $4260 |
| 386/20 | $3350 | $3750 | $4150 | $4710 |
| 386/25 | $3550 | $3950 | $4350 | $4910 |
| 386C/25* | $4000 | $4400 | $4800 | $5360 |
| 386C/33* | $4300 | $4700 | $5100 | $5600 |

**CGA/MGA Gas Plasma Portables**

| Drives Mb/Ms | 1 Floppy | 40/19 | 110/17 | 200/19 |
|---|---|---|---|---|
| 286/12 | $1745 | $2145 | $2545 | $3110 |
| 286/20 | $1945 | $2345 | $2745 | $3310 |
| 386/SX-16 | $2045 | $2445 | $2845 | $3410 |
| 386/20 | $2495 | $2895 | $3295 | $3855 |
| 386/25 | $2695 | $3095 | $3495 | $4055 |
| 386C/25* | $3145 | $3545 | $3945 | $4505 |
| 386C/33* | $3445 | $3845 | $4245 | $4805 |

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**Mitsubishi**
1381 14" Diamond Scan (to 800x600) ........ $499
HL6605 16" SVGA/EGA (to 1280x1024) ........ 1195
HL6905 20" SVGA/EGA (to 1280x1024) ........ 2095

**NEC**
GS-2A 14" MultiMono (to 800x600) ........ $249
2A 14" SVGA (800x600) ........ 479
3D 14" SVGA/EGA (1024x768I) ........ 649
4D 16" SVGA/EGA (1024x768) ........ 1150
5D 20" SVGA/EGA (1280x1024) ........ 2350

**Panasonic**
C1391 PanaSync (to 800x600) ........ $489
M1500 15" Mono DTP with adapter ........ 1208
M1900 19" Mono DTP with adapter ........ 1498

**Princeton Graphics**
Max15 14" Mono (to 1028x768I) ........ $249
UltraSync 14" SVGA/EGA (800x600) ........ 520
UltraSync 16" SVGA/EGA (1024x768I) ........ 879

**Princeton Publishing Labs**
Multiview 15" Mono DTP with adapter ........ $690

**Relisys**
9503 14" VGA Mono (640x480) ........ $145
9513 14" VGA Color (640x480) ........ 369
1520 15" SVGA (1024x768) ........ 679

**Samsung/Leading Technology**
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14" VGA Color .41DP (640x480) ........ 299
14" SVGA Color (to 1028x768I) ........ 419

**Seiko**
1440 14" SVGA (1024x768I) ........ $599

**Sony**
Multiscan HG 14" SVGA (to 1024x768) ........ $689
GDM-1606 16" CADD (1280x1024) ........ Call
GDM-1953 19" CADD (1280x1024) ........ Call

**Zenith**
ZCM1492 VGA Flatscreen (640x480) ........ $619

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Aboveboard Plus 512K ........ $419
Aboveboard Plus I/O ........ 469
Aboveboard Plus 8 2Mb/I/O 2Mb ........ 599/629
Inboard 386PC with 1M ........ 595
Inboard 386 AT with 0K ........ 859

**PC Brand** I/O Cards
AT 1P/2S/1G ........ $49
XT 1P/1S/1G/Clock/Calendar ........ 49

## Video Cards

**ATI**
VGA Wonder 256K/512K ........ $245/297

**NEC** *PC Magazine's Editors Choice*
Graphics Engine 16 (1024x768) ........ $679
Graphics Engine 256 (1024x768) ........ 969

**Paradise**
EGA Autoswitch 480 ........ $99
VGA 1024 with 256K ........ 199
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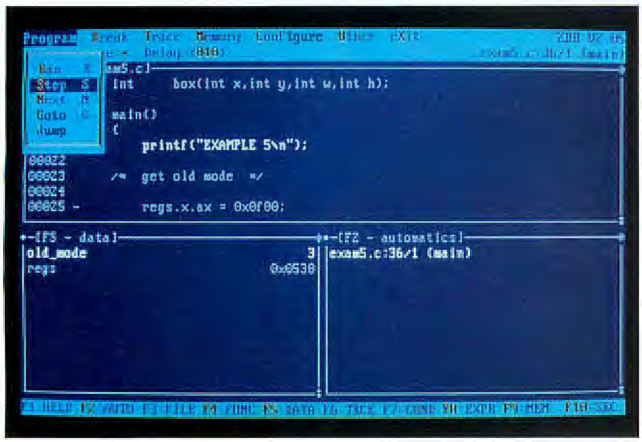
REVIEW

# C++, Plus




*Zortech's new multiwindowed debugging environment.*

You might not know it, but if you write more than a little software, you're already an object-oriented programmer. Every window you open, every C structure you declare, and even most BASIC subroutines you write are nearly objects. Without an object-oriented language, it is impossible to deal with these constructs in an intuitive way. In fact, objects work a lot closer to the way people think than do non-OOP constructs in other languages.

C has reigned supreme for several years now as the language of choice for commercial software production. C++, born at AT&T, is the heir apparent to C's following but has been held back somewhat by the quality of available tools. Most C++ compilers aren't really compilers at all; they simply turn C++ code into C code, which you then compile on your own. Function and variable names get mangled to internal representations. C debuggers can't help you make sense of these names, and they don't understand the C++ constructs and syntax, either. In short, there has been no way for a C programmer to painlessly make the switch to C's more capable offspring. Until now.

Zortech, a pioneer in the PC C++ business, has released the first PC-based compiler compliant with AT&T's latest language specification, version 2.0. The developer's edition of Zortech's product, reviewed here, combines a compiler that is compliant with both AT&T C++ 2.0 and ANSI C specifications, an integrated editor, a true C++ source-level debugger, a Microsoft-compatible linker, full library source code, and a set of ready-made classes (also accompanied by full source code).

AT&T's original language specification was pretty complete, but version 2.0 added some important features. Zortech has stayed close to this new language specification, adding virtually all the changes introduced by AT&T. Chief among these are *multiple inheritance*, whereby a class can inherit members from more than one base class, and *type-safe linkage*, which allows type checking of function arguments across separately compiled modules. The mechanism used allows C, Pascal, and assembly source modules to be easily linked in.

Zortech has also made some PC-specific additions, including new compiler and library (but not class) support for Microsoft Windows development, expanded memory, mouse functions, and TSR programs. All are callable from programs compiled with either C++ or the ANSI C-compliant compiler included in the package. Some library functions now have multiple names to make porting from Microsoft C easier. [Editor's note: *See the text box "But Wait, There's More" for some features added to Zortech C++.*]

## Getting It On

Installation is easy. If the setup routine detects a previous installation, it offers to update rather than install everything, which can save some time. It doesn't ask many questions, but you can't change answers without aborting the install process and starting over; this takes slightly under half an hour.

The installation guide refers to the creation of a tools directory, but it never appeared. I even repeated the installation thinking I missed something. I checked the contents of the disks against what got installed, and it was all there. I expect this may be a documentation error, but problems like this during installation can be frustrating.

## The Editor as Environment

Zortech's approach to the working environment is a little closer to the Unix way of doing things than to Borland's or Microsoft's. Rather than providing one huge program combining an editor, debugger, and compiler, Zortech's `zed` editor simply invokes the other tools as needed. This approach contrasts with Quick C and Turbo C, both of which load the entire integrated environment (compiler, debugger, and editor) into memory, leaving less room for each individual module. The `zed` editor can also run Make instead of calling the compiler directly, which is essential since C++ programs tend to be built from lots of small files.

The editor's mild integration is much better than none at all, but it also brings out a small gripe: `zed` can only work on five files at a time, and it can only put one file on the screen at a time. Five might be OK if you're working on a small project at home, but it's simply not adequate for a large commercial project. Of course, there's nothing to keep you from using EMACS, Brief, or some other editor that uses windows and handles more files simultaneously.

Despite its shortcomings, the editor has many features that make a professional's life easier. It listens for errors coming back from the compiler and places the cursor on the line in the source where the first error was reported. It remembers compile and link options from session to session, as well as the files you were working on, and the cursor position within each. There is mouse support and also a facility for recording and replaying keystrokes as macros. Brace, bracket, and parenthesis matching make it easier to read and fix nested statements and expressions. Another thoughtful feature is called block indent/outdent: It lets you put the cursor on a brace and press two keys to move the entire block of code in or out one tab stop. It can't be beat for fixing up the indentation after moving some big blocks of code around.

As is common with many programmer's editors, almost everything in `zed` is configurable. A special configuration program, `zconfig`, sets defaults for search paths, screen colors, and a seemingly endless list of other options. Key

*continued*

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bindings are modifiable, so it's possible to make zed behave like another editor entirely. These changes can be made from within the editor, so you can experiment with your changes on the fly.

## On-Line Help

Zortech's TSR on-line help program is `ztchelp`. Once the program is installed, you can get C and C++ help from within the `zed` editor by pressing Shift-F1 when the cursor is over the token for which you want help. This worked nicely for the keywords I tested (i.e., `for`, `#include`, and `void`), but I learned that `ztchelp` can get confused. Asking for help on `<<` got me the help screen for `raise()`. I was puzzled until I noticed that the token `rate` followed the `<<` in my text. Changing `rate` to `foo` produced the help screen for `fopen()`. Apparently `ztchelp` uses a best-guess method to determine the intended subject.

One thing about the help text (and the rest of the documentation) is that Zortech should run its text through spelling and grammar checkers. Typos and misused words may be acceptable in a draft but certainly not in a finished product.

## Make My Day

C++ has a Make utility that directs (via a text file called a make file) the compile/link process, and it can also be used as an intelligent batch file to conditionally run tests, install programs, and perform other tasks based on file-age relationships. Its origins, as with many good programming tools, are in the Unix world. Zortech's version of Make has always been better than Microsoft's, and the version included here is better still. Zortech's Make is much closer to the original Unix version, which fully automates the build process, but lets you do it just about any way you please. Microsoft's Make is little better than a DOS batch file; it does the requisite file-age comparisons, but that's the only thing useful about it.

Zortech has also added an `include` directive that lets you reference another make file in much the same way that C and Pascal programmers include header files. With it, you can put all your default how-to-compile rules and macros into one file and then `include` that file into your individual make files. It is also an excellent way to get a team of programmers all working in the same direction.

## The Real Thing

Zortech's debugger, `zdb`, is currently the only PC product that supports the source-level debugging of native C++ programs as well as C and assembly code. I admit to a pathological dislike of debuggers in general, but `zdb`'s ability to unmangle C++ names and follow overloaded functions and operators makes the thought of working on someone else's code (there's never a need to debug your own code, right?) less daunting. It's got the usual flashy stuff, too—pull-down menus, multiple windows (15 in all, although you don't see more than three at once), mouse support, and complex data type expansion and expression evaluation—but the real attraction beyond the C++ support is how easy it is to learn.

The `zdb` debugger outguns traditional C debuggers by virtue of its understanding of C++ constructs and syntax. A class window can be opened that allows simple examination of classes and their member functions. This becomes a sort of on-line help for understanding how a C++ program works, and properly written Zortech C++ programs become, to an extent, self-documenting.

## Source Included

The sources to the library routines and the tools classes are included with the developer's edition. Conventional wisdom has it that library source is great as a learning tool, or that it's essential if you need to create your own version of a routine because of local conditions. Those are both true, but I've always found that the best use of library source is convincing yourself that the incredibly subtle bug you've been chasing is really yours and not a library bug.

The tools reference guide also contains the source to the tools classes. To its credit, Zortech warns that the code in the book is only a guide, and that you should check the actual source if the details are that important. Take this warning to heart; I found several places where the actual code varies from the code that's in the book.

## Real Work

Zortech would like to woo current Microsoft C users (like myself), so my first test was to attempt to compile a complex Microsoft C program with Zortech's ANSI C compiler. I fed a Microsoft C–specific version of the MicroEMACS editor source to Zortech's compiler, and less than an hour later, I had a new (and smaller) program. It was very easy to build a Zortech-style make file to compile the modules. Not all Zortech library function names and argument lists match Microsoft's exactly, but all I had

*continued*

# But Wait, There's More

By the time this review was ready for publication, the face of PC C++ was changing dramatically. Zortech's next release (2.1) is nearly ready. In addition to enhancements to compile speed, the integrated environment, and tools, the new compiler includes virtual code management. Using VCM, a program can contain up to 4 megabytes of code, but it can still run on a 640K-byte PC. The company says that VCM requires no source code changes for most applications. Upgrades to version 2.1 will be available.

Borland, too, is preparing the first release of its compiler, Turbo C++. This is both ANSI C and AT&T 2.0 C++ compliant, and it is built around a revamped programmer's platform that has overlapping windows, an enhanced multifile editor, and mouse support. Turbo C++ also has a new memory management scheme, called the Virtual Run-Time Object-Oriented Memory Manager (VROOMM), which allows large programs to run in 640K bytes.

Turbo C++ will be reviewed in an upcoming BYTE.

to do was watch for "unresolved external" messages from the linker and patch the source to use Zortech's equivalent function.

It also seemed reasonable to work up some C++ code from scratch. I wanted to create a simple directory browser that would display a sorted list of files. Using the `directory` class from the tools collection, I quickly put together a function to build an array of filenames and attributes from the contents of a specific directory. It was almost too easy; all I did was declare the darned thing and then use the class's member functions to grab the files. The next step was to combine this with one of my sorting programs to produce sorted listings using various keys (e.g., time stamps and size). The sorted listings were used as data for objects created using the `dlist` doubly linked list class, which I then set up to display using pop-up window objects from the supplied `window` class.

For an encore, I used Zortech's `_handle` data type to allow the data to be stored and sorted in expanded memory. This takes little work beyond using `_handle` in the data declarations—the compiler does the correct magic to use your EMS driver to put the data in expanded memory.

I've worked up small projects like this from scratch in C before, and those efforts have led me to expect that the C++ equivalent would require a similar investment of time—several days. It's amazing how much time you can save by using the right tools; directories, linked lists, and windows are all proper objects, but C's ignorance of objects in general makes even simple projects like this a chore. But with Zortech's C++, I had everything finished in just one evening. What's more, I could have bundled the modules together as a class and declared subclasses to create a file-selection dialog box, an Xtree-type directory manager, or what have you. I'd like to see you do that as easily with C.

## Not a Bug?

Zortech has managed to avoid many of the bugs being found in `cfront` (AT&T's C++-to-C translator) versions of C++ 2.0. I have tested quite a few of the reported `cfront` bugs, and Zortech has fixed most of them. One bit of behavior was obviously wrong, though: I couldn't compile some perfectly legal code using virtual functions and derived classes, and it was driving me nuts. It would take another article the size of this one to explain the issue. In the end, I had to use a cast on a function call argument (of a derived type) to get the code to compile.

At least with Zortech C++, when I ran the hacked code I got the expected result. With a `cfront`-based compiler, the original code compiled just fine, but it produced the wrong answer. This turns out to be a known `cfront` bug, which, if you're curious, is described thus: The virtual function table is not constructed correctly when a derived object is passed by value as a base object (whew!). I don't know if Zortech has deliberately tried to avoid this problem by forcing the use of casts, or if the refusal to compile is simply a bug. Whichever it is, what matters to me is that Zortech C++ gives the correct output in the end.

## A Class Act

In all, Zortech has put together a commendable package long on features, fully suited to professional code development, and at a price that, while not cheap, is within the reach of working programmers. In addition to offering services to conventional DOS programmers, Zortech has also included support for Microsoft Windows and sells an upgrade kit that fixes the compiler to produce OS/2 protected-mode binaries. This support is limited, however, since Zortech's product lacks the classes you'd need to do real OOP for Windows or Presentation Manager. Third-party class libraries are on the horizon, but until they're available, C++'s potential in these areas will go mostly untapped.

If you're a C programmer, you should take a serious look at Zortech's compiler. Large, multimodule C projects become difficult to maintain because the sharing of data among modules is poorly handled. Global variables, unportable code, and the global callability of dangerous internal functions are all killer time wasters, and these are but a few of the problems C++ was invented to solve.

Unlike other OOP languages, C++ is immediately useful to C programmers because it is a superset of C. There's no magic here; it's just as easy (and maybe easier) to write ugly programs in C++ as it is in C. The difference is that the best C++ code will be more portable and more maintainable than the best C code. Zortech's C++ 2.0 and its accompanying tools create a quality environment that can increase the productivity of programmers working on large or complex projects. ■

*Steve Spicer is a Unix software engineer for Hewlett-Packard's Apollo division in Chelmsford, Massachusetts. He can be reached on BIX c/o "editors."*

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George Bond

REVIEW

# The Personal Network


*Lotus Notes deals with information in a familiar file-folder and icon manner.*

Lotus Notes 1.0 is a strange beast. It's a hybrid application program that is part E-mail system, part conferencing system, part database manager, and part network connection. When all its parts are combined, Notes forms an interesting distributed-database network.

To its credit, Notes retains the traditional strength of the personal computer—the *personal* part—and melds with the largely untapped strength of a network to support synergistic cooperative work. In other words, Notes helps groups of people communicate with each other using tools to share information.

On the personal level, Notes lets you build your own applications, fashion your own views of information, and maintain your own databases. For example, if you work for a company that uses formal performance ratings based on objectives and goals, you could create a private Notes database to track your progress against these goals. It would be accessible only to you, not anyone else on the network. The information you feed into this private database (e.g., facts about what you're doing and when) could come from other, shared Notes applications used in the daily running of the business. If your job is quality control, you could build your own tools for analyzing trouble reports filed in public areas of the system, working in a way that makes the most sense to you.

The synergy here is a by-product of people sharing information. The mail system is solid and easy to use, but Notes's real potential comes from its ability to emulate conferencing systems. Notes supports applications that distribute information on a many-to-many basis (many individuals communicating with many others, as opposed to mail systems and their one-to-one or one-to-a-few communication pattern). You can link messages and replies and read them at any time in a logical order, freeing discussion participants from constraints of time and space.

Notes also supports traditional static databases, such as policy manuals, catalogs, research reports, and personnel records. In addition, you can use Notes for such diverse functions as a ballot box, a suggestion box, a facility to generate and distribute newsletters and news bulletins, and a facility to maintain central schedules.

You can also set up Notes on multiple servers. Distributed over a single LAN or multiple LANs, or even over continents using wide-area networks (WANs), Notes automatically keeps itself roughly in sync through replication. This means each server exchanges information with the other servers in the system on a scheduled basis.

The technology to do this is far from breathtaking. Programs that do the same thing in bits and pieces are available separately in many forms from vendors of mail, conferencing systems, BBSes, databases, and communications programs. What sets Notes apart is the integration of these technologies for a nontechnical audience.

Notes presents a Microsoft Windows or OS/2 graphical user interface that is easy to learn and use, yet flexible enough to satisfy the demands of most power users. From the user's perspective, person-to-person mail, discussions involving large groups of people, and database manipulation are all done in the same way. You consistently use pull-down menus to select what you want.

There is, unfortunately, a serious flaw in the Notes system. It does not do record locking. This means that two or more users can work on the same record at the same time and each can make his or her own changes to it without knowing other changes are being made. When everyone is finished making changes, the version that was closed last is the one left in the database—whether or not it has the best information. This is a very strange omission from a groupware or enterprise computing product meant to be used concurrently by many people. To its credit, though, Lotus is clear and specific about this shortcoming in the Notes documentation. Lotus also says that it is working to fix the problem.

## A Familiar Database

Notes has a familiar structure. Information is entered into fields, which make up forms. Forms are used to construct documents, and documents are stored in databases. Views are used for customized displays of databases.

When creating a form, six data types are available: text, time, number, keyword, rich text, and document author. Text fields can accept multiple values, but each value must be separated by a punctuation mark. Text fields can contain numbers but cannot use them in calculations. The time field is really a time and date field, and you can vary its format.

You can use number fields for computation. The system stores numbers in floating-point format (scientific notation) from E±99, with 14-digit accuracy. Numbers outside of this range are rounded automatically. Notes recognizes integer, decimal-fraction, scientific-notation, and currency formats.

Keyword fields let you create a uniform set of descriptors to make searching a database easier. You can design a form to include a keyword field that users fill in when completing the form. For example, in a memo form you could include a keyword field for a subject to make organizing memos easier. Rich-text fields can include standard text, enhanced text (i.e., attributes including different typefaces, sizes, and color), and pictures. The document-author field automatically records and displays the name of the person creating the document and verifies the author's identity using an internal Notes security check.

*continued*


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**Software Needed**
OS/2 Standard Edition 1.1 with a Novell Requester or 3Com 3+Open package, or Extended Edition 1.1, or DOS 3.1 or higher. For DOS: Novell NetWare 2.10 or higher, IBM PC-LAN 1.2, or 3Com 3+Share 1.3.1 or 3+Open 1.0 or 1.1

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Documents can also have *hot links* to other documents. A hot link is a hypertext-like connection to information in other documents, even documents in different databases. Hot links allow both documents to reside in their own database, independent of each other.

A hierarchy of access levels and permissions lets you fine-tune how databases are used. You can give each user anything from the ability to delete a database to no knowledge that it even exists, all controlled by software switches.

Every Notes database has an access control list associated with it. This is the basic security system. The ACL is hierarchical with seven levels of access preprogrammed, plus five privileges as defined by the database designer. You can assign access levels and permissions to individual users, groups or classes of users, or everyone. ACL levels range from full access to no access and include read-only and write-only access. You can easily change these access rights; thus, you can have an engineering database accessible to the engineering and manufacturing staff but off-limits to the marketing staff during a product's development phase, and then you can open the database to marketing when the product is ready to go into production.

You can encrypt individual messages. Each user's system ID includes public- and private-key information that can be used for this.

## Hefty Requirements

Lotus Notes runs only on DOS or OS/2. For a Notes server, you need a 286-, 386- or i486-based computer with at least a 60-megabyte hard disk drive (40 MB for workstations), 10 MB of available hard disk space, and LAN Manager-compatible network hardware (e.g., IBM, 3Com, or Novell). You can use a CGA, EGA, VGA, Hercules, or IBM 8514 card. Lotus recommends at least a 386 and a 130-MB or larger hard disk drive for optimum performance.

The OS/2 version requires 5 MB of RAM; 8 MB is recommended. DOS requires 640K bytes of system memory with 490K bytes free after loading network and NetBIOS software, or 460K bytes free if you also have EMS 4.0. You can use OS/2 Standard Edition 1.1 with a Novell Requester or 3Com 3+Open package, or you can use OS/2 Extended Edition 1.1. A Hayes-compatible modem (preferably 9600 bps), an asynchronous communications port, and a direct-dial analog telephone line are required if the system is to be tied into a WAN over dial-up lines.

If you're using DOS, you'll need DOS 3.1 or higher. Microsoft Windows/286 2.1 or Windows/386 2.1 is optional. The Notes program includes a run-time version of Windows. The DOS version supports Novell NetWare 2.10 or higher, IBM PC-LAN 1.2, or 3Com 3+Share 1.3.1 or 3+Open 1.0 or 1.1. You don't need a mouse to work with Notes in either the OS/2 or Windows versions, but I recommend using one.

## Client-Server Configuration

Notes is based on a Notes server. This is not a LAN server but, in most cases, a separate computer specific to the Notes program. The Notes server supports client workstations, and both the server and workstations are attached to a LAN. The Notes server can also have a modem connection to make it part of a WAN. Several servers can coexist on the same LAN, and multiple LANs can be interconnected as a Notes network. The client workstations require special Notes software to communicate with the Notes server.

Server maintenance is done directly on the Notes server computer through a

*continued*

## AUTOMATING ON A SHOESTRING

*By Julie R. Caruso*

Automating an office on a budget is a common challenge businesses face. The project can be particularly difficult when the company doesn't have the money to replace a diverse base of equipment and software that has been purchased randomly throughout its history, and needs to incorporate these resources into an integrated, smoothly functioning network.

A case in point is the automation of the Fulton County Planning and Economic Development Department in Atlanta, GA. Faced with a limited budget, an odd assortment of computer brands and models, a need to connect four individual departments with 30 users located in two buildings, and a growth plan that demanded a doubling of the initial network solution within a one year period, the County set to work finding the best solution.

"Our major concern was to be able to link all the existing, yet different, types of personal computers, future add-on personal computers, and dumb terminals into a cost-effective system," said Dr. June Woodward, who, as Director of the Georgia Systems Development and Technical Systems Department, oversaw the project.

Woodward turned to National A. I. Lab, Inc., an Atlanta-based national distributor of network solutions, for help. After carefully assessing the County's needs, Jim Williamson, president of National A. I. Lab, recommended a "hybrid" system that combined both shared and distributed processing using PC-MOS and LANLink 5X, both products from The Software Link.

"By combining both types of technology using products that are compatible with the broad base of hardware and software that the county already had in place, we gave them a solution that didn't cost a lot of money and allows the expansion they require," said Williamson.

In fact, the system cost more than $200,000 less than other alternatives the county considered. In three years the network has grown from supporting 30 users to serving more than 104 users through a combination of PC-MOS, LANLink and Novell's NetWare.

"In addition to saving us money, our network has dramatically increased our productivity," said Dr. Woodward. Our word processing capacity has increased by more than 200 percent, and we're doing much more of our work by computer because the network is accessible to everyone who needs it."

*Julie Caruso is Managing Director and Director of Sales and Marketing for The Software Link, Inc.*

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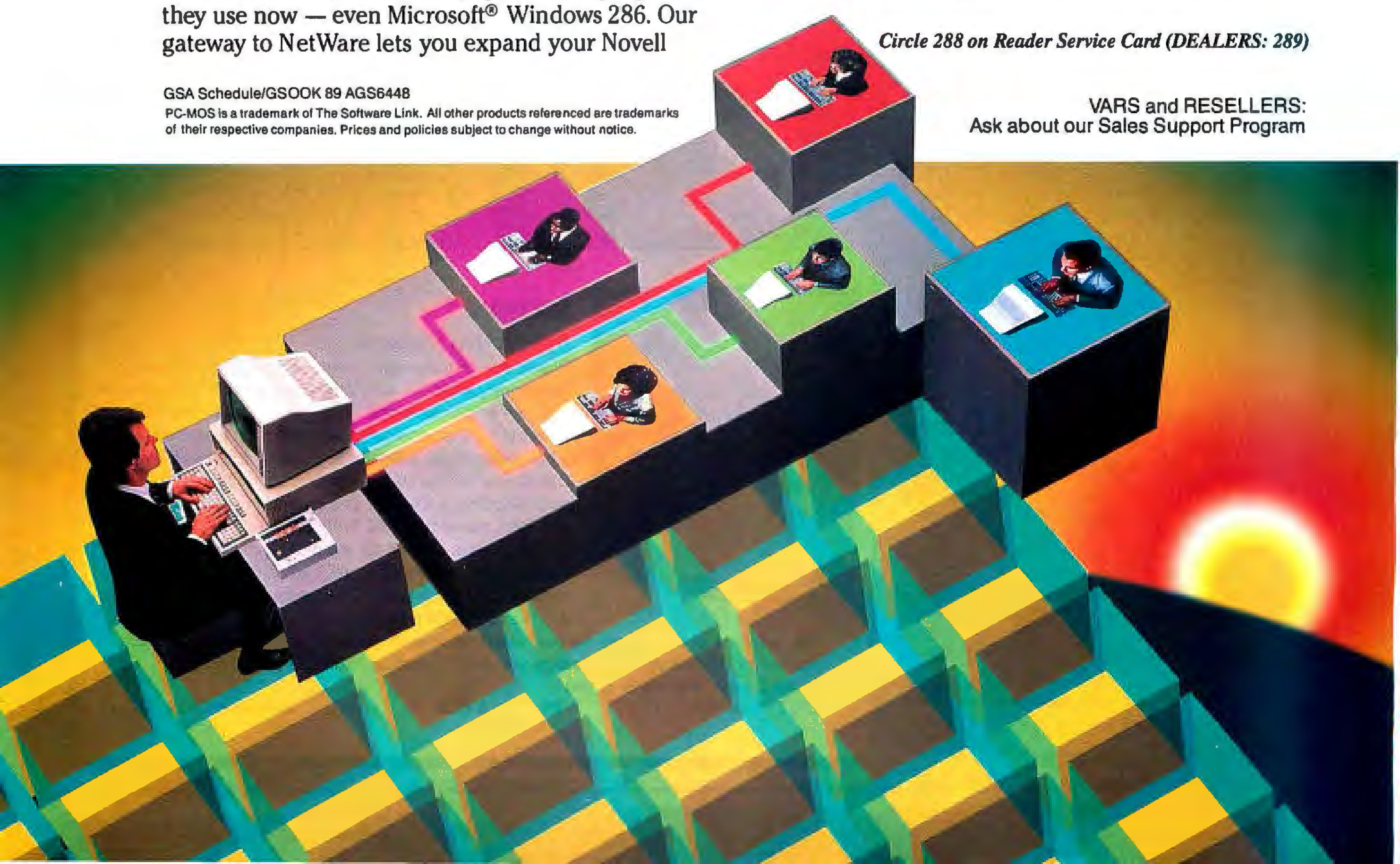

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| ProBas Prof. by Hammerly | 149 | Call |
| ProRef by Hammerly | 50 | Call |
| QBase | 149 | 139 |
| QuickPak Professional | 149 | 139 |
| Softcode/w Template | 100 | 89 |

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| Instant C/16M | 795 | 769 |
| Lattice C - 6.0 Compiler | 250 | 189 |
| Microsoft C6.0 | 495 | 299 |
| Microsoft QuickC | 99 | 69 |
| w/serial mouse | 199 | 137 |
| Turbo C - by Borland | 150 | 109 |
| WATCOM C7.0 | 395 | Call |
| Zortech C | 90 | Call |

### CASE & PROTOTYPERS

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|---|---|---|
| Dan Bricklin Demo II | 195 | 185 |
| EasyCase Plus | 225 | 209 |
| EasyFlow | 150 | 135 |
| Instant Replay III | 150 | 139 |
| Matrix Layout - flow chart | 200 | 179 |
| MetaDesign by Meta Software | 350 | 295 |
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| ProtoFinish by Genesis | 300 | 279 |
| Show Partner F/X | 395 | 279 |
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| Realia COBOL | 995 | 859 |

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| C Asynch Manager 3.0 | 189 | 155 |
| Essential COMM by S. Mtn | 329 | 259 |
| Greenleaf Comm Library | 299 | 249 |
| QuickComm | 139 | 129 |

### DBMS

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| Cause by Maxem | 295 | 259 |
| CLARION Prof. Dev. V2.1 | 845 | 549 |
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| R-BASE for DOS 3.0 | 795 | 499 |
| Tas Professional | 499 | 459 |

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| dbFAST/PLUS | 345 | 325 |
| dBMAN V | 295 | 275 |
| dBXL | 249 | 209 |
| Force by Sophco | 695 | 395 |
| FoxPro | 795 | 495 |
| FoxBASE + V2.1 | 395 | 279 |
| QuickSilver Diamond | 599 | 399 |

### DBMS TOOLS & LIBRARIES

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|---|---|---|
| AdComm For Clipper | 295 | 279 |
| Artful Lib | 200 | 200 |
| BRIEF w/dBRIEF | 285 | 239 |
| Buzzwords dAnalyst | 295 | 269 |
| CLEAR + for dBASE | 200 | 179 |
| dBase BlackBox | 100 | 89 |
| dBase Online - 6 pop-up refs. | 149 | 129 |
| dBX - dBASE III to C | 550 | 529 |
| dGE 4.0 | 295 | 279 |
| dQuery MU | 495 | 469 |
| dSalvage | 100 | 89 |
| FLIPPER Graphics Library | 195 | 179 |
| FUNCky.LIB | 195 | 179 |
| Genifer - code generator | 395 | 269 |
| Net Lib | 249 | 229 |
| Pro Clip | 149 | 125 |
| R&R Relational Reportwriter | 149 | 139 |
| w/Clipper module | 165 | 149 |
| Scrimmage by Synergy | 99 | 89 |
| SilverComm Library | 189 | 179 |
| SilverPaint | 100 | 100 |
| Steve Straley's Toolkit | 180 | 149 |
| Tom Rettig's Library | 100 | 85 |
| UI Programmer Dev's V2.0 | 595 | 479 |

### DEBUGGERS/DISASSEMBLERS

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| Dis Doc | 130 | 119 |
| Periscope IV | Varies | Call |
| RE:Source by Genesoft | 150 | 119 |
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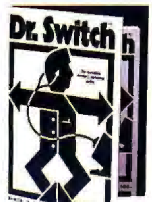


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| Btrieve/N - multiuser | 595 | 479 |
| C-Data Manager | 295 | 259 |
| c-tree by Faircom - source | 395 | 329 |
| CBTREE | 195 | 179 |
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| XQL | 795 | 649 |
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|---|---|---|
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| Fortran Opt. Compiler | 450 | 309 |
| Lahey FORTRAN F77L | 595 | 549 |
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| MS FORTRAN - CodeView | 450 | 309 |

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|---|---|---|
| C Tools Plus - V6.01 | 149 | 109 |
| C Utility | 185 | 137 |
| Greenleaf Functions | 229 | 209 |
| Greenleaf SuperFunctions | 299 | 239 |
| Opt-Tech Sort | 149 | 119 |
| Turbo C Tools | 149 | 109 |

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| Halo | 395 | 279 |
| Hoops | 795 | 759 |
| Matrix Toolkit 3.0 | 395 | 379 |
| MetaWINDOW | 250 | 209 |
| MetaWINDOW/PLUS | 325 | 289 |
| PCX Programmer's Toolkit | 195 | 179 |
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| Sunshow Adv Image Toolkit | 250 | 239 |
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limited set of commands available in server mode (on a character-based, not graphical, screen) and through a more extensive command set reached using the workstation software.

The first time you install Notes, you'll have a Lotus representative holding your hand as you learn the system. However, after six months, you'll be on your own, unless you get some sort of extended-support contract. To find out what life with Notes would be like without a service contract, the BYTE Lab installed its review system alone. The Notes server was a Tandy 4033LX 33-MHz 386 with 8 MB of RAM and an 80-MB Quantam SCSI hard disk drive. The operating system was MS-DOS 3.3, which was attached to a Novell network running NetWare 2.12A.

Configuring the server is a bit tricky. Using the workstation screens, you create a password-protected certifier ID; this is the master key to the Notes system. It's required to validate new Notes servers and users. Once you have the certifier ID, you move on to creating a domain, naming a server administrator, creating a name and address book for the server, and making a system ID for yourself. This is all done with fill-in-the-box screens, but it requires attention because much of the terminology is unfamiliar.

In theory, the installation of a Notes workstation is about the same as that of a server—fire up a floppy disk and follow the prompts. In reality, it may not be that easy. It wasn't at BYTE.

First, there is the question of memory. A lot of BYTE's computers don't have 490K bytes of memory free in their normal configuration, so the BYTE Lab had to adjust the CONFIG.SYS and AUTOEXEC.BAT files before anything could happen. This required some negotiating with users who were unhappy about losing TSR programs and drivers in the process.

Once enough memory was made available, the workstation installation proceeded smoothly, except for one bothersome glitch—Notes sometimes could not find NetBIOS on the workstation, even though NetBIOS was installed and running; this caused the installation to fail. Needed files were not transferred from the Notes server to the workstation. This requires either cleaning out the Notes directory entirely and starting from scratch, or editing the `notes.ini` file to delete all but its first two lines and starting the workstation installation process again. In either case, it's not something you'd do by choice at a 100-computer site. Lotus says that the problem is most likely caused by operating-system or network operating-system incompatibilities and would have to be diagnosed on a case-by-case basis.

Notes allows remote access over telephone lines. The idea behind this is to let field staff call in and use the Notes databases just as if they were in the office. Notes supports Hayes-compatible modems at speeds of from 1200 bps to 19,200 bps. The installation is simple point-and-shoot selection using Windows' radio buttons and check boxes—

*The first time you install Notes, you'll have a Lotus representative holding your hand as you learn the system.*

COM1, click; Auto (modem-speed select), click; enable port, click; OK, click. As easy as that. But the hardware end was a bit messier. Notes would not talk at all to the first modem that was tried (a Kyocera 1200-bps external unit). The BYTE Lab eventually got it talking to a Supra 2400-bps internal modem, but only after much switch-fiddling and initialization-string experimentation. Once the hardware and software recognized each other, life got easy again. Calling into Notes is, in fact, just like using Notes on a LAN—but slower. Lotus recommends 9600-bps modems for Notes, and using that speed can help.

### User Notes

When you open a Notes workstation on your computer, you see a typical Windows screen with a menu-selection bar across the top and six tabbed, stacked file folders in the main text area. These file folders are your workspaces and basic organizational tools. They hold your address books and other databases. You'll find some icons in one of the folders—at least server and personal name and address books and a mailbox. You can open any of the icons as you would in any Windows application.

You can have many views of a database. Your mail, for example, could be organized by sender, date, or keyword. Notes comes with seven database templates and has an extensive language for creating your own.

Notes will also import and export data from other applications. It recognizes Lotus 1-2-3 and Symphony worksheets; ANSI Metafiles; .GMC, .GMF, and .PIC files; graphics pasted from the Windows or Presentation Manager clipboard; Lotus Agenda files; word processing files from Lotus Manuscript, WordPerfect, Microsoft Word, MultiMate, WordStar, DisplayWrite; and any program that generates a plain ASCII file.

One of the comments from the BYTE staff using Notes was that it's slow. But this is more of a perception problem than a performance problem. A quick-and-dirty benchmark test, loading and saving a 66K-byte database imported from Lotus Agenda, gave times of about 1½ seconds to load and 1 second to close in Notes. In Agenda, the same database took 1 second to load and 1½ seconds to close.

### The Target of Notes

Notes is for large businesses. It carries a price tag of $62,500 and comes complete with installation help and training by Lotus representatives. You also get six months of maintenance and telephone hot-line support, and 10 sets of manuals.

That price may sound high, but if your business is large and you want a lot of Notes workstations, it comes out to a typical per-unit price for microcomputer software. Your $62,500 buys you licenses for 200 workstations. That comes to $312.50 per workstation. Additional licenses beyond the original 200 are $295 each and are valid for either a server or a workstation. There is a hidden cost, however. Like a LAN, Notes requires administration—one or more users to take care of it. The complexity of administration is up to the user.

If you can live with the lack of record locking in Notes, and if you have enough workstations to justify the cost, the program is worth a careful consideration. Notes's well-integrated collection of features should be easy for the nontechnical user to learn. And its ability to organize group discussions moves Notes far beyond any capability of regular E-mail. ■

---

*George Bond is a consultant in communications—electronic, traditional print, and person-to-person. He has more than 20 years' experience with major information companies and is cofounder of BIX. You can reach him on BIX as "gbond."*


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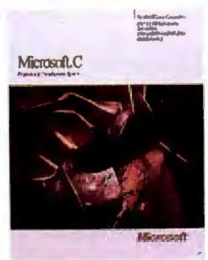


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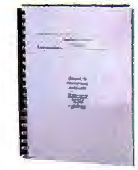

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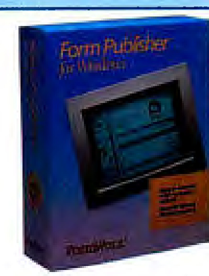


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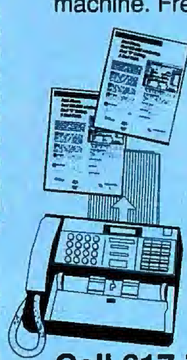

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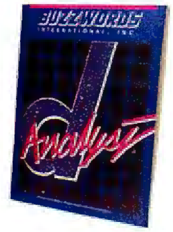


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by Black & White Int'l., Inc.

Dr. Switch-ASE turns any size Clipper application into a RAM Resident (TSR) program that occupies only 13K of RAM. Dr. Switch-ASE supports both Expanded and Extended memory and is full network compatible. Applications that include Dr. Switch-ASE may be distributed royalty free.

LIST Price $100 **PS Price $95**

***FastFaxts 1178-006***

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| | | |
|---|---|---|
| Sbrowse | 245 | Call |
| Source Print by Powerline | 99 | 97 |
| TLIB | 100 | 89 |
| Zortech C++ Tools | 150 | Call |
| **EDITORS** | | |
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| Cheetah | 245 | 199 |
| Edix | 195 | 179 |
| Epsilon | 195 | 169 |
| KEDIT | 150 | 139 |
| QEdit TSR | 99 | 89 |
| RimStar PM:Editor | 195 | 179 |
| Sage Prof Editor | 295 | 249 |
| SPF/PC - V2.1 | 245 | 199 |
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| **EXPERT SYSTEMS** | | |
| Exsys Professional | 795 | 695 |
| Knowledge Pro Windows | 695 | 589 |
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| Accsys w/source | 795 | 739 |
| Btrieve ISAM - V5.0 | 245 | 199 |
| Btrieve/N - multiuser | 595 | 479 |
| C-Data Manager | 295 | 259 |
| c-tree by Faircom - source | 395 | 329 |
| CBTREE | 195 | 179 |
| CodeBASE 4 | 295 | 279 |
| C -Trieve | 199 | 189 |
| C-SQL/APIC | 495 | 429 |
| CQL - full w/ source | 395 | 359 |
| db_FILE/RETRIEVE - SU | 295 | 279 |
| UNIX or XENIX - MU | 595 | 569 |
| Faircom Toolbox Prof. | 1095 | 889 |
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| WKS Library | 195 | 189 |
| **FORTRAN** | | |
| FOR_C - FORTRAN '77 w/so | 875 | 789 |
| Fortran Opt. Compiler | 450 | 309 |
| Lahey FORTRAN F77L | 595 | 549 |
| Lahey Personal FORTRAN | 95 | Call |
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## BLAST
by Communication Research

BLAST puts powerful data transfer, remote control, scripting, terminal emulation, datacompression, and other communications magic into one product for PC, Unix, Xenix, VAX, Macintosh, and even mainframe communications... all with the same look, feel, menu interface, protocol, and script language! Easy for developers to link into existing applications for automated, 100% error-free data transfer and fast, reliable remote control.

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***FastFaxts 1674-001***

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|---|---|---|
| **GENERAL ADD-ONS** | | |
| C Tools Plus - V6.01 | 149 | 109 |
| C Utility | 185 | 137 |
| Greenleaf Functions | 229 | 209 |
| Greenleaf SuperFunctions | 299 | 239 |
| Opt-Tech Sort | 149 | 119 |
| Turbo C Tools | 149 | 109 |
| **GRAPHIC ADD-ONS** | | |
| Codemaster II | 289 | 269 |
| Essential Graphics | 399 | 349 |
| GraphiC | 395 | 319 |
| GSS Dev't Toolkit (Graphics) | 595 | 525 |
| Halo | 395 | 279 |
| Hoops | 795 | 759 |
| Matrix Toolkit 3.0 | 395 | 379 |
| MetaWINDOW | 250 | 209 |
| MetaWINDOW/PLUS | 325 | 289 |
| PCX Programmer's Toolkit | 195 | 179 |
| HSC Sunscan | 250 | 229 |
| Sunshow Adv Image Toolkit | 250 | 239 |
| Sunshow C Image | 250 | 229 |


## Clarion Prof. Dev 2.1
by Clarion Software

A powerful, easy-to-use DBMS application developer, can cut development time by 50%. Imports/exports dBase, BASIC, and DIF files; interfaces with routines from C and Assembler. Includes Report Writer for creating ad-hoc reports and queries. Built-in LAN support: no run-time system required for distribution. Recent winner of PCWeek poll of corporations using programmable databases.

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limited set of commands available in server mode (on a character-based, not graphical, screen) and through a more extensive command set reached using the workstation software.

The first time you install Notes, you'll have a Lotus representative holding your hand as you learn the system. However, after six months, you'll be on your own, unless you get some sort of extended-support contract. To find out what life with Notes would be like without a service contract, the BYTE Lab installed its review system alone. The Notes server was a Tandy 4033LX 33-MHz 386 with 8 MB of RAM and an 80-MB Quantam SCSI hard disk drive. The operating system was MS-DOS 3.3, which was attached to a Novell network running NetWare 2.12A.

Configuring the server is a bit tricky. Using the workstation screens, you create a password-protected certifier ID; this is the master key to the Notes system. It's required to validate new Notes servers and users. Once you have the certifier ID, you move on to creating a domain, naming a server administrator, creating a name and address book for the server, and making a system ID for yourself. This is all done with fill-in-the-box screens, but it requires attention because much of the terminology is unfamiliar.

In theory, the installation of a Notes workstation is about the same as that of a server—fire up a floppy disk and follow the prompts. In reality, it may not be that easy. It wasn't at BYTE.

First, there is the question of memory. A lot of BYTE's computers don't have 490K bytes of memory free in their normal configuration, so the BYTE Lab had to adjust the CONFIG.SYS and AUTOEXEC.BAT files before anything could happen. This required some negotiating with users who were unhappy about losing TSR programs and drivers in the process.

Once enough memory was made available, the workstation installation proceeded smoothly, except for one bothersome glitch—Notes sometimes could not find NetBIOS on the workstation, even though NetBIOS was installed and running; this caused the installation to fail. Needed files were not transferred from the Notes server to the workstation. This requires either cleaning out the Notes directory entirely and starting from scratch, or editing the `notes.ini` file to delete all but its first two lines and starting the workstation installation process again. In either case, it's not something you'd do by choice at a 100-computer site. Lotus says that the problem is most likely caused by operating-system or network operating-system incompatibilities and would have to be diagnosed on a case-by-case basis.

Notes allows remote access over telephone lines. The idea behind this is to let field staff call in and use the Notes databases just as if they were in the office. Notes supports Hayes-compatible modems at speeds of from 1200 bps to 19,200 bps. The installation is simple point-and-shoot selection using Windows' radio buttons and check boxes—

*The first time you install Notes, you'll have a Lotus representative holding your hand as you learn the system.*

COM1, click; Auto (modem-speed select), click; enable port, click; OK, click. As easy as that. But the hardware end was a bit messier. Notes would not talk at all to the first modem that was tried (a Kyocera 1200-bps external unit). The BYTE Lab eventually got it talking to a Supra 2400-bps internal modem, but only after much switch-fiddling and initialization-string experimentation. Once the hardware and software recognized each other, life got easy again. Calling into Notes is, in fact, just like using Notes on a LAN—but slower. Lotus recommends 9600-bps modems for Notes, and using that speed can help.

### User Notes

When you open a Notes workstation on your computer, you see a typical Windows screen with a menu-selection bar across the top and six tabbed, stacked file folders in the main text area. These file folders are your workspaces and basic organizational tools. They hold your address books and other databases. You'll find some icons in one of the folders—at least server and personal name and address books and a mailbox. You can open any of the icons as you would in any Windows application.

You can have many views of a database. Your mail, for example, could be organized by sender, date, or keyword. Notes comes with seven database templates and has an extensive language for creating your own.

Notes will also import and export data from other applications. It recognizes Lotus 1-2-3 and Symphony worksheets; ANSI Metafiles; .GMC, .GMF, and .PIC files; graphics pasted from the Windows or Presentation Manager clipboard; Lotus Agenda files; word processing files from Lotus Manuscript, WordPerfect, Microsoft Word, MultiMate, WordStar, DisplayWrite; and any program that generates a plain ASCII file.

One of the comments from the BYTE staff using Notes was that it's slow. But this is more of a perception problem than a performance problem. A quick-and-dirty benchmark test, loading and saving a 66K-byte database imported from Lotus Agenda, gave times of about 1½ seconds to load and 1 second to close in Notes. In Agenda, the same database took 1 second to load and 1½ seconds to close.

### The Target of Notes

Notes is for large businesses. It carries a price tag of $62,500 and comes complete with installation help and training by Lotus representatives. You also get six months of maintenance and telephone hot-line support, and 10 sets of manuals.

That price may sound high, but if your business is large and you want a lot of Notes workstations, it comes out to a typical per-unit price for microcomputer software. Your $62,500 buys you licenses for 200 workstations. That comes to $312.50 per workstation. Additional licenses beyond the original 200 are $295 each and are valid for either a server or a workstation. There is a hidden cost, however. Like a LAN, Notes requires administration—one or more users to take care of it. The complexity of administration is up to the user.

If you can live with the lack of record locking in Notes, and if you have enough workstations to justify the cost, the program is worth a careful consideration. Notes's well-integrated collection of features should be easy for the nontechnical user to learn. And its ability to organize group discussions moves Notes far beyond any capability of regular E-mail. ■

*George Bond is a consultant in communications—electronic, traditional print, and person-to-person. He has more than 20 years' experience with major information companies and is cofounder of BIX. You can reach him on BIX as "gbond."*


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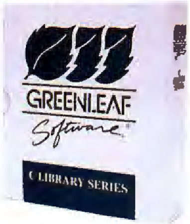


## Financial Mathlib
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Financial Mathlib, an unprecedented C library, furnishes programmers with hundreds of financial functions, such as amortizations, cash flow analysis, statistical, and interest calculations. All these are performed without rounding errors, using Greenleaf's exact decimal math. C programmers can now write great financial software easily!

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## Microsoft C 6.0
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The long-awaited C 6.0 is an integrated system of powerful tools for professional DOS, Windows and OS/2 developers. Compiled programs are smaller and faster than with C 5.1; new Source Browser allows interactive browsing through a project database.

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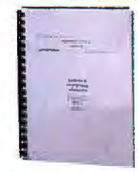
***FastFaxts 502-112***



## Cogent HyperBase
by Cogent Software

The ideal tool for creating intelligent hypermedia-based documentation. HyperBase hypertext, graphics, expert system capabilities of prolog & unlimited access to external programs. HyperBase is being used extensively for creating help desks, adaptive computer based training manuals and intelligent documents. No royalties with Developer Version. Requires MS-DOS, 512K memory.

HyperBase Dev. List $249 **PS Price $219**
HyperBase Pers. List $99 **PS Price $95**

***FastFaxts 1353-006***

***Circle 213 on Reader Service Card.***

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| **NETWORKS** | | |
| dBXL/LAN | 599 | 519 |
| Netware SQL | 595 | 519 |
| Netware C Interface | 295 | 239 |
| **OBJECT-ORIENTED/C++** | | |
| Actor | 695 | 639 |
| C Talk/views | 450 | 419 |
| C++ 80386 by Intek | 495 | 469 |
| Smalltalk/V | 100 | 85 |
| Smalltalk/V-286 | 200 | 185 |
| Smalltalk/V-PM | 495 | 469 |
| Turbo C ++ | 200 | 159 |
| Turbo C ++ Prof. | 300 | 259 |
| Zortech C ++ | 200 | Call |
| Zortech C++ Debugger | 150 | Call |
| Zortech C ++ Dev. Edition | 450 | Call |
| **OS/MS WINDOWS-SUPPORT** | | |
| C - Trieve/Windows | 395 | 329 |
| DESQview | 130 | 109 |
| Graphics Server SDK | 495 | 479 |
| MKS Toolkit - Unix shell | 249 | 229 |
| MS Windows/286 | 99 | 69 |
| MS Windows/386 | 195 | 139 |
| MS Windows Dev. Toolkit | 500 | 319 |
| OS/286 or 386 | 495 | 459 |
| OS/2 PM Toolkit | 500 | 369 |
| **OTHER LANGUAGES** | | |
| Modula-2 Dev. System | 249 | 229 |
| RPG II Dev. Systems | 1600 | 1469 |
| TopSpeed MODULA-2 Complr | 100 | 89 |

## WATCOM C 8.0/386
by WATCOM

WATCOM C 8.0/386 is 100% ANSI C optimizing compiler/runtime library for Intel's 80386 architecture, generating applications for 32-bit protect mode. Features include: protected mode version of the compiler; VIDEO full-screen source-level debugger; MS library-& source-compatibility; execution profiler; high proformance linker; graphics library; supports MetaWare High C 386 runtime calling conventions; SAA compatible.

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***FastFaxts 1044-004***

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| **OTHER PRODUCTS** | | |
| 386 Max Professional | 130 | 119 |
| Baler | 495 | 399 |
| Carbon Copy Plus | 199 | 159 |
| CO/SESSION | 249 | 229 |
| Dan Bricklin's PageGarden | 100 | 89 |
| The Duplicator Toolkit-Pro 3.0 | 129 | 119 |
| Fastback Plus | 189 | 159 |
| File Shuttle | 120 | 109 |
| Flow Charting II Plus | 229 | 179 |
| Headroom | 130 | 89 |
| HiJaak | 149 | 139 |
| LapLink III | 150 | 129 |
| Link & Locate ++ - ROM MSC | 395 | 349 |
| Math Advantage | 495 | 475 |
| Norton Utilities Advanced | 150 | 109 |
| Paginate by Accumatics | 99 | 89 |
| PC Anywhere III | 145 | 129 |
| PC Tools Deluxe 6.0 | 129 | 109 |
| PC Kwik Power Pack | 130 | 119 |
| Pizazz Plus | 149 | 129 |
| QEMM-386 | 100 | 89 |
| Remote2 | 195 | 139 |
| SpinRite II | 89 | Call |
| Time $heet | 150 | 135 |
| Coterm 220 | 245 | 219 |
| **TURBO PASCAL** | | |
| graphics-Menu | 149 | 139 |
| Turbo ASYNCH PLUS | 189 | 169 |
| Turbo Pascal 5.0 by Borland | 150 | 109 |
| Turbo POWER TOOLS PLUS | 149 | 109 |
| Turbo Professional | 125 | 109 |
| Turbo Programmer | 300 | 269 |
| **TEXT SCREEN ADD-ONS** | | |
| AEWindows | 499 | 459 |
| C Windows Toolkit | 100 | 89 |
| C Worthy w/forms | 295 | Call |
| Greenleaf DataWindows | 395 | 339 |
| Hi-Screen XL Professional | 325 | 289 |
| JAM by JYACC | 595 | 469 |
| MEWEL | 179 | 149 |
| POWERSCREEN by Blaise | 149 | 109 |
| Vitamin C - source, menus | 225 | 169 |
| VC Screen - painter | 149 | 139 |
| Vermont Views-Obj+Source | 890 | 819 |
| **UNIX/XENIX** | | |
| ESIX Systemss | | |
| ESIX/V 386 Devlp (2 user) | 595 | 569 |
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| Interactive Systems | | |
| Application Devel. 2 user | 1445 | 1349 |
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| Workstation Devel. 2 user | 1995 | 1869 |
| Workstation Starter 2 user | 495 | 469 |
| Santa Cruz Operations | | |
| XENIX 286 Complete Sys. | 1495 | 1279 |
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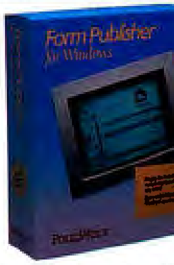


## Form Publisher for Windows
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DTP software designed expressly for making forms. Uses unique object-oriented design techniques; incorporate text from other programs; add graphics in PCX, MSP, and TIFF, or scan in your own. Compile forms into HP macros to print from other programs. Over 550 standards forms included.

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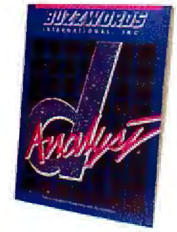

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| sPORT by WHS | 80 | Call |
| Trapper | 200 | 189 |
| Zortech C Debugger | 90 | Call |

**DEVELOPMENT TOOLS**

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| Documenter | 295 | 245 |
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| MKS Lex & Yacc | 249 | 199 |
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| c-tree by Faircom - source | 395 | 329 |
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| db_FILE/RETRIEVE - SU | 295 | 279 |
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## User Notes

When you open a Notes workstation on your computer, you see a typical Windows screen with a menu-selection bar across the top and six tabbed, stacked file folders in the main text area. These file folders are your workspaces and basic organizational tools. They hold your address books and other databases. You'll find some icons in one of the folders—at least server and personal name and address books and a mailbox. You can open any of the icons as you would in any Windows application.

You can have many views of a database. Your mail, for example, could be organized by sender, date, or keyword. Notes comes with seven database templates and has an extensive language for creating your own.

Notes will also import and export data from other applications. It recognizes Lotus 1-2-3 and Symphony worksheets; ANSI Metafiles; .GMC, .GMF, and .PIC files; graphics pasted from the Windows or Presentation Manager clipboard; Lotus Agenda files; word processing files from Lotus Manuscript, WordPerfect, Microsoft Word, MultiMate, WordStar, DisplayWrite; and any program that generates a plain ASCII file.

One of the comments from the BYTE staff using Notes was that it's slow. But this is more of a perception problem than a performance problem. A quick-and-dirty benchmark test, loading and saving a 66K-byte database imported from Lotus Agenda, gave times of about 1½ seconds to load and 1 second to close in Notes. In Agenda, the same database took 1 second to load and 1½ seconds to close.

## The Target of Notes

Notes is for large businesses. It carries a price tag of $62,500 and comes complete with installation help and training by Lotus representatives. You also get six months of maintenance and telephone hot-line support, and 10 sets of manuals.

That price may sound high, but if your business is large and you want a lot of Notes workstations, it comes out to a typical per-unit price for microcomputer software. Your $62,500 buys you licenses for 200 workstations. That comes to $312.50 per workstation. Additional licenses beyond the original 200 are $295 each and are valid for either a server or a workstation. There is a hidden cost, however. Like a LAN, Notes requires administration—one or more users to take care of it. The complexity of administration is up to the user.

If you can live with the lack of record locking in Notes, and if you have enough workstations to justify the cost, the program is worth a careful consideration. Notes's well-integrated collection of features should be easy for the nontechnical user to learn. And its ability to organize group discussions moves Notes far beyond any capability of regular E-mail. ■

*George Bond is a consultant in communications—electronic, traditional print, and person-to-person. He has more than 20 years' experience with major information companies and is cofounder of BIX. You can reach him on BIX as "gbond."*

# Computing Without Keyboards



People are pretty amazing creatures, if you think about it. Most of us have five senses: sight, touch, taste, hearing, and smell. Most of us have two legs to provide mobility and two hands for manipulation (we even have opposable thumbs to facilitate the task). On top of it all, our species has one of the most highly developed brains on the planet, endowing us with an awareness and intelligence that enable us to handle complex tasks. But only recently have we begun to realize some of these talents and capabilities in how we interface with our computers.

The graphical user interface was the first step toward recognizing that we are more than the sum of our keyboards—but it was only the first step. Although we tend to associate the GUI with the Macintosh, it has actually been around longer than that. In "Smoke and Mirrors," Bill Buxton makes a case for moving on to bigger and better things. After all, the GUI and its requisite sidekick, the mouse, are limiting our input options by letting one of our hands go to waste.

One improvement would be to enter notes and rough sketches directly into your computer without keying them. While this doesn't use more of our abilities, it saves transcribing such things from a notepad to a screen, a mindless task if ever there was one. In "Sign Here, Please," Gale Martin, James Pittman, Kent Wittenburg, Richard Cohen, and Tom Parish discuss the merits and uses of interactive tablets that enable these activities. In fact, you can enter signatures directly into the computer, bypassing the hard-copy step completely.

Another input option is voice. Imagine being able to talk to your computer while you use your hands or eyes for other purposes. What a great way to take notes on a long report. In "The Spoken Word," Kai-Fu Lee, Alexander G. Hauptmann, and Alexander I. Rudnicky delve into voice interfaces, in both theory and practice. The voice interfaces of today have come a long way from those of the past.

No matter how you look at it, the screens of most microcomputers are flat—relatively, if not actually—and require that you work in two dimensions. True, some packages let you create three-dimensional models, but what you see on the screen is either a 2-D flattened image of the model or a 2-D slice of it. Spatial information can make a great deal more sense in 3-D than in 2-D. In "Telltale Gestures," Paul McAvinney looks at various 3-D input options. One of them, 3-Draw, is a design tool that lets you sketch in 3-D. Emanuel Sachs describes it in the text box "Coming Soon to a CAD Lab Near You."

Of course, the pièce de résistance is the virtual environment. Got work to do? Just jump right in and get your feet wet. That may be a slight exaggeration, but the concept is fantastic enough to make you check for wet socks afterward. Actually seeing in 3-D requires some sort of stereoscopic vision. In "Living in a Virtual World," Scott S. Fisher and Jane Morrill Tazelaar examine the 3-D world of virtual environments. No more flat images here. You can get right inside the computer and experience its images in full 3-D.

User interfaces must meet the challenge of using more of our human capabilities. If they do not, they will become candidates for computer museums while they are still in use. Many of tomorrow's technologies are available today. Strange as they may seem at first glance—I too am much attached to my keyboard—they will broaden and expand our horizons and capabilities to meet the challenges of the 1990s and beyond.

*—Jane Morrill Tazelaar*
*Senior Editor, State of the Art*

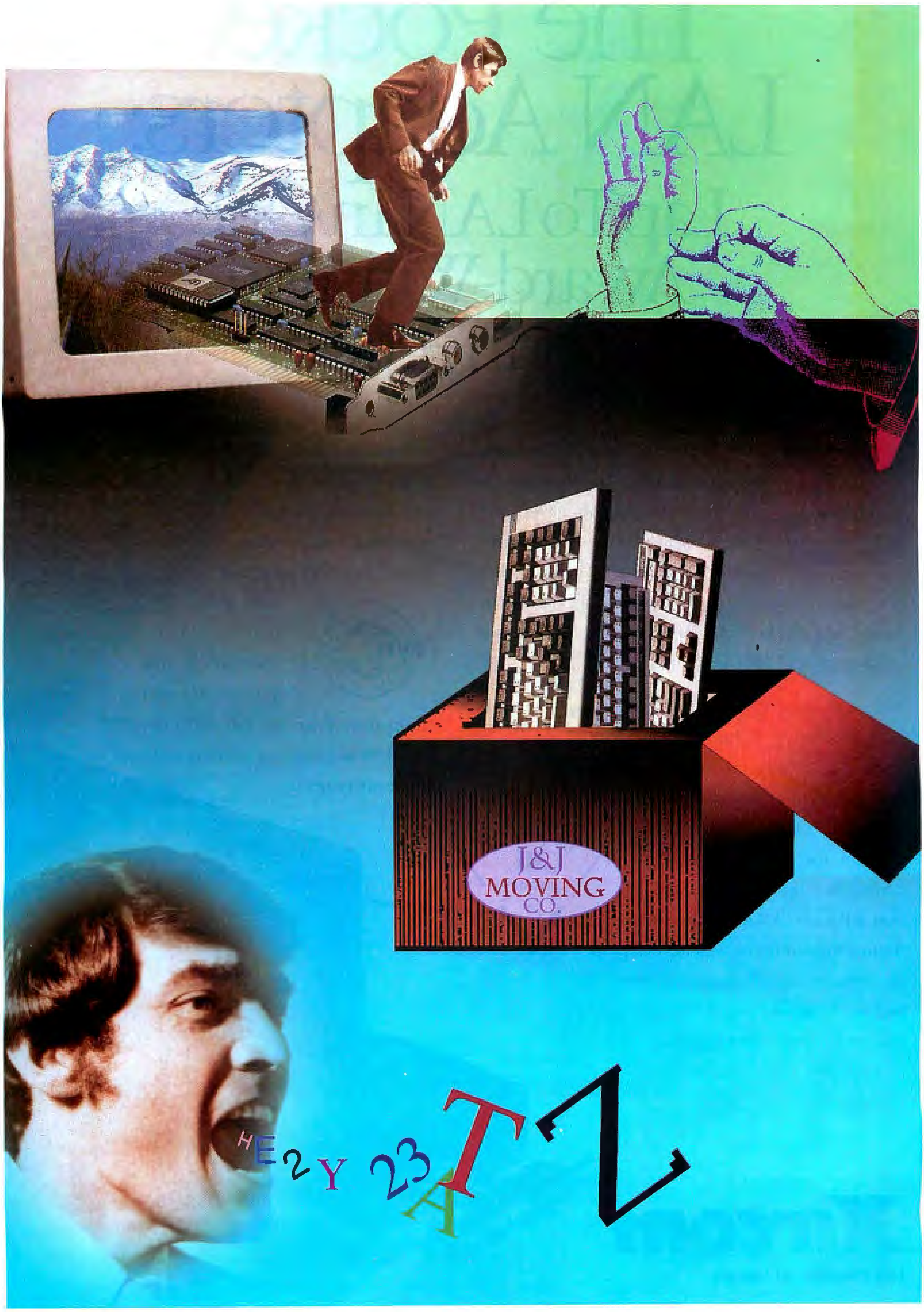


ILLUSTRATION: MARC YANKUS © 1990

# Smoke and Mirrors

*Every time I read about yet another GUI, I get this feeling of "déjà vu all over again." Isn't it time to move on?*

*Bill Buxton*

Little question remains that computers are more accessible today than they have ever been before. Introduced by the Xerox Star and popularized by machines like the Macintosh, the graphical user interface (GUI) has had a huge impact on the usability, usage, and usefulness of computers.

But now, nine years after the Star's introduction, I feel locked in a time warp. This sensation is reinforced every time I read about yet another GUI. Each one triggers a familiar flash of déjà vu.

Don't get me wrong. I'm not complaining that the PC and Unix worlds are finally becoming fit for human consumption. I have the highest respect for the teams that invented the GUI, but I just can't accept that there are no more significant breakthroughs to come.

In an industry as new as ours, it's too early to rest on our collective laurels. We can do far better than the "we can do GUIs, too" attitude that is all too common today. We can explore and champion some of the emerging alternatives to the GUI—alternatives as creative and important in today's environment as the Xerox Star was in 1982.

## In the Looking Glass

Rather than use a crystal ball to look into the future evolution of user-interface development, I prefer to employ a little smoke and three mirrors. Why mirrors? Because they are reflective.

Using the first mirror, you can ask, "How well does the system reflect the human motor/sensory system?" Does it acknowledge, for example, that most people have eyes, ears, feet, and *two* hands?

Using the second, you can ask, "How well does the design reflect the human cognitive or problem-solving mechanisms?" For example, does the system reflect how people think and make decisions?

Finally, the third mirror can test how well the technology reflects the sociopolitical structure of day-to-day life and work. For example, how does the technology reflect or support group activity or affect power structures?

Together, these three mirrors emphasize how user-interface design goes well beyond questions of how to best design menus, or whether to use a joystick or a mouse. To be truly effective, a design must provide a reasonably undistorted reflection from all three mirrors. Very few systems in use today stand up to this test.

Discussions of emerging or future systems tend to include the conflict between technology and user-driven design. Too often, change has been technology-driven, resulting in a tail-wagging-the-dog situation, which creates more problems than it solves. The loser in this conflict is usually the user.

*continued*

ILLUSTRATION: MARC YANKUS © 1990

Despite the pitfalls, however, technology is an important element, not as a force to drive future development, but because of the opportunities that it affords. Knowing the technology can help you create a better match between what can be done and what needs to be done. However, you need to approach the problem from both ends simultaneously.

## Look and Feel

The concept of "look and feel" has had a lot of attention recently. It encompasses those aspects of the user interface reflected in the first mirror—the motor/sensory system. Today's user interfaces have far more look than feel, and the use of sound is so impoverished that it does not even rate a mention.

Even the concept of "look" is impoverished. It is unidirectional and doesn't take into account the capability of the eyes to indicate direction (or to be used as an input device, as the photo illustrates). In short, the balance is out of all proportion with what people are capable of.

Technology may be able to render wonderful ray-traced images, but without mortgaging my house, I can't purchase a system that lets me draw a line whose thickness varies continuously with pressure (something I can do with a 15-cent pencil). One of the first priorities of the next generation of user interfaces, therefore, is to correct the imbalance that the first mirror reflects.

## MultiSomething

Multimedia is another topic that inevitably arises when discussing emerging technologies. The discussion usually includes two principal components: (a) Multimedia is the future! and (b) What is multimedia? The resulting debate is generally more than a little confused.

Much of the excitement about multimedia is well founded. However, by definition, multimedia focuses on the medium or the technology rather than on the application or the user. Therein lies a primary source of confusion. If you take a user-centered approach, you quickly see that it's not the medium per se that is important. Rather, it is the human sensory modalities and the channels of communication that multimedia uses that make it different. Therefore, the following terms might be more appropriate and focused:

- *multisensory*: using multiple sensory modalities;
- *multichannel*: using multiple channels, of the same or different modalities; and
- *multitasking*: recognizing that people can perform more than one task at a time (as driving a car demonstrates).

Seen in this light, the real value of multimedia is the role that it can play in smoothing out the distortions seen in the first mirror. From this perspective, you can reverse the question from "Why do I need two-handed input or audio?" to "Since I have two hands and two ears, why doesn't this system permit me to use them to full advantage?"

## The SonicFinder and Beyond

One of the most interesting pieces of software that is circulating in the research underground is something called the SonicFinder. It was developed at Apple Computer's Human Interface Group by Bill Gaver. The SonicFinder is a prototype of the Macintosh Finder based on the novel proposition that most people can hear. This may seem fairly obvious, until you look at the sonic vocabulary most computer systems use.

The SonicFinder uses sound in a way that reflects how it is used in the everyday world. You can "tap" on objects to determine their type (e.g., application, disk, and file folder) and their size (small objects have high-pitched sounds; large objects are low-pitched). When you drag an object, you hear a scraping sound. When a dragged object collides with a container (e.g., a file folder, disk, or the Trashcan), you hear a distinct sound.

All this may seem to suffer from terminal cuteness, but how many times have you missed the Trashcan when deleting a file, or unintentionally dropped a file into a file folder when dragging it from one window to another? Frequently, if you're like me. Yet these are precisely the kinds of errors that disappear when you add sound.

Machines that exploit sound are finally becoming more common. It started with the Commodore Amiga, which comes with rich audio and text-to-speech capabilities. Now, audio is becoming an important ingredient in other platforms (e.g., the NeXT machine). In fact, it is the major interface in some systems (see "The Spoken Word" on page 225).

The challenge is in learning how to use audio effectively, not just for music or to provide an acoustic lollipop, but as a means of providing a sonic landscape that helps you to navigate through complex information spaces.

## A One-Handed Waterloo

Just as most people can hear, most can also manipulate items with two hands. Every day, you turn pages with one hand while you write with the other. You steer your car with one hand while changing gears with the other. You hold a ruler or drafting machine with one hand and use a pencil in the other. All these tasks require everyday motor skills that computer systems largely ignore.

It seems to me that the Macintosh was designed for Napoleon: Unless you are typing, you can work all day with one hand tucked into your jacket. This is great if you are one-handed, but a waste if you're not. The image of the user reflected in the technology is lopsided.

"Hands-on" computing is largely a myth. It would be better called "hand-on" or even "finger-on." To accurately reflect human potential, a system should let you scroll through a document by manipulating a trackball with one hand and using the other to point with a mouse. You should be able to scale an object using a potentiometer in one hand, while dragging it into position with the other. Or, in a program like MacDraw, you should be able to move the drawing page under the window using a trackball in one hand and keeping the "pen" in the other.

High-end interactive computer-graphics systems have used this type of interaction for years, but it has not yet penetrated the mainstream microcomputer market. This is about to change.

## The Bus Stops Here

Many of the problems of having a variety of inputs are logistical: How do you connect this device to that machine? The Apple Desktop Bus (ADB) is a good attempt to address this class of problem. It provides an electrical, mechanical, and logical standard for connecting input devices to a computer. Thus, it becomes easy to mix, match, and change devices.

But perhaps the most important (albeit hidden) capability of the ADB is its ability to sense and distinguish among different simultaneously connected input devices. At the recent SIGCHI conference, Dan Venolia and Michael Chen of Apple's Human Interface Group demonstrated this capability using a mouse and a trackball together. The result was a prototype utility on the Mac that supported many two-handed transactions. This is a clear case of technology that supports human needs and suggests better things to come.

## Handling the Pressure

Just using two hands is not enough, however. Another ability that people have that current technologies don't reflect is the hands' ability to control and sense pressure. One place where this has been recognized and used is in electronic musical keyboards. Each key has what is known as "aftertouch"—the ability to sense how hard the key is being pressed.

Hopefully, aftertouch will soon be standard on mouse buttons, providing natural control for line thickness, scrolling speed, and the speed of fast-forward or rewind on videos and CD-ROMs. A few manufacturers, such as Wacom and Numonics, already make pressure-sensitive styli for digitizing tablets.

But no matter how well the look, feel, and sound of a user interface are developed, it still may not fit how you think or how you work; therefore, it will fail. Understanding these elements brings the second mirror into focus.

**Data Overload**

Would-be sages and futurists will tell you that we are in the middle of an information revolution—a revolution whose impact is matched only by the one that followed the invention of the printing press or the industrial revolution. Unfortunately, this is false.

By definition, information is that which informs and can serve as the basis for informed decision-making. Rather than an information revolution, the current situation is more of a data explosion. The combined advances in contemporary telecommunications and computational technologies have helped to spawn an era where true information is more and more difficult to find, and almost impossible to find in a timely manner.

Information technologies that deserve the name are less computational engines than technologies that filter and refine data into a form where it informs. Just as you want systems to reflect how you hear, see, and touch (the first mirror), you want them to accurately reflect and support how you think, learn, solve problems, and make decisions (the second mirror).

The spreadsheet is one of the greatest successes in the microcomputer world because it fits the way that people think about certain problems. Rather than generate masses of new numbers, it helps you refine data into information by enabling you to explore and understand new

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*A nonintrusive eye tracker. A video camera mounted under the display tracks the position of the eye's pupil and translates the data into screen coordinates. Thus, the eyes can "point." (Photo courtesy of L. C. Technologies, Fairfax, VA)* relationships. A similar notion is behind one of the emerging "hot" topics of computer science: scientific visualization. Its objective isn't to make pretty pictures (although many are) but to render complex data in a visual form that enables you to better understand the underlying phenomena.

Thus far, scientific visualization has been primarily a means of presentation. Data is rendered and displayed, but the degree of interaction is minimal (largely due to the computational overhead of the rendering process). However, as machines become more powerful, such rendering techniques will be married to state-of-the-art input technologies, thereby creating rich interactive systems for exploring information space. (The technologies discussed in "Living in a Virtual World" on page 215 and "Telltale Gestures" on page 237 are examples of trends in this direction.)

**Alone in the Corner**

Back in grade school, when I misbehaved, I was taken out of the group and forced to sit alone, usually facing the wall or a corner. Now that I've grown up and have a computer, where do I find myself?—out of the group, sitting alone, usually facing the wall or a corner. The reasons are different, but the punishment is the same.

The designs of the technologies used in today's workplace have largely ignored the social dynamics (the third mirror) of how people work. You face walls because the backs of the machines are so ugly and full of cables that you want to hide them. You are anchored to your designated position by the umbilical cord connecting your computer to the wall socket. You sit alone because virtually all microcomputer systems assume that you interact with computers one on one, face to face.

**Instruments of Change**

Technologies have had a major impact on how you work, with whom you work, and who has what power. That isn't likely to change. What can change, however, is who or what is in the driver's seat.

In the past, work has been automated and technologies introduced based on what was possible. If a new technology became available, it was put in the workplace and the organization had to adjust accordingly. Since routine tasks were the easiest to program, they were the first to have technological support.

Of all the user-related changes emerging today, perhaps the most significant is the change from this approach. We are beginning to realize that rather than the technology dictating the organizational structure, the organization should dictate the technology. The key to improved productivity isn't the technology—it's the people and how they work.

I can't overemphasize the importance of this change. No matter how perfectly your icons and menus are designed, or how well a system supports you in performing your job, if you are doing the wrong job, the system is a failure.

For example, putting computers into patrol cars is intended to help police perform their job. But if the technology causes the police to devote more time to relatively minor offenses (e.g., unpaid traffic fines) instead of to major crimes, the system may be a failure. The courts are clogged with minor offenses, and little has been done to help investigate serious crimes.

**A New Breed**
The past 10 years have seen the development of a new profession: applied psychology. Traditionally, psychology has been a discipline that analyzed and tried to understand and explain human behavior. Now, largely due to problems encountered in human-computer interactions, a new branch of psychology is attempting to apply this understanding in the context of a design art. The shift is from the descriptive to the prescriptive.

Today, a similar phenomenon exists in the discipline of socio-anthropology. If you want the society and social structures of work (and play) to drive technology, the obvious place to look for expertise is in disciplines like sociology and anthropology. Like psychology, these are traditionally analytical, not design, disciplines. However, change is coming, and a new discipline is being born: applied socio-anthropology.

Hence, a new breed of anthropologists, such as Lucy Suchman and Gitte Jordan (who last studied birthing rites in Central America), are stalking the halls of the Xerox Palo Alto Research Center. They are studying the structure of organizations and work, with the intent of laying the foundation for a design art that takes into account the larger social context. Like psychology, socio-anthropology is becoming a prescriptive as well as analytical science.

**Group Dynamics**
Perhaps these social concerns are most visible in the rapidly emerging areas of computer-supported cooperative work and groupware (see the In Depth section of the December 1988 BYTE). This is a prime example of the outside-in squeeze. On one side, theory is growing out of the applied social sciences; on the other, important enabling technologies—such as LANs, new display technologies, and video conferencing—are emerging.

Architectures like Xerox's prototype System 33 will enable you to create, save, index, annotate, retrieve, and share documents independently of how they were created or stored. Human concerns, such as retinal consistency (i.e., documents' tendency to remain visually consistent) and the reality of different platforms, will drive the design.

Telecommunications, video, and computer LANs are converging, resulting in new forms of collaboration, such as the Cruiser system developed at Bell Communications Research by Robert Root and Bob Kraut, and Xerox's Mediaspace. By integrating a range of technologies, both systems permit a degree of telepresence and remote collaboration previously impossible.

Slowly but surely, the emerging technologies are going to let you come out of the corner to take a full and active role in the group. As all three mirrors start to work together, they will let you do what people do best—namely, be human.

**Bringing Blue Sky Down to Earth**
The danger in writing about technology and the future is that you quickly fall into the credibility gap. I have used some isolated examples to support my case for the inadequacy of the GUI to meet the needs of today and tomorrow. But are they only isolated examples, or is there some evidence of a new trend?

Evidence for a new approach to user-interface design can be found in machines such as the GridPad, Scenario's

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DynaWriter, Toshiba's PenPC, Sony's Palmtop, and Go Corp.'s new laptop. All these machines have portability and on-line character recognition in common (see "Sign Here, Please" on page 243).

These differences lead the way to more than just a change of interaction style. By being portable, the machines are freed of the anchor of their power cord. The technology can go with the worker, rather than the worker going to the technology. This is an important change.

Similarly, compared to the GUI, the stylus-driven interface better matches the style of work and skills that people have built up over a lifetime of work and education. While the systems' recognition skills are still fairly primitive, this style of interface leads toward a way of capturing all kinds of spatial and temporal information, such as the types of figures and annotations found on blackboards and notepads.

Several different techniques have been used for symbol recognition, including template matching, feature recognition, and neural networks. An early but elegant feature-recognition technique, called *trainable character recognition*, was developed by K. S. Ledeen in 1967. It is described in detail in Newman and Sproull's classic *Principles of Interactive Computer Graphics* (McGraw-Hill, 1973 and 1979). [Editor's note: *Pseudocode for the Ledeen character recognizer is available on BIX. See page 5 for details.*]

Being mobile still may mean working alone. But the wireless network communications of the Agilis System point toward a time when mobile workstations will be able to communicate with each other, and with larger systems such as servers.

Perhaps nowhere do these concepts come together better than in the new portable from the Active Book Company in Cambridge, England. This package has true workstation power (5 million instructions per second average, 10 MIPS peak) in a portable package powered by the Acorn RISC Machine's RISC processor. In addition to having a stylus-driven interface with character recognition, it includes a touch surface that you can use to "thumb through" the documents you are reading or editing.

The true power and insight of Active Book's machine come, however, from other emerging technologies, especially the new Digital European Cordless Telecommunications standard. In mid-1991, there will be a new pan-European cellular phone network, known as D1, that will have a digital channel with built-in error correction. Portable workstations like Active Book's will be able to network from anywhere in Europe, even when in motion, thus greatly increasing the range and scope of both telecommunications and information technologies.

People should and must be at the center of all these new technologies. As these technologies evolve, the concerns become more complex and demand ever greater attention. But I would argue that there are grounds for optimism. As technologies evolve, so do the methods and theories of design and analysis. New capabilities are emerging, and if you and I so choose, we can reap their full potential by design in human terms. ■

*Bill Buxton is an adjunct professor of computer science at the University of Toronto and a consultant for Xerox PARC and Commodore Business Machines. You can reach him on BIX c/o "editors."*

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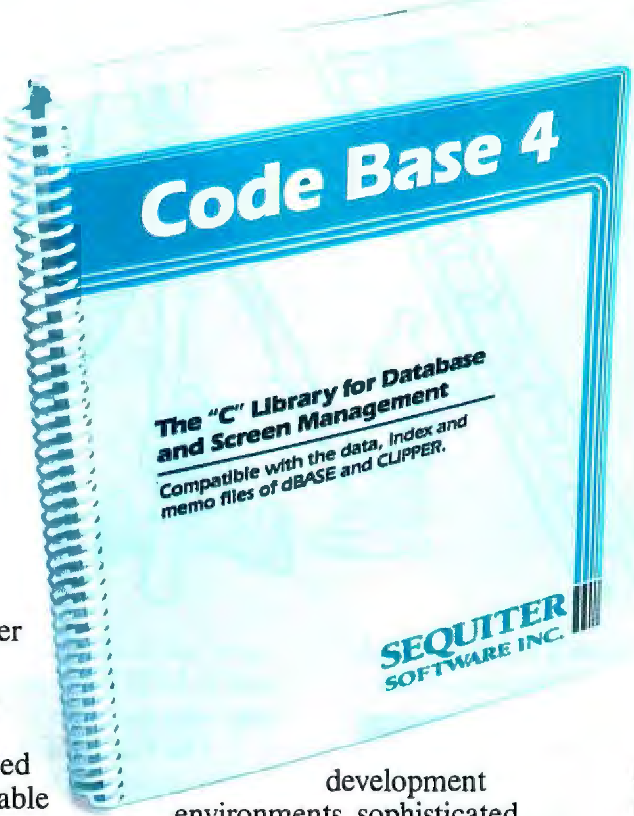


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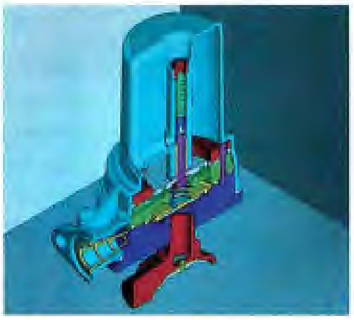

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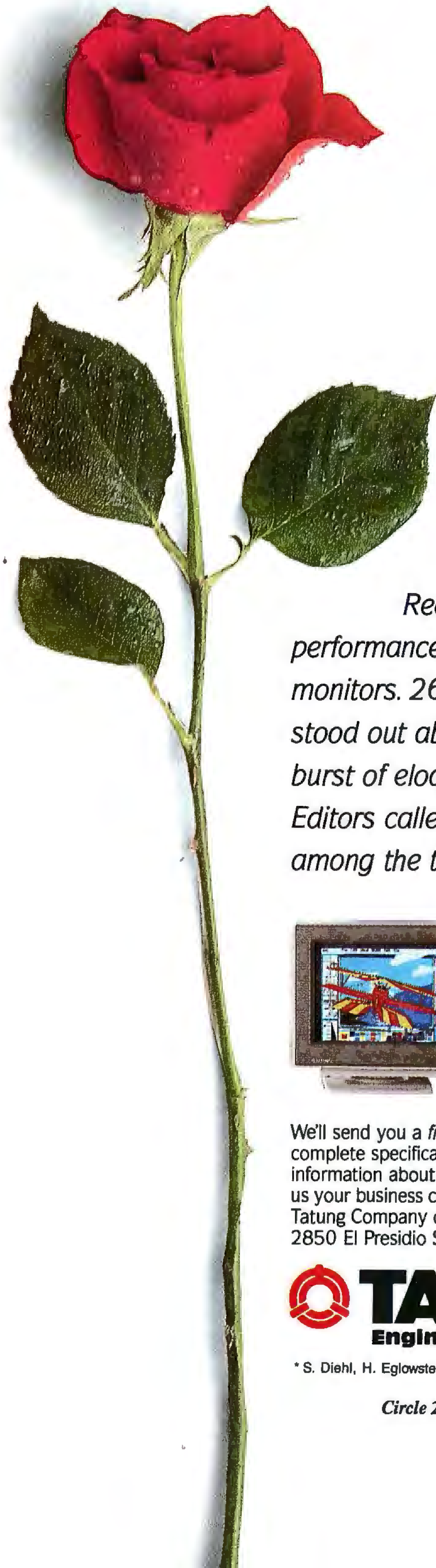

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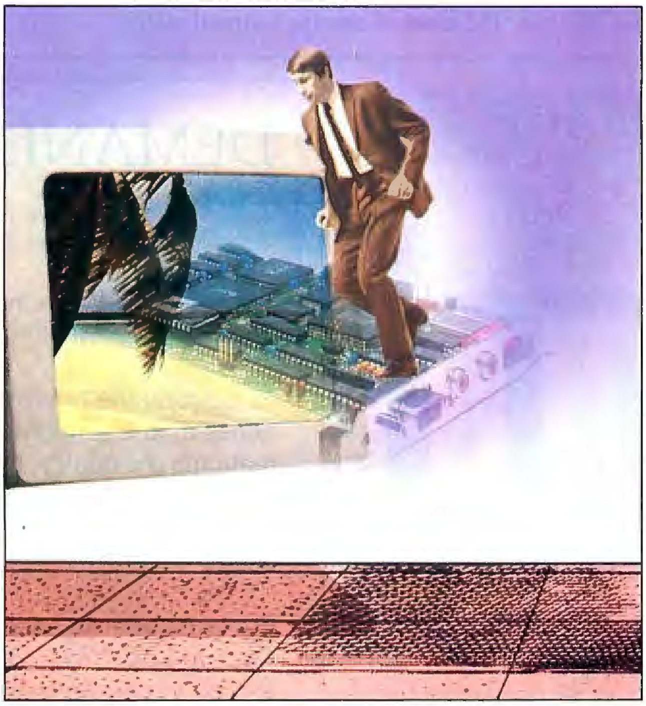
# Living in a Virtual World

*Stereoscopic vision lets you enter 360-degree 3-D virtual environments—and do real work there*

*Scott S. Fisher and Jane Morrill Tazelaar*



Imagine learning about computers by taking a trip inside them. You can look to the left or the right as your whim dictates because you have a complete 360-degree image-surround viewpoint available. If a particular chip catches your eye, you can approach it and look at it from all sides. You can see firsthand how it connects to the board and how it relates to other chips. You can "walk" the circuits to see where they lead. If you see something that you don't understand, you can pick it up and examine it more fully. Sounds like *Tron*, doesn't it?

Imagine creating a three-dimensional model with a CAD package. But, instead of viewing it on a 2-D screen, you put on a headset or turn to a stereoscopic viewer and move into 3-D space with your model. You move around the model and into it, seeing it from all sides, looking for errors, making sure that what you created was what you intended to create, and fixing problems in real time.

Once again, science fiction is turning into science fact. Three-dimensional virtual space is becoming another option in the panoply of interfaces available. And the more you think about it, the more applications come to mind. Architects could tour their buildings during the planning stages, thus discovering problems while they're easily and inexpensively fixed. Doctors could practice delicate surgery without risk to the patient. Computer operators could enter a virtual data environment, manipulate data and monitor system tasks, move windows around in three dimensions, push simulated buttons on virtual control panels, or reconfigure the system as needed without leaving the console.

A variety of technologies enable this dimensional switch. One is the stereoscopic vision that allows you to see in three dimensions. In the real world, depth and distance perceptions are possible because we have two eyes, each of which sees the world slightly differently. To translate this ability to the virtual world, that perceptual difference must be maintained. Therefore, two screens are necessary, each of which provides a slightly different view of the subject. And for each eye to see only the screen containing its view of the world, these screens must be shown only to the appropriate eye. Head-mounted devices and stereoscopic viewers provide this type of interface.

## A New Style of Headgear

One of the leaders in the research into head-mounted devices is NASA's Ames Research Center. The intent is to provide a multisensory, interactive, 3-D interface for use with the space program, but the resulting environments and devices

*continued*

are far more versatile than that focus would suggest. The scientists at Ames have developed the Virtual Interface Environment Workstation (VIEW), a wide-angle, head-mounted, stereoscopic display system that the operator's voice, position, and gestures control (see photo 1). This system enables you to explore all 360 degrees of a virtual environment and interact with it in various ways.

The idea of surrounding an operator in a 360-degree virtual world is not new. In 1958, Philco developed a remote stereo-camera pair and head-mounted display. And Dr. Ivan Sutherland helped to create a head-mounted transparent 3-D display system while he was at Harvard. Some current head-mounted devices show a 2-D display to one eye while the other sees the real world. (See the text box "You Say You Want an Evolution" on page 218.)

The original head-mounted displays developed at NASA Ames were retrofitted into a motorcycle helmet. The visor contained two LCDs, one for each eye, with 100- by 100-pixel screens. The current headset, however, is much lighter and far less claustrophobic than this helmet was. The ultimate aim is to come up with a simple visor-like apparatus. Several devices on this order are currently in prototype. In addition to their 3-D display capabilities, they also include a head-tracking device, a microphone to be used for continuous-speech recognition, and earphones for 3-D sound cueing.

**Photo 1:** *VIEW is a wide-angle, head-mounted, stereoscopic display system controlled by the operator's voice, position, and gestures.*

The sense of entering a virtual reality is reinforced by the wide-angle image that can be generated in high resolution (up to 1000 by 1000 pixels). The image appears to surround you, and the head-tracking technology (with six degrees of freedom) enables you to change your point of view by simply turning your head. The effect is one of being present within a computer-generated (or remote-camera-recorded) world. To maintain this effect, the image is updated in real time (up to 30 frames per second) when it changes. In addition, the two displays are closely synchronized to present coordinated images to the eyes. Eye cups are used to prevent any ambient light from interfering with the illusion.

As the technology evolved, so did the desire to be able to interact with the virtual environment—to touch its objects, pick them up, examine them, and even speak to or about them. NASA Ames also developed enabling technologies that allow interaction with this virtual world. This interaction can be tactile (using touch-oriented technologies), verbal (using speech recognition), or optical (using eye-tracking technology).

*continued*





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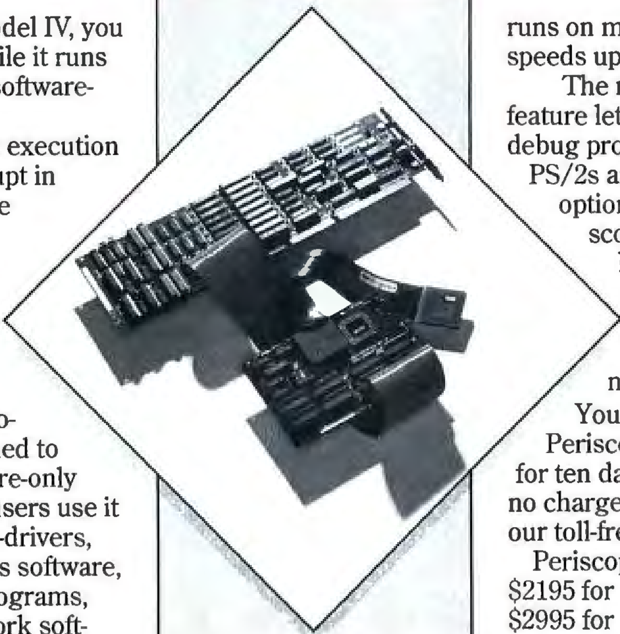

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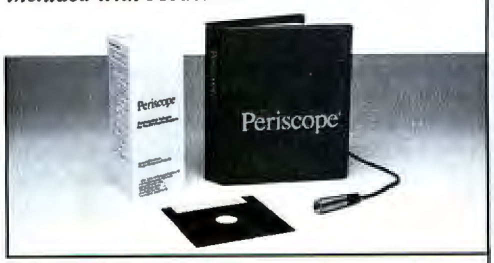


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# You Say You Want an Evolution

Bob Ryan

Not all advances in man-machine interfaces involve radical new technology. Some advances are more evolutionary, although they can have revolutionary effects.

A case in point is The Private Eye, a computer monitor from Reflection Technologies (see photo A). Like the CRT display on your desk, it outputs characters and graphics from a personal computer. The difference is that The Private Eye weighs a mere 2¼ ounces and fits easily in the palm of your hand.

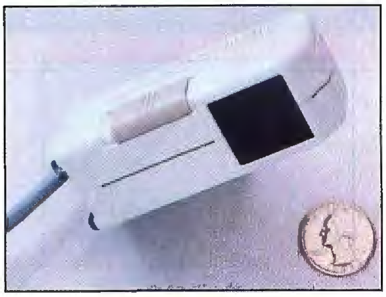

**Photo A:** *The Private Eye computer monitor is more useful than it may first appear. It lets you view important data while simultaneously working on tasks, and it provides the ultimate in portability.*

### Red Lights and Mirrors

The Private Eye uses a 280-element LED, an adjustable lens, a vibrating mirror, and the persistence of your vision to produce a 720- by 280-pixel display in a viewing window less than 1 inch square. It produces CGA text using a 9- by 11-pixel font instead of the normal 8 by 8, and standard 640- by 200-pixel CGA graphics.

Unlike a conventional CRT display, which "paints" its output 1 pixel at a time from the top left to the bottom right of the display, The Private Eye works with whole columns of pixels at once. When attached to a personal computer, for example, it gets each output frame from its specialized display-adapter card and stores the frame in a buffer. It then uses the data for the first column of the display to activate its 280-element LED. A mirror reflects this output into a lens, which focuses it onto your eye.

Next, the second column of the display activates the LED, while the mirror changes angle slightly so that the second column is reflected to the right of the first. It repeats this procedure for all 720 columns of the display, 50 times per second. Because your eye fools your brain into thinking that it sees all 720 columns at the same time, you see the complete 720 by 280 display.

### Focal Points

Because The Private Eye uses a lens instead of a screen, you can focus its output to appear close at hand or far away. This is important, because The Private Eye works with one eye only. To prevent eyestrain, you focus both eyes on the same object and then focus The Private Eye so that it appears as far away as the distant object. The output is thus superimposed over the background.

Because you don't constantly change focus between your display and the background, The Private Eye lets you work at other tasks while viewing important data. With the headset attachment, it also frees your hands for other tasks. For example, a surgeon could position The Private Eye for viewing vital patient information with an upward glance without breaking concentration.

In addition to providing freedom for hands and eyes, The Private Eye also obviously redefines the lower limits of portable computing. Systems using it promise to make vest-pocket computers a practical reality. The Private Eye can also enhance the utility of products that don't currently have a full-size display. For example, it can add display capability to a hand-held fax or a radio pager.

### Changes in Perception

While The Private Eye uses some very interesting technology, it does not represent a new paradigm for getting information from a computer. It remains a recognizable member of the family of computer displays.

What The Private Eye demonstrates is how an evolutionary advance in technology can change how we interact with computers. By making displays more portable and less obtrusive, it makes many more areas accessible to computers. Imagine what the next evolutionary advance will bring.

*Bob Ryan is a BYTE technical editor. He can be reached on BIX as "b.ryan."*

### It's What's Inside That Counts

Within the headset, the twisted-nematic, monochromatic LCDs accept a standard National Television System Committee signal and need some sort of backlighting (current versions use very bright, miniature fluorescent tubes that create a contrast ratio of about 7 to 1). The current size of each display is 3.9 inches (on the diagonal) with a 4-to-3 aspect ratio.

LCDs were used because they are lightweight, safe, and inexpensive, and they draw little power. Their resolution at present is 640 by 220 pixels with approximately 16 levels of gray scale. They are viewed through a pair of wide-angle magnifying lenses mounted about 5 millimeters from the screens. These lenses distort the displayed image with a "pincushion" effect. To compensate for this distortion, the image capture or generation technology must create a "barrel" distortion compensation in order to represent the image correctly.

The very wide-angle field of view of these optics is also key in the display. The feeling of being in a virtual world requires that the field of vision closely resemble that of human binocular vision. A small window into the virtual world will not suffice. The displays must completely fill your field of vision to give you a true sense of being present in the virtual environment (120 degrees both horizontally and vertically, with up to 90 degrees overlap in the binocular fields).

The headset also contains a tracking device that detects where within the environment you are looking. Currently, NASA Ames is using an electromagnetic device for this purpose, one that can determine where the head is within a magnetic field. It combines azimuth elevation and roll information with $x,y,z$ position information (with 0.03-inch resolution and 0.10-degree accuracy). With this information, the system can refresh the image shown to one that matches the position of your head. New images are drawn so quickly that it feels as if you're

*continued*

## An Alternative Approach

The counterbalanced CRT-based stereoscopic viewer provides an alternative virtual-environment viewing technology that should be easier to integrate into the typical desktop environment than the head-mounted device. Its display characteristics are similar to those of the headset. However, the CCSV sports handles with which you can move it around to a convenient position, much as you would a pair of binoculars (see photo B).

Although the CCSV is not head-mounted, it is head-coupled. The device is mounted on a counterbalanced kinematic linkage (permitting unrestricted motion within a 35-inch radius from a fixed point of attachment) and includes a dual-CRT-based stereoscopic viewer with wide-angle optics, a dedicated microprocessor system that monitors joint angles in the linkage, and a video-electronics box.

The device includes a dedicated 8088 microprocessor card, an A/D conversion card, and an RS-232C communications card housed in an STD-bus box. The software that is executing on the microprocessor polls the RS-232C line waiting for data requests from the host. When a data request comes, the STD system assembles the current values of the six A/D channels (one for each of the joint readings that the host translates into angles) into a 12-byte packet. Then it sends this packet over the RS-232C interface to the host at speeds of 9600 bps to 19,200 bps. (In the next version of the CCSV, NASA Ames is planning to replace the STD box with an IBM PC or AT.)

The CCSV provides a wide field of vision, 360 degrees of freedom, and a strong three-dimensional illusion, and it lets you easily enter and leave its virtual world. Imagine how awkward it would be to try to take a quick peek at something through a head-mounted device.

### How Does It Differ?

This viewer uses two inexpensive ($50) black-and-white TV screens (4½ inches on the diagonal and with a 4-to-3 aspect ratio) with integral implosion protection and meeting radiation x-ray emission standards. CRT faceplates are flat (within 0.006 inch) for both internal and external phosphor-bearing surfaces. In this case, flat matters; the optics of the CCSV were designed assuming a flat-image source.

The CRT screens display about 400 lines each. While this resolution is quite modest, compare it to the headset's LCDs (about 220 lines each). The color mask used by current color LCDs further reduces their effective resolution by more than 50 percent, so the improvement in the resolution is quite noticeable.

**Photo B:** *The CCSV, a stereoscopic viewer fixed on a counterbalanced kinematic linkage, lets you easily enter and leave the virtual world.*

You can place diffusion filters in front of the LCD to reduce the graininess, but they blur the images. The filters also blend the color triads. Since the CRTs in the CCSV are analog devices, they have no shadow mask. Thus, individual pixels appear as a smooth image rather than as an array of dots.

### But It's Not Perfect

The optics in the CCSV introduce a chromatic aberration that appears more pronounced than that in the LCD viewers. It is particularly noticeable along the borders of computer-generated images; the change in contrast creates a blue or yellow fringe effect. This is probably due to the increased contrast ratio of the CRTs. Using color CRTs wouldn't solve the problem, because the shadow mask would be visible through the wide-angle optics.

The CCSV also suffers from the pincushion distortion seen in the headset. Again, this distortion is balanced with an equal but opposite barrel distortion when using a remote camera. Computer-generated graphics, however, don't compensate for this problem, but it's not as distracting as you might think. You have to really look to find it.

Another problem with the CCSV occurs in a group work environment. As you pass the device from one person to another, the viewpoint changes. It would be nice to have some sort of "viewpoint freeze" button on such a unit so you could easily pass the device to someone else and know that he or she will see the exact same point in a 3-D image that you were looking at.

really there (the typical pixel response time is about 32 milliseconds).

There are some disadvantages to the headset approach. For one, while you're wearing a headset, you're pretty well tethered to one place. For another, it's more complicated to switch back and forth between different tasks if you have to take off the headset every time you want to see something outside the virtual world. And you may need to view some things in higher resolution than the current LCD-based headsets allow. Thus, a separate CRT-based stereoscopic viewer was developed to supplement, and in some cases replace, the headset (see the text box "An Alternative Approach" above).

Another technology under investigation at NASA Ames is eye tracking. Eye tracking will reveal the point at which your eyes converge—that is, where they are focused. Thus, you could pull down menus or move a cursor simply by looking at a certain point. In addition, the options for depth-of-field information increase when eye tracking is used. (For more information on eye tracking, see "Between Man and Machine," September 1988 BYTE.)

Plans for the VIEW system's near future include

- correcting the distortion problem on computer-generated images,
- speeding up the frame refresh rate,

- raising the resolution,
- adding color display elements,
- adding spatially correct 3-D sound cueing,
- providing tactile feedback,
- integrating multiple viewpoints, and
- creating multiple workstation configurations that allow the various operators to be present and interactive in the same virtual environment.

### A Portable, Interactive Workspace

Unlike most 360-degree virtual environments, such as flight simulators, VIEW doesn't use large, special-purpose projection configurations. It is portable and inexpensive and doesn't require a large amount of space or equipment. Compared to other head-mounted displays, it is unique; it presents a stereoscopic image that is very similar to human binocular vision. It also uses state-of-the-art speech, auditory, and tactile inputs.

The VIEW system provides a level of interaction that can reduce your workload and training requirements while increasing your productivity. It does this by providing a uniform, graphical interface for a variety of tasks, and multimodal channels for speech, touch, and vision inputs. Seeing task-related information in a full 360-degree 3-D environment can increase your awareness and effectiveness in monitoring spatial tasks and spatial portrayals of 2-D tasks. ■

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# The Spoken Word

*Replace the "look and feel" of GUIs with the "ask and tell" of voice interfaces*

*Kai-Fu Lee, Alexander G. Hauptmann, and Alexander I. Rudnicky*


Although you no longer use toggle switches to communicate with computers, computer input is still more of a barrier than a gateway for the average person. Voice interfaces offer the possibility of interacting with computers using our most natural and best-developed communication skill—speech.

The promise of speech-recognition technology is that it will remove the communications barrier between people and their machines. It will make the power of computers available to everyone, and it will help those who use computers daily to do so more effectively.

Besides ease of expression, speech offers many other advantages in communicating with your computer. Speed is one: Most people easily speak at rates of 200 words per minute, yet few can type better than 60 wpm. Speech can also remove some of the physical limitations of interacting with computers: You could control your computer while working in the dark (say, in a photographic darkroom) or without sitting at the keyboard (e.g., while rummaging through a file cabinet or reading in information over a telephone).

Speech recognition can even let you use a computer in places where it would otherwise be impossible or dangerous—imagine being able to use a voice-activated navigation assistant while driving your car.

Although speech is not the ultimate mode of input (you might not want to talk for 8 hours straight every day, or describe pictures verbally), it nevertheless offers unique advantages not available in other types of interfaces.

## Speech Background

Two decades of R&D have established the importance of the following dimensions in understanding the properties of a given speech-recognition device:

• Speaker dependence versus independence: A speaker-dependent system is trained to recognize only a single voice. A speaker-independent system can recognize anyone's speech, but with less accuracy.

• Discrete words versus continuous speech: A discrete-word system (also called an isolated-word system) requires pauses between words. Continuous-speech recognition lets you speak in a natural manner, but it is more complex and error-prone.

• Vocabulary size and grammar complexity: A system vocabulary defines the set of recognizable words, and the grammar defines the types of sentences (i.e., word sequences) allowed or preferred. Small vocabularies and restrictive grammars are easier for speech recognition,

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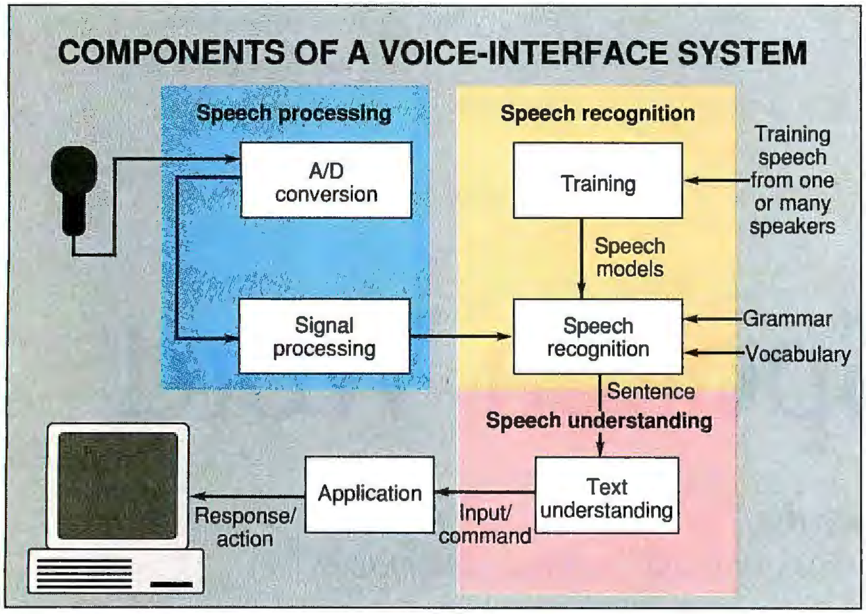



**Figure 1:** *A voice-input system consists of three primary components. Speech processing converts spoken utterances into a digital representation of the input using A/D conversion and signal-processing techniques. Speech recognition matches the input representation with models built into the system. Vocabulary and grammar constraints eliminate many alternative interpretations. Speech understanding is a higher-level function that tries to make sense of the input. Small domains can be understood fairly well, but current systems don't deal well with unconstrained speech.*

but systems with large vocabularies and loose grammars are more useful.

• Speech recognition versus speech understanding: A speech-recognition device produces a sequence of words, while a speech-understanding system tries to interpret the speaker's intention.

All voice-interface systems—both commercial and research—strive for high accuracy. Invariably, they achieve it, but only by compromising on one or more of the above dimensions. When you select a system, you must carefully consider your needs and understand the capabilities your application requires.

Figure 1 shows a common organization for voice-interface systems. All of them have, in one form or another, three components: speech processing, recognition, and understanding.

## Sound Bites

Speech processing is a sequence of transformations that converts an analog speech signal into a compact yet informative digital representation of speech. It is essentially a signal-processing function. A microphone converts the changes that the speech causes in air pressure to voltage variations. The system samples these variations and digitizes them using an A/D converter. A system typically samples spoken input 6000 to 20,000 times per second, with each sample consisting of about 12 bits to ensure adequate representation of the sound. The sequence of numbers thus created is called the *digital waveform.*

In principle, you could try to directly recognize the digital waveform. But because a 5-second utterance may produce up to 100,000 numbers, such processing is prohibitively expensive. Also, the waveform contains both redundant information and unimportant variations; processing it all would also be redundant and inefficient. Accordingly, speech systems apply digital-signal-processing techniques to reduce the redundancy and to enhance the salient features of speech. These techniques typically generate a descriptive vector of about eight to 20 floating-point numbers for each 0.01 second (centisecond) of speech.

Common reduction techniques include filter banks and fast Fourier transforms that, for each centisecond of speech, determine the energy level in different (usually logarithmically scaled) frequency bands, and linear predictive coding, which generates a vector of the coefficients of a linear equation that predicts the spectrum of the current centisecond of speech, based on previous samples.

These techniques produce about 1000 to 2000 floating-point numbers per second of speech, about an order of magnitude reduction from the waveform. Essentially, no information is lost in this representation, because resynthesized speech sounds about the same as the original speech. To gain further efficiency at a small loss in accuracy, some systems compress speech to as few as 200 bytes per second.

## Matchmaking

Speech recognition involves comparing an utterance—now a sequence of representation vectors—against prestored speech models, subject to lexical and grammatical constraints. In all cases, you need to train speech models before you can use the system for recognition. These models can be based on a number of speech units, depending on the approach taken. Some of them include whole words or phrases, syllables, and phonemes. Some of the common modeling techniques include the following three:

• *Dynamic time warping*, which matches speech patterns against prestored pattern templates by temporally aligning them using dynamic programming algorithms. DTW models are trained by averaging several exemplars of each word in the vocabulary. DTW is widely used in commercial speech recognizers.

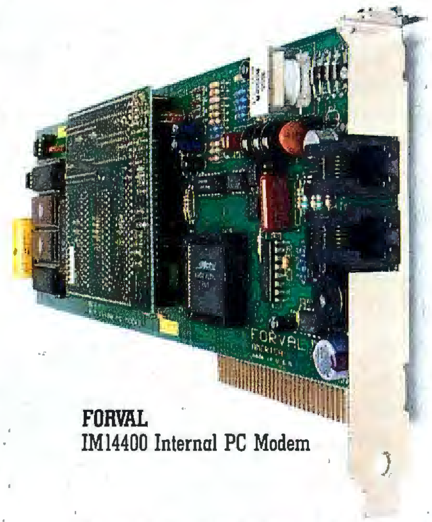
• *The Hidden Markov model*, which abstracts properties of speech in a probabilistic framework. Using automatic algorithms, the system learns probabilities of speech events and their durations. HMMs have superior generalization ability, and they have been found suitable for large vocabularies and continuous-speech, as well as speaker-independent, applications. HMMs are the predominant technology in most research systems and some commercial systems.

• *Neural networks*, which constitute a promising new technology that codes speech properties in a distributed representation (see "Building Blocks for Speech," August 1989 BYTE). Neural networks have many desirable properties, such as generalization and discriminative capabilities. Although there are no large-scale neural-network speech-recognition systems, they have been used as components of research systems and in some commercial systems.

The sequence of models that are produced by the speech-recognition system

*continued*

# The End Of The Me-Too Modem.

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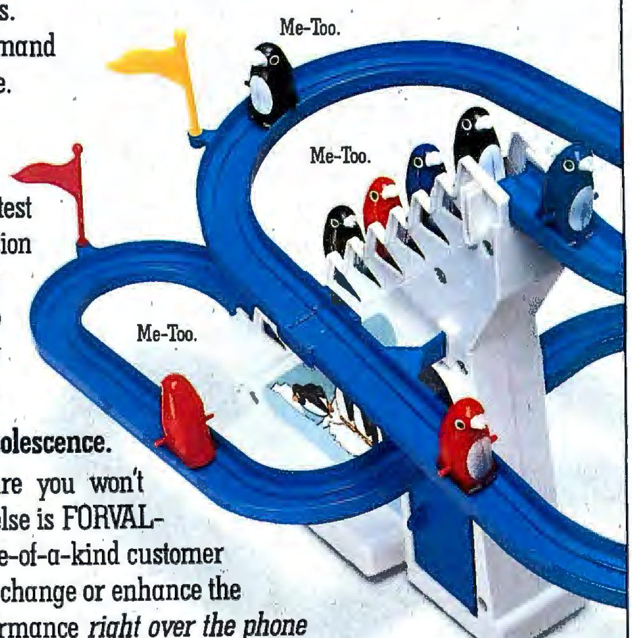


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# Practically Speaking

Voice interfaces are available to anyone who owns an IBM PC, XT, AT, or compatible. Total vocabulary, however, is not the best measure of a system's performance. The *active* vocabulary—the number of words from which you can choose at any given moment—is a better measure. In addition, rated vocabulary size represents only the capacity of a system and does not imply an adequate accuracy at full capacity.

When the active vocabularies are small, many commercial systems allow applications to switch contexts and load a completely new vocabulary at appropriate points. Thus, even relatively limited active vocabularies can accommodate tasks requiring larger lexicons, as long as you can subdivide them.

The trade-offs that are found in research systems—speaker dependence versus speaker independence, discrete words versus continuous speech, and vocabulary size versus performance—are also evident in commercial systems. In addition, price plays a role.

No recent rigorous testing of recognition accuracy has been performed to compare the different products. While every commercial system claims accuracy rates greater than 90 percent (up to about 99 percent), in practice we have found that these estimates are often quite confusing. They strongly depend on the actual words used to evaluate the systems, the noise environment during the evaluation, and the linguistic-model constraints expressed in the grammar. As a result, we cannot comment on the actual performance accuracy of these systems.

Every supplier of voice-interface technology offers some set of development tools to help you create an interface suitable for your application task. These interfaces may provide facilities for retraining the system to understand words that are poorly recognized and for building a linguistic model that reduces the effective number of words that the system must discriminate. There are also different approaches to error recovery: by keyboard, mouse, or voice alone, and with different types of "error-editing" capabilities.

At the high end of the performance spectrum, you find relatively large vocabulary systems of 5000 words to 40,000 words (from Kurzweil Applied Intelligence, Speech Systems, and Dragon Systems). Dragon Systems' DragonDictate-30K and Kurzweil's VoiceReport system require that you pause slightly between words, while Speech Systems' DS200 accepts continuous voice input. These systems are the most expensive, requiring more processing power and memory and more sophisticated algorithms.

## Speech Training

Many systems offer alternate training techniques to avoid having to train a system by repeating each of up to 40,000 words several times. The DS200 splits speakers into males and females and delivers a speaker-independent vocabulary for each group. This eliminates the training process. Note that 40,000 words represents a theoretical limit; actual applications would use smaller vocabularies to achieve higher accuracy and acceptable response speed.

DragonDictate-30K provides a 25,000-word pretrained speaker-independent core vocabulary and lets you augment the system with 5000 other words trained on your own voice. Also, it continuously adapts to your voice when in use, so initial vocabulary-training deficiencies quickly disappear in favor of better, more customized word models.

VoiceReport follows another route. You enter only a phonetically balanced and representative set of words, from which the system generalizes to the complete 5000-word vocabulary. (A recently announced improvement only requires you to speak the digits, as a kind of microphone check.)

While in principle large-vocabulary systems allow large-vocabulary speech recognition, in practice, recognition accuracy may drop if they must discriminate among very many word choices at any one time. Recognition times are directly related to the size of the currently active vocabulary. As a result, it's up to a language model (which provides syntactic, semantic, and pragmatic constraints) to limit the number of words that need to be identified at each point.

In most cases, the application developer chooses the language model and the limits of the active vocabulary. DragonDictate-30K, however, comes with a predefined general language model based on a large body of English text.

## Independence and Vocabularies

At the other end of the spectrum, Voice Processing Corp. and Voice Control Systems offer speaker-independent continuous-speech recognition products that can recognize only 13 to 50 words each. The smallest vocabularies are just big enough for a digit-entry task with two command words to control the interface (i.e., the digits 0 through 9, the letter *O*, and the words *yes* and *no*).

Although these systems accept fluent speech from any speaker, the size of the vocabulary limits possible applications. However, the products tend to be much more robust in their recognition accuracy, so they can be used over the telephone. They also cost significantly less.

## Middle Ground

In between the two extremes are a few products that allow a moderate vocabulary size of roughly a few hundred words. They are either speaker-dependent continuous-speech-recognition systems or speaker-independent discrete-word systems. The trade-off is clear and should be dictated by the needs of the target application.

For example, Scott Instruments offers a system that recognizes speaker-independent discrete-word speech and has an active vocabulary of about 160 words. The system can provide more flexibility by allowing any English-speaking person to use the system, but at the expense of a smaller vocabulary.

Verbex Voice Systems and Votan both market speaker-dependent continuous-speech-recognition systems with active vocabularies of a few hundred words each. First, you train these systems to your individual voice characteristics. Then, the systems can accept fluently spoken utterances, without artificial pauses between every word.

Again, the cost for this fluency is a reduced vocabulary (when compared to speaker-dependent discrete-word systems). While continuous speech offers speed and ease-of-use advantages over discrete words, the training requirement limits these systems.

Many vendors, including The Voice

Connection, Covox, Voice Recognition Technologies, and Articulate Systems, supply products for speaker-dependent discrete-word speech recognition. The products are often surprisingly inexpensive. Vocabularies usually contain several hundred words, with added features provided on many boards, such as a phone interface, dual-tone multi-frequency (DTMF, or Touch-Tone) functions, voice storage and playback, and text-to-speech capabilities. While individual products tend to vary, we expect that this group will provide the highest accuracy recognition, since its approaches are more restrictive and better researched.

The table on page 230 shows a list of commercial products and their capabilities. The systems all include add-on boards that perform digital signal processing in practically real time. But larger vocabularies often produce more-noticeable delays, due to the amount of search involved. Accuracy figures are not included, since the claimed accuracies tend to be for simple applications rather than for the maximum active vocabulary size. Remember, each desirable feature (i.e., speaker independence, continuous speech, and large vocabulary) comes with a performance degradation. In particular, the capacity to handle a large active vocabulary does not imply that the product can recognize that vocabulary accurately.

**Balancing Act**

Clearly, you have a wide choice of voice technologies, depending on your budget and your requirements. Don't let any particular set of numbers dazzle you. Once you decide on your requirements (e.g., speaker dependence/independence, continuous speech/discrete words, phone-interface requirements, and rough size of the active vocabulary) and budget, you should carefully evaluate the recognition speeds and accuracies of competitive products.

You can overcome any limitations on the total vocabulary size by partitioning application tasks into subvocabularies and swapping them in and out at appropriate points. Determining the actual recognition accuracy that a particular product will give in your application environment is vital to the successful implementation of this technology.

constitutes the system's best guess at what the input is. Since each model in the sequence is known (i.e., specific speech sounds, words, or phrases), you can "recover" what the speaker said by examining the model sequence.

With current technology, matching all sounds (phonemes) against the input provides unacceptably slow performance, so speech recognizers take advantage of lexical constraints to consider only phoneme sequences that represent words. They also apply language constraints to ensure that they consider only legal word sequences (thus reducing the number of active words examined during speech recognition), or to bias the system toward more likely sentences.

Evaluating the model and applying lexical and language constraints are typically combined into a one-step search process. Many applications developers build highly constrained grammars into their systems to obtain the best possible performance, both in response time and accuracy.

**Coming to an Understanding**

For some applications, such as dictation, voice dialing, and data entry, you only need to recover the sequence of words spoken. But for others, the system must understand the meaning of what was said. For example, the simple database query "How many new customers in Region 6?" may require fairly complex processing (how would you interpret *new*?) that takes into account not only the structure of the sentence itself but also the outcomes of previous queries, as well as general knowledge about the domain of application.

Unconstrained speech and language understanding (something humans perform effortlessly) is very difficult and remains an unresolved problem. But for small domains, natural-language understanding is possible, and spoken-language understanding (which combines speech recognition and natural-language processing) will be available shortly.

**Voice Recognition at Work**

Voice interfaces are not simply a matter of academic interest; they are here today (see the text box "Practically Speaking" at left). Voice interfaces are most frequently used to control a computer. Such a system accepts voice commands and translates them into a sequence of keyboard commands or macros. One spoken word can translate into a keystroke equivalent involving several hundred characters. The generated keystrokes are then fed to an application that cannot distinguish the transcribed keystrokes from actual keyboard input.

In this way, you can use voice to interface with many off-the-shelf, self-contained keyboard applications, such as spreadsheets or database programs, without completely redesigning them. Of course, there are some shortcomings to this approach related to error handling and correction.

Voice interfaces are often used as aids to the disabled. A blind person can enter queries or commands into the computer verbally rather than with a keyboard. Computer output is spoken through text-to-speech capabilities. There is even one report of a blind skipper successfully using a voice-interface system to query various navigational instruments on board a boat. Physically disabled users, such as quadriplegics or patients with severe arthritis, can also use voice technology to control computers, telephones, and so forth. The ability to control computers without typing is crucial to such users.

*You can use voice to interface with many off-the-shelf, self-contained keyboard applications, such as spreadsheets, without completely redesigning them.*

**Beyond Computers**

Voice interfaces are not limited to character-based computers. One interesting application area involves the integration of voice technology with telephones, visual interfaces, fax machines, and voice mail. For instance, Articulate Systems has adapted algorithms developed by Dragon Systems to let you operate a Macintosh by voice input.

Mobile phones can also contain voice-dialing capabilities (one such product is sold by Motorola). In general, these systems are not as sophisticated as some of

*continued*

## VOICE INPUT FOR PERSONAL COMPUTERS

*Don't let any particular set of numbers dazzle you. Decide whether you need speaker dependence or independence, continuous speech or discrete words, or a phone interface, and determine the rough size of the active vocabulary you need and how much you have to spend. Then you can evaluate the recognition speeds and accuracies of competitive products.*

| Company | Product name | PC type | Card/box/ stand-alone | Memory required | Speaker independent/ dependent | Discrete-word/ continuous speech | Maximum active vocabulary | Phone interface |
|---|---|---|---|---|---|---|---|---|
| **Articulate Systems** | Voice Navigator | Mac Plus | Box | 2 MB | SD | DW | 200 | Yes |
| **Cherry Electrical** | VoiceScribe 1000 Plus | PC/XT/AT | Card | 640K | SD | DW | 1000 | N/R |
| **Covox** | Voice Master Key | PC/XT/AT | Card | 256K | SD | DW | 64 | No |
| **Dragon Systems** | DragonDictate-30K<br>DragonWriter-1000 | 386 (AT)<br>286 (AT) | Card<br>Card | 8 MB<br>512K | SI<br>SD | DW<br>DW | 25,000<br>1000 | N/R<br>N/R |
| **Kurzweil Applied Intelligence** | VoiceReport | 386 (AT) with 80387 coprocessor | Card | 10 MB and 40-MB hard disk | SD | DW | 5000+ | No |
| **Scott Instruments** | SIR Model 20 | PC/XT/AT | Card | 80K | SI | DW | 160 | N/R |
| **Speech Systems** | DS200 | Sun SPARC-Station | Card | 8 MB and 140-MB hard disk | SI | CS | 40,000 | No |
| **Texas Instruments** | TI Voice Card | PC/XT/AT | Card | 256K and two floppy disk drives | SD | CS | 50 | Optional |
| **The Voice Connection** | Introvoice-5<br>PTVC-756 | PC/XT/AT<br>Portable/PC | Card<br>Stand-alone | 64K<br>1 MB | SD<br>SD | DW<br>DW | 250<br>250 | No<br>No |
| **Verbex Voice Systems** | Verbex 5000<br>Verbex 6000<br>Verbex 7000 | N/A<br>AT<br>N/A | Stand-alone<br>Card<br>Stand-alone | N/A<br>None<br>N/A | SD<br>SD<br>SD | CS<br>CS<br>CS | 80<br>300<br>1980 | N/R<br>N/R<br>N/R |
| **Voice Control Systems** | TeleRec<br>VR-4 | XT/AT<br>PC/XT/AT | Card<br>Card** | 64K<br>64K | SI<br>SI | DW<br>DW | 16<br>50 | Yes<br>Yes |
| **Voice Processing Corp.** | VPC-1000 | AT | Card | None | SI | CS | 13 | Yes |
| **Voice Recognition Technologies** | Voicebox | PC/XT/AT | 1/2 card | 80K | SD | DW | 500 | No |
| **Votan** | Voice Card VPC-2100 | PC/XT/AT | Card | 256K | SD | CS | 125 | Yes |

**Note:** This table includes no claims for the accuracy of the voice interface.
N/R = Not recommended by the vendor.
N/A = Not applicable.

the workstation-based technologies, but they are perfectly adequate. They let you store a spoken list of names in the phone, each with an associated telephone number. Then, using voice commands, the phone will dial the appropriate number based on the spoken name.

Another successful application of voice interfacing is in controlling robotic systems. In hospitals, voice commands can control the position of patient beds. In laboratories, voice commands can control the magnification and position of large microscopes, scanners, or other optical equipment. In such "eyes busy" situations, voice technology provides a significant edge.

### Manual Freedom

In typical "hands busy" or "eyes busy" situations, voice technology can successfully save labor. For example, workers sorting packages can use their hands to manipulate the objects while verbally entering information about the package's destination into the computer through their headsets. In other inventory or inspection tasks, workers are often physically moving around the facility to inspect it, or looking through a microscope or at an x-ray machine while simultaneously entering voice data into the computer. The drawbacks of limited vocabularies and having to train operators are insignificant compared to the benefits of voice in these tasks.

Telephone communication is an increasingly important area for voice interfacing. However, businesses usually cannot train their customers' voices in advance. You can't expect customers to adapt to a discrete-word system, and high recognition accuracy is crucial for acceptance.

As a result, currently only speaker-independent continuous-speech-recognition applications with very small vocabularies exist in this domain. The applications generally can distinguish between yes and no (e.g., in collect-call-acceptance questions) and maybe recognize digit sequences for telephone numbers, social security numbers, or bank account codes. However, you can expect rapid growth in this area in the future as more robust speech technology becomes available with larger vocabularies.

Another area where small time savings translate into large dollar amounts is in the medical field. Several intensive efforts are under way to use voice interfaces to aid doctors and nurses.

Both Kurzweil and Lanier Voice products (the latter using Dragon Systems technology) have been used to shorten the report-generation time for radiologists. Kurzweil has also brought voice-interface products into emergency medicine and pathology. Speech Systems markets an application that transcribes spoken medical reports to text.

In each case, medical reporting follows a highly standardized format, in which a limited vocabulary is sufficient to account for almost all situations. In

| Text-to-speech capability | Voice playback and storage | DTMF (Touch-Tone) functions | Price | Comments |
|---|---|---|---|---|
| No | No | Optional | $1295 | Toolkit optional; uses Dragon Systems algorithms; connects to SCSI port. |
| Optional | No | No | $3600 | Uses Dragon Systems algorithms. |
| Optional | Yes | No | $149.95 | Toolkit optional. |
| No | No | No | $9000 | Can also be trained to your voice. |
| No | No | No | $3600 | Multiple speakers can be trained into one model. |
| Optional | Optional | Optional | $26,500 | Price includes PC; fax option also available. |
| No | Yes | No | $1495 | Toolkit is optional. |
| Optional | No | Yes | $33,900 | Toolkit included; acceptable accuracy and speed require syntactic language model constraints on active vocabulary. |
| Yes | Yes | Optional | $995 | Toolkit is extra; also available for Xenix systems with 386 processor. |
| Optional | No | No | $495 | |
| Yes | No | No | $2995 | Includes PC with minikeyboard and RS-232C port; full miniature version also available. |
| Yes | No | No | $5600 | Includes toolkit. |
| Optional | No | No | $5600 | Includes toolkit. |
| Yes | No | No | $9600 | Includes toolkit. |
| No | No* | Yes | $2495 | *Voice-prompt playback. |
| No | No* | Yes | $3600 | *Voice-prompt playback. **Card is piggybacked with Dialog/4x voice card from Dialogic Corp.; other daughtercards also available. |
| No | No | No | $5500 | Toolkit included. |
| | | | $3500 | For evaluation kit. |
| No | No | No | $395 | Includes toolkit. |
| No | Yes | Optional | $1750 | Multibus card available. |

addition, voice macros allow report templates to be generated with only a few fields that must be filled in individually.

Typing that is totally "hands-free" is currently beyond the scope of the technology due to its inability to handle unfamiliar, untrained words. But recent increases in vocabularies to 5000 words—and even 30,000 or 40,000 words—show promise for less rigid situations.

## Office Communications

Voice technology is used in microcomputers for purposes other than speech recognition or understanding. Its most prevalent use is for voice annotations and voice mail, as well as for synthesized speech output.

Some systems—the NeXT Computer, for example—let you record a spoken message in digitized form on the machine. You can then send the message as E-mail to someone else who has a workstation with playback capability. In that respect, voice mail can function much like an answering machine.

Another use of voice-interface technology currently gaining popularity is voice annotation for documents. This can take the form of a spoken comment inserted into the document at text locations you specify. (Several PC add-on boards available through different vendors provide that kind of capability.)

More sophisticated voice-annotation technology is available in the Wang Freestyle system. It lets you record a spoken commentary synchronized with other inputs. Thus, as you are verbally commenting on a section of text, you can also write comments around the text using an electronic pen and mail the integrated multimedia document to someone else.

Finally, many text-to-speech systems have been developed for personal computers. These convert ASCII text into reasonable-sounding speech. The speech currently still has an unmistakable computer-generated quality, but it is quite intelligible.

## Voice in Your Future?

In the future, you *will* see even more microcomputers offering voice-interface capabilities. Workstations will probably integrate this capability as standard equipment, while microcomputers will offer it in the form of add-on boards.

Future applications software will likely include standard voice-mail capabilities, voice-message storage and playback integrated with text-to-speech capabilities, and fax communication features. You can expect these software packages to integrate multiple modalities (e.g., voice, text, and bit-mapped pictures) for manipulation in many different ways. While current voice-interface products still require plenty of individual customizing before they can be integrated into an application, you can expect more-powerful integration tools in the near future.

## Research Trends

Unlike commercial systems, research speech-understanding systems are not concerned with cost. Investigators are thus able to test complex algorithms and more advanced technology on large, expensive computers. Because rapidly improving computer technology may make a personal computer in the 1990s as powerful as a supercomputer was in the 1980s, a look at the research systems of today will give you a good idea of what applications will become possible in the next decade.

For over 10 years, researchers at IBM have been working on a natural-language dictation system that would let you say anything you want. Based on probabilistic expectations learned from 1 billion words of text, the system distinguishes sentences based on their likelihood. Combined with a good speech recognizer, the system attains over 95 percent word accuracy on a 20,000-word discrete-word task, and over 90 percent accuracy on a 5000-word continuous-speech task. The limitation of the system is that you must voice many utterances (100 for the discrete-word system and 2000 for the continuous system) to train the system.

At AT&T Bell Laboratories, researchers have focused on recognizing continuously spoken digits over the telephone. Telephone-based voice-interface systems must deal with different handsets, noise that is introduced during transmission over telephone lines, and frequency bandwidth limitations. Also, such systems must be speaker-independent.

Although commercial products exist

*continued*

that can handle these tasks, Bell Labs uses more advanced techniques that require much more computation. In a field trial on real speech and real credit card numbers, a Bell system correctly recognized over 98 percent of the number strings—that's about 99.9 percent digit accuracy. This system is the best of its kind and is believed to be good enough for credit card applications.

Finally, at Carnegie Mellon University, we have developed Sphinx, the first large-vocabulary speaker-independent continuous-speech-recognition system. Sphinx can achieve a word accuracy of 96 percent on the 1000-word Naval Resource Management benchmark task.

To understand how a sophisticated speech-recognition capability might be integrated with natural-language capabilities and operate in an unconstrained work environment, we have been building systems that provide, either individually or in combination, a voice interface to common office programs such as spreadsheets, appointment calendars, personal-information databases, voice mail, and applications. Our goal is to create an environment that provides you with multiple input channels (speech, keyboard, and mouse) integrated into a single interface.

Our work, and that of many other researchers, is sponsored by the Department of Defense. For example, MIT and Unisys are developing a voice interface to a graphical directory assistance system. Bolt, Beranek, and Newman is building defense-related training and database-retrieval applications, and SRI is building an automated travel agent. These interactive problem-solving systems require not only speech recognition but also speech understanding. If they succeed, you can expect to see simple interactive-dialogue systems on the market in five to 10 years.

## Today and Tomorrow

Current computers insist that you do things their way. Using a computer device requires that you accommodate yourself to how the computer works and constantly monitor the input process. This is quite unnatural and, for most people and applications, requires too much effort.

Useful voice technology is available now, if you are willing to compromise on certain capabilities. When considering products, however, you should remember that almost every desirable capability (e.g., speaker independence, continuous speech, and rejection) also degrades the accuracy of a system. You might want to think twice about whether your application needs all those fancy capabilities.

Most major computer manufacturers recognize that accessible voice input is the next frontier in interface technology. You will see the necessary hardware appear as standard equipment within five years. You can also expect to see the more advanced research systems become available commercially.

The trend in voice interfacing is toward systems that possess more and more of the characteristics of a human listener. These systems will let you realize the full potential of voice-based communication with your computer. ■

*The authors research speech interfaces at the school of computer science at Carnegie Mellon University (Pittsburgh, PA). Kai-Fu Lee is an assistant professor, Alexander G. Hauptmann is a Ph.D. candidate, and Alexander I. Rudnicky is a systems scientist. They can be reached on BIX c/o "editors."*



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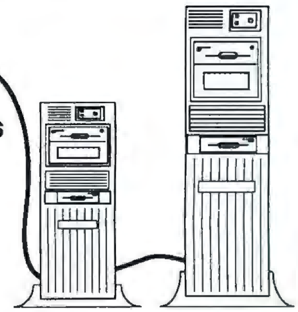

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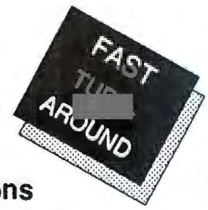


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# Telltale Gestures

*3-D applications need 3-D input*

*Paul McAvinney*

Even before they begin to speak, children acquire plenty of spatial knowledge about the world around them. In time, this knowledge translates into discernible skills. For example, many young children can thread a nut onto a bolt before they go to school. This task requires more than six degrees of freedom per hand (i.e., positioning and orienting the object in three-dimensional space, plus grasping it).

Most workstations available today allow (in the case of a mouse) simultaneous manipulation of only two independent spatial parameters. While it's possible to specify and manipulate representations of 3-D objects with a mouse, decomposing a six-parameter task into at least three sequential two-parameter tasks is time-consuming, counterintuitive, and error-prone. It is also a waste of time, given advances in the field of gesture-based input devices.

One problem associated with direct-manipulation interfaces in a design environment is that a particular user may not be skilled or precise enough to achieve the desired result. You can alleviate this problem by using virtual tools. Displayed on a computer monitor, virtual tools are analogous to real tools used for cutting, smoothing, shaping, and joining operations.

Virtual tools map multifinger two-dimensional and 3-D gestures into the operations performed by the "business end" of the tool (e.g., the blade of a cutting tool), with constraints imposed by the model of the tool itself, the material or workpiece being operated on, and your objectives. The virtual tool lets you sculpt a smooth 3-D surface, varying the curvature or even the smoothness of a curve as you draw it.

You might use virtual tools to add material to a workpiece, to cut material, or to extrude it. You might filter the motion of a tool, for example, with the distance between two fingers controlling the filter-cutoff frequency.

As hierarchies of virtual tools evolve, productivity will hopefully increase. If you can significantly shorten design time, customization will be easier. As virtual tools cut design time, learning time will also be shorter, in relation to productivity. This is especially true if you can see immediate feedback on your latest design at low cost.

## The Gesture Workstation

What capabilities would you want in a workstation that you intend to use to design or modify a 3-D object, such as a piece of furniture, a molecule, or a nozzle for a rocket engine? You'd want it to permit rapid prototyping of real-world objects. You'd want it to let you interac-

*continued*

ILLUSTRATION: MARC YANKUS © 1990

# Coming Soon to a CAD Lab Near You

Emanuel Sachs

If you've ever drawn in the air with a Fourth of July sparkler, you'll feel right at home with 3-Draw. 3-Draw is a computer-based design tool under development at the CAD Lab at MIT. It provides an intuitive, natural, easy-to-use interface so that you can sketch out your ideas directly in three dimensions.

*Using 3-Draw to design an automobile body. One of its creators, Andrew Roberts, is holding the object sensor—the palette—in one hand and the drawing stylus in the other.*

### Defining the Elements

3-Draw's user interface is based on two six-degree-of-freedom input devices, one held in each hand. Two sensors enable you to position and orient objects relative to each other in a displayed virtual world with the same ease as manipulating two hand-held objects. The simultaneous use of two sensors takes advantage of most people's innate ability to know where their hands are, relative to each other.

Using 3-Draw is just like holding an object in one hand and a tool in the other. The photo shows Andrew Roberts using it to create an automobile fender. (3-Draw's creators include Roberts, David Stoops, and me.)

Roberts is holding an object sensor in his left hand. This sensor is in the form of a palette, and it corresponds to a moving reference frame located in the virtual world. Objects created in the virtual world are automatically attached to this reference frame and, hence, continuously move in response to motions of the palette hand. In his right hand, Roberts is holding a stylus that corresponds to a configurable drawing and editing tool in the virtual world.

A "floor" in the virtual world is also shown in the photo. This planar graphical aid is an analog of the real-world floor and provides a static reference frame with which you can orient yourself. Shadows of objects in the virtual world can be projected onto this floor to provide positioning cues.

You can also rotate the object shown in the photo. Rotation automatically results in a different perspective view. 3-Draw lets you rotate and translate the object while you are creating and editing curves.

A Polhemus 3Space Tracker provides the two sensors used in 3-Draw. In the setup at the MIT CAD Lab, the sensors are interfaced to a Silicon Graphics Iris 4D/70 GT graphics workstation. The system is so fast that very little time lag occurs between rotating the object sensor and seeing the corresponding rotation of the model on the display.

### Free from Constraints

The current set of features can be grouped into three broad categories, each of which uses the configurable stylus in a different way. You can use it as a pencil to create free-form curves with a sweep of the hand, to move curves around as if they were rigid bodies, and to change the shapes of existing curves.

3-Draw can be used to create unconstrained 3-D curves, thus allowing for a high degree of freedom of expression. In some cases, however, you may want to use a feature that allows you to prespecify some constraints on the curve you are going to draw.

For example, you can prespecify the endpoints of a curve. You can then draw the curve anywhere in space and to any scale. After you have finished, it will be automatically scaled and snapped into place. You can then specify the desired

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tively specify or modify the shape of an object using spatial gestures and virtual tools. You'd also want it to build the object as rapidly as possible. Let's call this new type of workstation a desktop manufacturing (DTM) workstation. It should include the following components:

- A powerful CAD workstation that displays colored, shaded 3-D objects, with full-motion video capability.
- A "3-D copier" similar to the stereolithography device manufactured by 3-D Systems Corp. This device, or some variation on it, could quickly fabricate a prototype or a custom part. Currently, at least three companies are working on this aspect of DTM technology, and the number will probably increase.
- A 3-D gesture sensor, with gesture-recognition software and a virtual-toolmaker's toolkit.

angular orientation of the curve by rotating the stylus, which twists the curve around the line connecting its endpoints. You can also create curves by mirroring them around a reflection plane. In these ways, you can concentrate on getting just the right shape, independent of scaling and positioning.

After you've drawn a curve, you can move it as a rigid body using several translation and rotation features, each of which applies different constraints to the curve. For example, the "ball and socket" feature allows you to grab the curve and rotate it with one endpoint fixed as if it were in a ball-and-socket joint. The "axis twist" feature rotates a curve around the line connecting its endpoints.

After drawing a curve, you can modify it using several features. The "force gun," for example, makes the stylus behave like a tool that gently pushes the curve into the desired shape. It uses a physically based modeling technique (developed by George Celniker under the supervision of Professor David Gossard, director of the MIT CAD Lab).

**New and Improved**

Several new features are currently under development. One will allow you to work on models projected by a stereoscopic display (see "Living in a Virtual World" on page 215). Another feature will let you skin a surface over the wireframe models and modify it to the final desired form.

User interfaces like 3-Draw will become an integral part of CAD systems in the future. While industrial design is the first application expected, mechanical CAD, architectural CAD, and animation are sure to follow.

*Emanuel Sachs is a professor of mechanical engineering at MIT, specializing in design and manufacturing. You can reach him on BIX c/o "editors."*

• An optional 3-D laser scanner for scanning 3-D shapes.

Capturing 3-D input is one of the last obstacles in realizing a DTM workstation. One method is described in the text box above. Other approaches use hand gestures to manipulate spatial objects.

The DataGlove from VPL Research and the Dexterous Hand Master (DHM) from Exos both sense finger-flexing motions. The DataGlove also senses your hand position and orientation using a Polhemus sensor developed by McDonnell Douglas. The Polhemus sensor determines the position and orientation of the hand using an externally generated oscillating electromagnetic field (see "Reach Out and Touch Your Data" on page 283).

A DataGlove with a Polhemus sensor can sense relatively large-scale hand positions and orientations. Given the position and orientation of the palm of your hand, a program can use knowledge of finger-joint flexure to determine fingertip position, and use it in grasping and tool-manipulation applications. In addition, by inserting piezoelectric transducers in the fingertips of the glove, you could conceivably provide some degree of touch feedback.

Force feedback is a more difficult problem. The DHM has the advantage here; its determination of finger-joint flexure appears to be considerably more accurate and repeatable than that of production DataGloves. On the other hand, it does not currently provide hand position and orientation, although this could probably be implemented if market demand warranted it. According to people who have used it, DHM is lighter and less encumbering than it looks, although the time required to fit it to the hand seems to preclude casual use.

**Glove Limitations**

Using glove-like sensors to sense gestures poses some problems. Currently, these devices use a cable to transmit data from the glove to the workstation, making casual use difficult. Hand-position sensing (as opposed to detection of finger-joint flexure) requires the relatively expensive Polhemus sensor, and its use can be complicated by the presence and movement of ferrous metals in its vicinity. A variation of the DataGlove developed for Nintendo games, the Power Glove, uses sonar devices mounted in the glove, but this severely constrains the possible orientation of the hand.

Another problem with glove-like sensors is that all users need their own gloves. A workstation supporting the device must have multiple gloves available to support left- and right-handed persons with varying hand sizes. Also, neither the DataGlove nor the DHM yet provides fingertip-position information that is sufficiently accurate and repeatable to use in a virtual-tool environment. This fact argues against using glove-like devices in a virtual-tool (as opposed to virtual-reality) environment. Nevertheless, for many applications, they provide a reasonably cost-effective solution.

**The Gloves Come Off**

One alternative to glove-like devices is the Spaceball from Spatial Systems—essentially a 3-D joystick. It is slightly larger than a tennis ball and mounted in a way that makes extended use very comfortable. The Spaceball is excellent for positioning and orienting displayed 3-D objects as well as for modifying your view of a stationary object. It is accurate and repeatable. Because it functions like a joystick, it has some of the joystick's disadvantages (compared to a mouse), and it has only six degrees of freedom. While that's adequate for positioning and orienting objects, you need more to manipulate virtual tools. Once the tool is positioned, you must do more things with it to make it work; therein lies the problem.

Another possibility is the Flying Mouse from SimGraphics Engineering. It's a three-button mouse with a Polhemus sensor inside, designed to be easy to pick up. You can position and orient it in space and then press the buttons. It's almost good enough for virtual tools, but not quite. For virtual tools, you'd prefer the buttons to be more pressure-sensitive. A convenient feature of the Flying Mouse is that it can function as a normal 2-D mouse when on a tabletop. The company is emphasizing the development of software necessary for future "virtual tool" environments. This is a plus.

These technologies are in their infancy and subject to rapid change. Many of my reservations about current products may become quickly outdated as they evolve and mature.

**Further On Down the Road**

A different approach to the problem of sensing multifinger gestures involves the use of vision-based systems. Computer-vision systems that analyze complex real-world scenes in real time remain just beyond the state of the art. Nevertheless, in some applications, such as visual inspection, where scenes are specialized and predictable, systems are approaching feasibility. Simple, low-level computer vision may also be useful in observing human gestures.

In the present context, a gesture is a set of points that describes the path of a group of fingers in space and time. The

*continued*

utility of gestures for pointing at objects is readily apparent to those who use mice and touchscreens. What is less obvious is their utility for manipulating spatial representations of objects (e.g., sculpting and extruding solid shapes, cutting, smoothing, and joining surfaces, and using virtual tools).

Sensor Frame Corp. is developing a gesture-input device called the Sensor Cube. It is an outgrowth of the Sensor Frame, a 2-D optical finger-tracking device developed jointly at Sensor Frame Corp. and Carnegie Mellon University. Using four sensors, the Sensor Frame reliably tracks up to three fingers in two dimensions at 30 Hz even though fingers sometimes block one another from some of the sensors. This ability to track multiple fingers distinguishes the Sensor Frame from common touchscreens.

### 3-D Sensing

The Sensor Cube was intended to be simply a "thicker" version of the Sensor Frame. However, recent research results indicate that the Sensor Cube can be built using fewer sensors than the Sensor Frame, yet can still track up to three fingertips in three dimensions.

Several important considerations drive the design of the Sensor Cube:

- It must allow for at least 10 degrees of freedom per hand. This would allow positioning and orientation of a virtual tool relative to a workpiece, followed by $x,y$ manipulation of analog inputs on the tool itself by two opposed fingers.
- It must allow casual use. This becomes especially important as increasingly powerful virtual tools permit a given operation to be completed in a short time, so you can do something else that may not require using the gesture-sensing device. Good virtual tools should preclude the need for constant use. This would lessen concern about the fatigue caused by holding your hand in the air all day.
- It must leave your hands free to use other devices, such as keyboards and telephones. This might preclude the use of gloves and/or wires.
- It must sense the position of fingers relative to screen objects.
- It should be able to sense fingers in the vicinity of a video monitor. You should be able to attach it to the monitor so that you don't need to sacrifice desk space.
- It should operate independently of the video monitor so that it can be mounted in another location.
- It should be inexpensive in mass production to encourage general use and standardization of application and user-interface software.

The Sensor Cube is still under development. Nevertheless, it has helped to define the requirements for a DTM workstation.

### One Is Not Enough

Gestures are appropriate for quantifying many parameters in parallel and for spatially constraining the scope of an operation. Speech compares poorly with them when you are specifying quantitative things, especially in parallel.

However, simple disconnected speech is good at selecting one of many operations from a menu, especially a large menu. Using gestures may sound like a good idea at first, but if you have to learn American Sign Language to use a device, it probably won't be too successful.

Interfaces should use gestures where appropriate and speech where appropriate. By mixing the two, you might have a tool more powerful than either one taken alone. Such a system, for example, might let you use three or four fingers to surround certain objects displayed on a monitor, while it responds to the spoken word "green" to color those objects.

### Space Is the Place

Transferring spatial knowledge from people to computers has been an intractable bottleneck in CAD applications, possibly because today's formal computer languages represent that knowledge inappropriately. By gaining the ability to capture human expression, computers can provide a better alternative to traditional manual methods of design.

Much of the motivation for building gesture-based systems comes from the potential to increase productivity in the future. Today, most spatial input devices have some drawbacks. But as technologies improve, 3-D input will permit you to perform design functions in a more natural and intuitive manner. ■

*Paul McAvinney is the founder and chairman of the board of Sensor Frame Corp. (Pittsburgh, PA) and inventor of the Sensor Cube, Stage Frame, and VideoHarp. He can be reached on BIX c/o "editors."*

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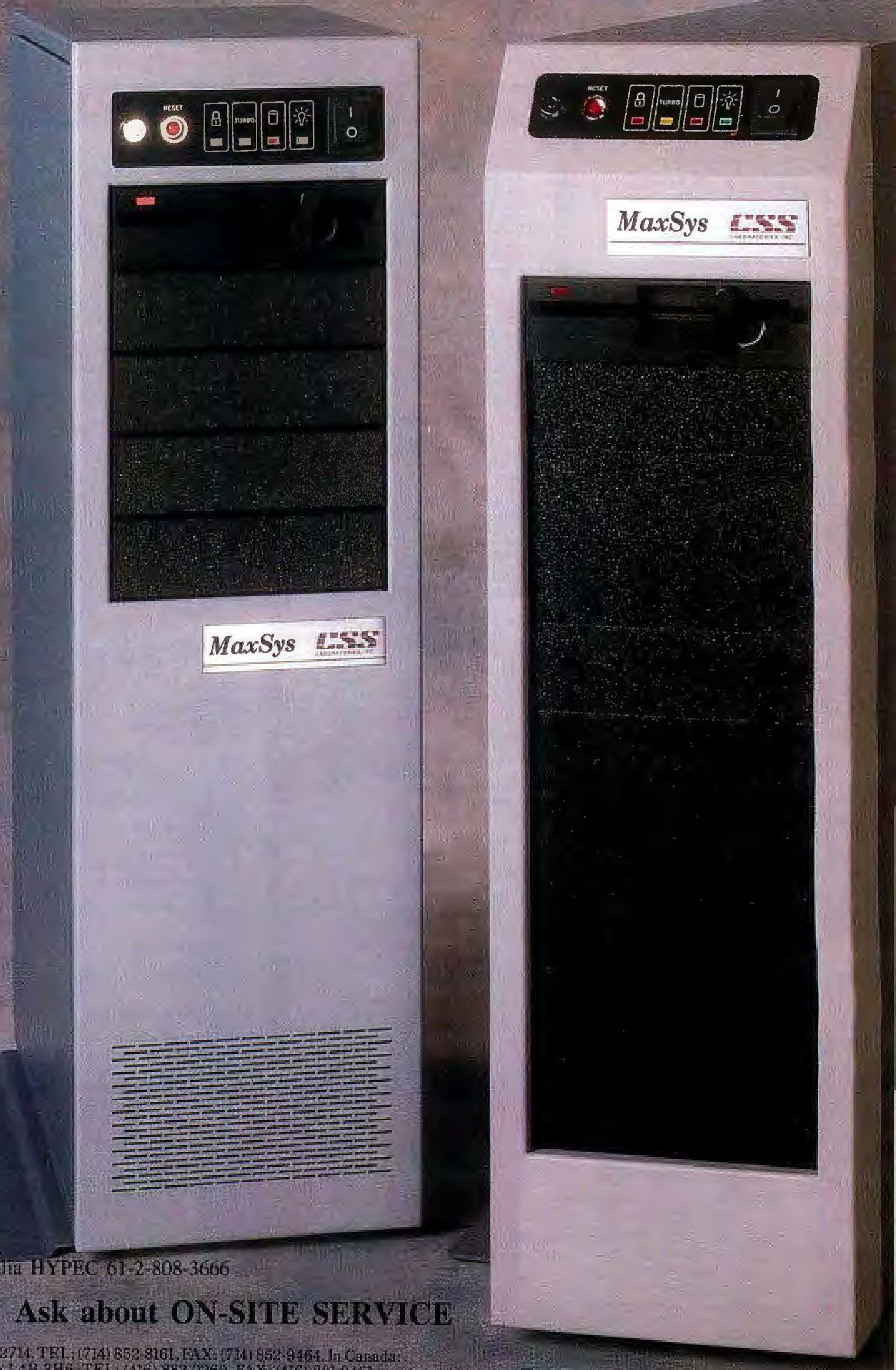


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*Gale Martin, James Pittman, Kent Wittenburg, Richard Cohen, and Tom Parish*

Like new species, new technologies emerge to fill niches of opportunity. VCRs, fax machines, and microwave ovens have become commonplace because they satisfy widespread needs, and because the state of technology is sufficient to build reliable products. On the horizon for the 1990s is a new technology—computer-based interactive tablets—that promises to bring computer power to everyday activities.

Interactive tablets will look more like checkbooks, notebooks, or drafting tables than today's workstations, with their keyboards, mice, and CRT monitors. You will communicate with them through handwriting and sketching, and they will communicate to other computers through radio-link technology.


## Pen and Paper

Modern culture has evolved using pen and paper to communicate. Your day-to-day activities bear the artifacts of this history: calendars, checkbooks, notebooks, insurance forms, sales receipts, blueprints, bills, address books, even Post-it notes. Standard computer workstations, although more than sufficient for many tasks, stand in the way of automating many of life's most common activities. In some cases, they're not portable enough, or they're too big for the work area. These are the niches that interactive tablets will fill.

Standard workstations also fail when the information you enter departs from standard text. For example, you'd be hard pressed to find a keyboard that lets you enter Japanese and Chinese characters, sign your name, write math equations, or sketch PERT charts and flowcharts. Graphics design tasks are also difficult with standard workstations. Several years ago, we watched VLSI designers using a CAD system and were surprised to find that a large part of their activities centered around pen and paper rather than the system itself. Recent comparisons of CAD tools for designing power supplies reveal that traditional paper methods are three to 10 times faster. CAD tools offer designers powerful capabilities; workstations should not block access to them.

## Future Perfect

Although available now for limited, specialized applications, interactive tablets have a long way to go before they realize their full potential. The technology requires the development of a true electronic equivalent of pen-and-paper media.

Advances in portability will come from a variety of sources, from research into wireless LANs to the international initiative for high-definition TV, which includes a push to build low-cost, flat-

*continued*

*Standard computer workstations stand in the way of automating life's most common activities.*

panel displays of all sizes. Neural-network and AI blackboard architectures hold the promise of interpreting free-form input. But what technologies are required to make interactive tablets an everyday reality?

## The Communications Factor

Interactive tablets must be able to communicate easily with existing personal computers and computer networks. Imagine getting your E-mail or uploading your recent meeting notes while sitting in O'Hare Airport without waiting in line for a phone or fumbling with cables and connectors.

A recent partnership between Motorola and IBM to link portable computers with a host by transmitting over local radio frequencies heralds a new trend in wireless communications. The Agilis hand-held computer also features transparent communications via a radio-frequency transmitter. Many researchers are investigating how to best use the now-crowded radio spectrum to provide low-power, in-office radio LANs. One promising approach is a cellular network that shares the spectrum presently set aside for cellular phones. Another involves the use of laser and infrared transmissions.

## Electronic Paper

Writing on an interactive tablet should be as much like writing on paper as possible. The display should provide a high-quality image on a thin, flat panel. Needed for interactive tablets are both large desktop- or blackboard-size panels and small hand-held units with low power consumption.

The three available flat-panel display technologies are LCD, plasma, and electroluminescent (see the BYTE In Depth section, September 1988). All three technologies sandwich some active material between two "container" walls, which are usually made of glass. The walls contain electrodes that apply a voltage across a pixel to turn it on or off. With LCD panels, the active material is a liquid of crystals that reorients or twists when the voltage is applied. Transparency or polarization properties change during the twist. With a gas-plasma panel, the active material is a gas that glows when the voltage is applied. With the electroluminescent panel, the glowing material is a phosphor film.

Each technology has its strengths and weaknesses. At present, all are suitable for small, monochrome interactive tablets. Plasma and electroluminescent panels have higher-contrast, more-readable displays than LCDs, but LCDs consume less power, which can be critically important for portable, hand-held units. Most vendors package the displays with EGA or VGA display drivers, making them compatible with current software.

On the horizon for the 1990s are larger, full-color displays. LCDs seem to be the best prospect for color, but they are the weakest with respect to scaling up to larger sizes. Plasma panels have the best record with respect to large displays. Electroluminescent displays are intermediate; their special strength lies in the reliability of the technology.

## Electronic Pens and Beyond

The input device for an interactive tablet is a stylus, which ideally should feel and behave like a pen. Recent stylus products have come close to this goal. Some are as light and as small as pens and avoid the mushy feel of excessive tip-switch travel. Some have shed their cables; others have reduced cable bulk to the point that they are no worse than the chained pens at bank counters.

Just as a stylus should emulate a real pen, the "electronic ink" it produces should act like real ink. Parallax should be minimized by minimizing the distance between the image plane and the writing plane. The calibration should be good enough to register the exact display pixel. Many styli provide resolution far above that of the display and then waste it with bad calibration.

With an interactive tablet, you can also use the stylus to indicate mode changes, act like a paintbrush, or appear as a mouse. This allows the stylus to drive popular software without modification.

But a stylus has to be more than a mouse. The stylus software should echo the ink stroke, and do so fast enough to keep up with the stylus movement. It should be able to erase the strokes after handwriting recognition takes place so that you can replace them with an icon or a diagram, and do so without disturbing

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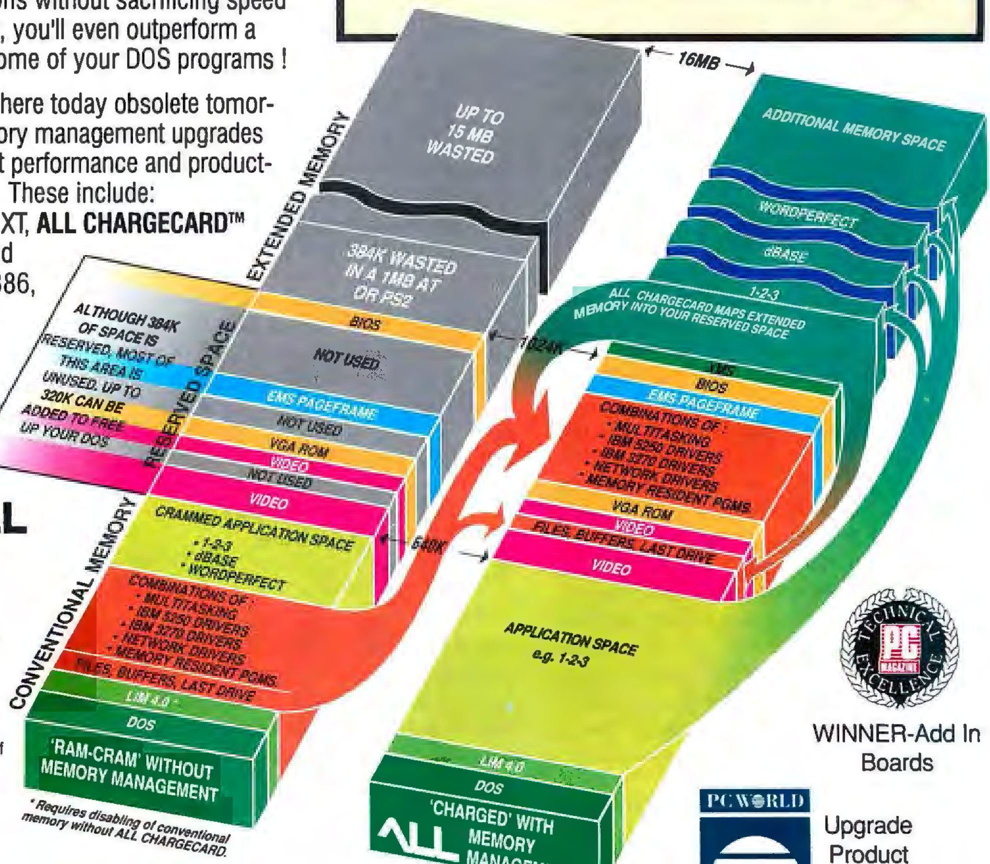


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# The Blackboard Metaphor

The blackboard model is based on a computational metaphor suggested by Allen Newell in the early 1960s. The metaphor suggests that several people cooperating to solve a problem cannot talk to each other, but can communicate only by writing information related to the problem on a blackboard.

Each participant has different knowledge and can solve different parts of the problem. When participants see subproblems on the blackboard that they can solve, they step up to the board and write something they think may contribute to solving the overall problem.

The blackboard model was originally used in building AI programs. But it can be useful in many situations where extensibility and flexible control flow are important, whether the platform is a PC or a mainframe.

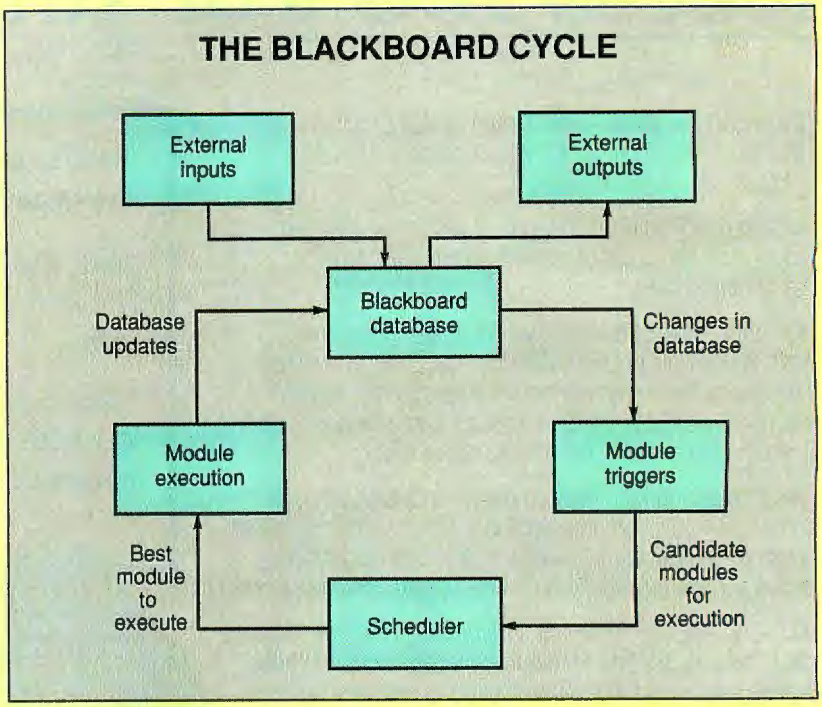


**Figure A:** *A blackboard system lets multiple modules work on the same input. In an interactive-tablet system, the modules might consist of a neural network, lexical insertion, and a spacial parser.*

## The Computational Model

The blackboard computational model is composed of a set of modules (knowledge sources), a central database (the blackboard), and a scheduling mechanism for determining the order of execution of the modules.

The modules can share information through the blackboard (and only through the blackboard) and do not retain their own state information. Each module can transform or combine certain types of data on the blackboard as steps toward a possible solution to the problem.

Each module can "look" at new data added to the blackboard and indicate whether it may be able to contribute toward a solution using the new data (possibly in conjunction with other data on the blackboard). The scheduler chooses from the modules that can work on the data on the blackboard, and executes one of them. This module may add more information to the blackboard (if it succeeds), or it may not (if it fails).

The blackboard repeats the following cycle over and over until the problem is solved (see figure A):

1. Choose a module.
2. Execute the module.
3. Update the blackboard data as specified by the module.
4. Go to step 1.

The blackboard architecture provides a structure for a set of separate modules, each of which can contribute part of a solution to a problem. The module execution is triggered by changes to the database and controlled by the heuristics of the scheduler. The implementor chooses what should be represented in the database, how to decompose the various steps in building a problem solution, and the scheduler heuristics that control the order in which steps in the problem solution are tried.

A key aspect of blackboard architecture is the separation of heuristic control from the individual knowledge sources. This allows some flexibility in deciding how to apply the different knowledge sources to the problem, separate from deciding what knowledge sources to use and how they should work internally.

nearby graphics. This could mean placing echo ink in a separate graphics plane or keeping tables of strokes for precise erasure.

## Matters of Interpretation

It is tempting to interpret stylus input in a straightforward manner with a simple loop that reads, echoes, and records strokes. When a time-out occurs or the next stroke is too distant, such a system assumes that a notation is finished and sends it to the handwriting-recognition system. Once a symbol is recognized and an appropriate action taken, the input loop is repeated.

This was the initial approach we took at Microelectronics and Computer Technology Corp. (MCC), where we are developing interactive-tablet technology. However, we found that such simple event-loop architecture does not give rise to a product-quality system. Quite simply, with an interactive tablet, you can't count on strokes being drawn in a particular order (e.g., you may cross your *t*s after you've written a word or wait until you've finished the sentence), so the particular recognition sequence may have to be rerun at any time.

Recognizing and interpreting free-form input involves many interdependent processes: segmenting characters, gen-

Typical blackboards used in AI applications support powerful mechanisms for triggering knowledge sources (often using mechanisms similar to those of rule-based systems). A blackboard also requires a truth-maintenance system to support asserting and retracting information on it.

These characteristics provide a powerful blackboard substrate for AI applications, often at the expense of computation time and space. Luckily, the requirements for user interfaces permit significant simplifications and efficiencies compared to these applications.

The blackboard architecture supports integration of multiple input modes, combining mode-dependent and mode-independent modules. Several modules can contribute toward a solution that none could produce individually. The modules interact as peers rather than as masters and slaves.

For example, several techniques may need to be combined in order to resolve the meaning of seemingly ambiguous input. The architecture can also support parallel, heuristic, opportunistic searches, possibly at several levels of granularity.

**Next-Generation User Interfaces**

The 1990s will see a coalescing of standards for the look and feel of graphical user interfaces (GUIs). However, user interfaces will push beyond these standards as people begin interacting more ambitiously with their computers via stylus, touch, voice, keyboard, and mouse.

The blackboard architecture provides enabling technology for building advanced computer interfaces. From a blackboard architecture tuned to the requirements of GUIs, the next generation of human-machine interfaces will emerge.

## PATTERN RECOGNITION WITH NEURAL NETWORKS

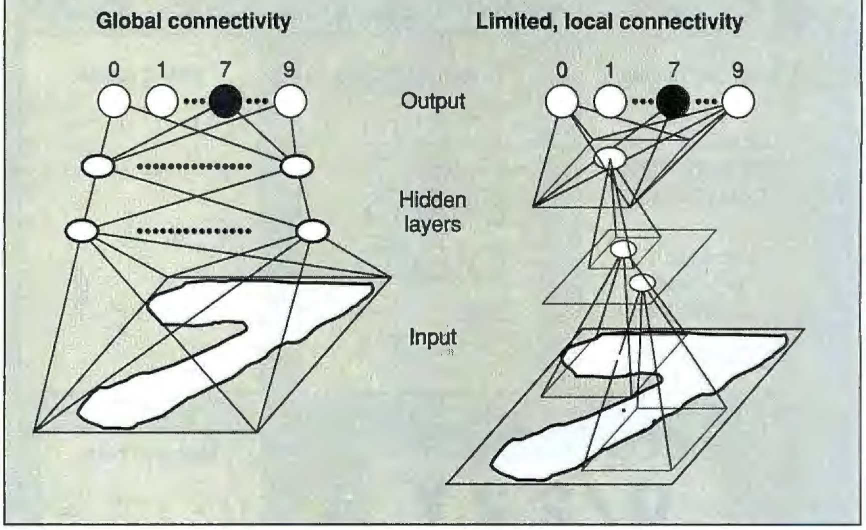


**Figure 1:** *Back-propagation techniques enable a neural network that starts out with randomly valued connections to learn to correctly recognize input patterns. Network architectures with limited connectivity represent one way to make these recognition systems compact enough to fit on small machines.*

erating best-guess recognition decisions, and incorporating context into handwriting recognition. The bottom line is that every component depends on every other component, and each wants to run last so that it can use the output of the others.

At MCC, we've embodied these free-form handwriting-recognition requirements in an AI blackboard system (see the text box "The Blackboard Metaphor" above). The system provides a control structure in which very different technologies, such as neural-network character recognizers and AI-based natural-language parsers, cooperate and share information. These different software components run whenever the system makes enough data available to them. The system posts results in a common format that other software components can use as input.

The blackboard can support parallel competing interpretations of input. Later input may confirm or refute an interpretation. Thus, the system combines the strengths of different strategies and technologies, all working on the same problem at the same time.

### Handwriting Recognition

Recognizing handwriting is an involved process. An interactive tablet should be able to accurately recognize a large vocabulary of both hand-printed and handwritten symbols. This includes uppercase and lowercase letters, numbers, punctuation marks, math symbols, editing marks, graphics symbols, and other symbols you create on the fly. Handwriting-recognition accuracy should improve with context and by adapting to your idiosyncrasies. A good handwriting-recognition system should not restrict your writing to little, predefined boxes.

The tablet should handle the details of segmenting input into individual symbols. Handwriting-recognition decisions should also reflect alternative guesses and levels of certainty, not just a binary choice. Finally, the tablet should recognize symbols in a fraction of a second on a low-end personal computer and have a nice functional interface for current and future applications.

No current technology satisfies all these requirements. Most available systems severely limit their symbol vocabularies, typically to uppercase letters. Current systems accomplish symbol segmentation either by constraining you to write in boxes or through ad hoc techniques that fail when you write naturally.

Reported accuracy rates are typically in the 90 percent range. But these figures are ambiguous. Accuracy varies depending on test samples and conditions. Current technology is adequate for very constrained, limited applications, but it falls short of what you need to make interactive tablets commonplace and generally useful. The buyer should beware.

Some of these problems can be overcome by moving away from traditional pattern-recognition techniques to neural-network techniques (see figure 1). Traditional approaches divide development into feature selection and classification. You choose what seems to be a good set of features for representing inputs and a statistical or syntactic classification technique for defining category membership. When accuracy is too low,

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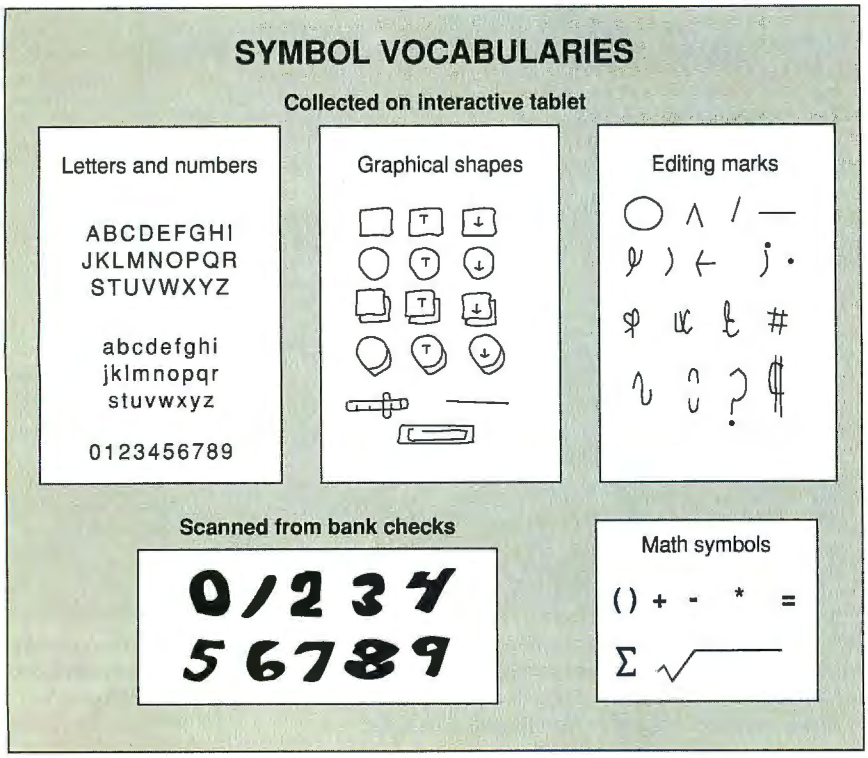


**Figure 2:** *Neural networks at MCC have been trained to recognize a variety of handwritten symbols. This technology makes it easy to train the system in alternate pattern types.*

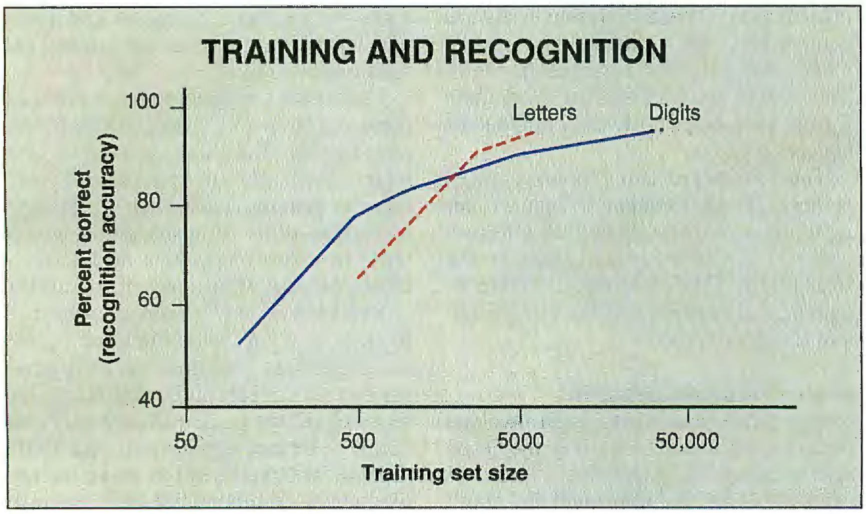


**Figure 3:** *The figure plots accuracy rate versus the size of a training set for a back-propagation neural network. You need large training sets to achieve high accuracy rates.*

you tinker. This approach leads to slow development and brittle systems. Expansion to new symbol sets essentially requires that you begin again from scratch.

## The Neural-Network Connection

Neural-network techniques avoid these problems by combining feature selection with classification, and automating the complete process so that very little intervention is required. At MCC, we use presegmented bit-map arrays, not featural representations, as input to a back-propagation network, and we obtain high accuracy rates (in the mid to high 90 percent range).

The network outputs are continuously valued variables that reflect the certainty of the handwriting-recognition decision. This lets the system query you about ambiguous inputs and achieve near-perfect performance on the remainder of the patterns. Extension to other symbol vocabularies (see figure 2) is relatively automatic, using essentially the same type of network and network parameters.

The only change we have had to make is to increase the size of the network. Also, we have trained networks on a combined set of uppercase and lowercase letters and numbers. While the overall accuracy rates are lower, the errors tend to occur where humans would also make errors, such as confusing *C* with *c*, 1 with *l*, and 5 with *S*. The buyer should still beware, but the future looks more promising.

One disadvantage of the back-propagation neural-network approach is that you need to use very large training sets to achieve high handwriting-recognition rates (see figure 3). You may also need to train the network for days or even weeks. This makes it difficult to build a system that adapts to the idiosyncratic style of a primary writer or to new symbols created on the fly. It also means that systems development requires collecting or borrowing large training samples.

Training samples, and not the underlying algorithms (which are widely available in scientific literature), therefore become the critical, proprietary aspect of developing handwriting-recognition systems. Similarly, critical tools for systems development become facilities for processing large training sets, not facilities for tinkering with the underlying algorithms.

Another often-heard complaint about using neural networks for low-end personal computer applications is that they are computationally intensive and require large amounts of memory. This limitation, however, will probably disappear.

Once a network has been trained, it can be represented in a low-precision format without hurting accuracy. Networks trained with limited connectivity, such as that in figure 1, also cut down on memory requirements as well as, in some cases, on processing needs. Finally, digital-signal-processing chips represent an inexpensive path to giving low-end personal computers high-end performance. We've found the 24-bit precision available on some of these chips sufficient to train networks for hand-printed symbol recognition.

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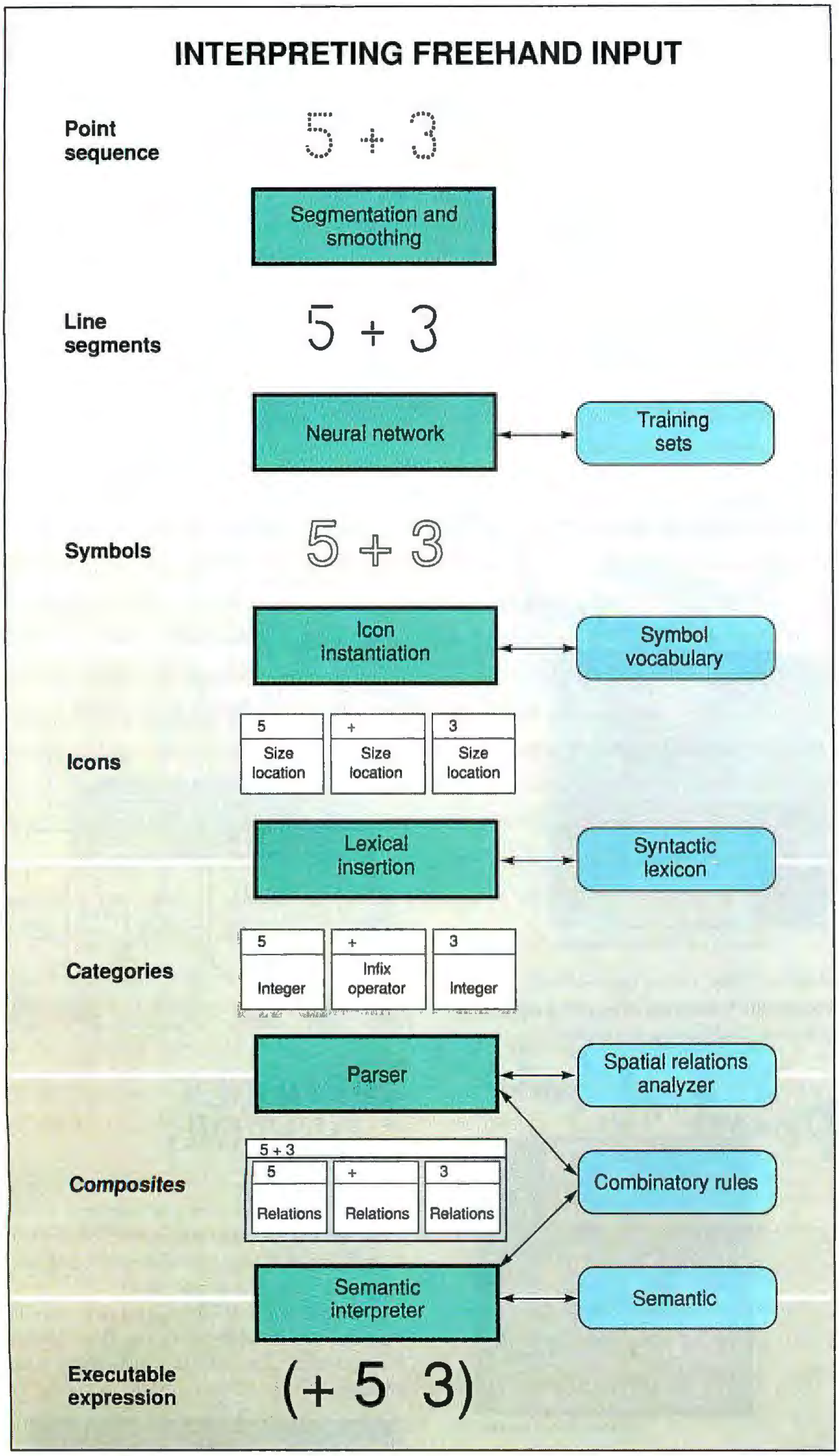


**Figure 4:** *This figure shows how an interactive-tablet system interprets freehand input. The input is a digitized point sequence (shown at top); the result is an executable mathematical expression (shown at bottom). Knowledge sources in the middle column transform the data types in the left column using the data banks listed in the right column. Segmentation and recognition transforms the input into strokes and a set of symbols, respectively. Visual parsing works with symbol sets located in space (icons) and forms a composite expression using a visual grammar and lexicon. A semantic interpreter converts the parser output into an executable form.*

The critical milestones for neural-network or any other symbol-recognition technology lie in combining symbol segmentation with recognition and incorporating higher-level constraints to improve recognition accuracy. Higher-level constraints refer to the fact that different sequences of symbols, such as a string of letters constituting a sentence, are not equally likely. Language and the physical world impose constraints that can be used to improve symbol-recognition accuracy.

We believe that it will be fruitful to push neural-network technology as far as it will go in achieving these milestones. One approach is to combine solutions to the segmentation and higher-level constraint problems. You train a network to recognize a letter in a larger input field, where it is surrounded by its natural context as dictated by typical letter strings appearing in natural language. Ultimately, though, it will probably be necessary to use hybrid systems that combine neural-network techniques with state-of-the-art parsing techniques, because context operates at multiple levels.

## Beyond Recognition

Assume your interactive tablet can recognize and differentiate your *t*s and *i*s. You can write a number sequence, as with pencil and paper, and the machine will recognize your 7s, whether or not you cross them. What's next?

If you glance through the notebooks and sketchpads you use in meetings, in classes, or at home, you will find that many of your jottings gather their meaning not just from the linear sequence of symbols or characters, but also from their relative location in space.

For example, consider math calculations. A horizontal line can indicate subtraction (a minus sign), division (a fraction line), a negative number, or simply a boundary marker to total the calculations in the column above it. Which of the meanings is the right one? It depends on the other symbols in the immediate context and where they are relative to each other.

Other languages that have a spatial element are those of musical notation, editing corrections, engineering layouts and diagrams, flowcharts, PERT charts, and family trees. In fact, most designers first sketch a design on paper in a notation specific to their domain (e.g., architecture or engineering). Only when the initial set of problems is solved through the sketching activity will the design be translated through a series of commands and/or direct-manipulation actions and transferred into, say, a CAD program.

Spatial language parsing will cut out "the middle man" by allowing you to sketch as you always have, in the spatial languages most suited to solving your particular design problems. Parsers will then be able to interpret the sketches directly and allow earlier interaction with back-end applications (see figure 4).

## Spatial Parsing

The problem of assigning meaning to aggregations of symbols based on spatial relations is to some extent analogous to parsing linear languages—for example, programming languages, natural human languages appearing as text or speech, and command or mouse-based languages appearing in user interfaces.

What all these one-dimensional languages have in common is that a simple concatenation of symbols, characters, or events of some kind forms the basis of the input. Moving into two-dimensional space brings some new twists, including the need to separate the temporal sequence of the input from the 2-D space in which it exists.

For one-dimensional languages, you can generally assume that space and time are 1-to-1. The data structures and methods reflect this assumption. For example, classic table-driven parsing technologies for command languages and programming languages parse left-to-right over the input stream, predicting, and thereby constraining, the next possible input.

Spatially based languages, however, generally don't have just one temporal order for forming complex expressions. For example, you don't necessarily draw the bubbles and arcs of PERT charts from the top down or from left to right.

One approach is to ignore the temporal order of the input and impose an ordering over the 2-D space that will be convenient for the parser. For example, the system could start from the upper left corner of a 2-D space and proceed left to right, from the top down, whether or not you entered your input in that order.

This is an appropriate response for parsing static displays. However, in a dynamic sketching situation, where the system must use the constraints of parsing to help with basic symbol or character recognition, it seems inappropriate. Further, the temporal information is at least a heuristic for interpretation and should probably not be ignored altogether.

In other words, although most 2-D notations don't have a single enumeration order, humans tend to work outward from a beginning symbol by enumerating adjacent symbols rather than by jumping all over the place. Parsers for interactive tablets need to be able to work incrementally with your temporal ordering and thus be flexible with respect to the enumeration in 2-D space.

Another challenge in parsing 2-D stylus-based input is in segmentation and closure. Mouse and keyboard devices automatically segment the input into a series of primitive events or characters. For example, a particular keystroke or mouse-click explicitly indicates the end of a "sentence."

On the other hand, freehand sketching on a display does not provide such an easy method of determining the set of primitives involved in a 2-D expression. Strokes can span logically separate symbols. And you must expect individual variation in the number and order of strokes required to make a single symbol or character.

While symbol- and character-recognition technologies are designed to cope with these problems, you can expect a certain amount of indeterminacy at this low level. Parsing, then, is still another source of constraints on a particular segmentation of symbols.

Independent knowledge sources must work together to solve the overall interpretation problem. Blackboard technologies promise to help solve some of these problems by providing a framework in which communication can be coordinated across different constraining knowledge sources.

## Moving into Common Usage

Simply developing reliable technologies won't make interactive tablets commonplace, however. Mitch Kapor, founder of Lotus Development, notes, "The problem of making computers useful to people as communication and information devices is not an engineering problem. It's a design problem. Engineers are trained to eliminate the subjective factors. But it's exactly the subjective factors that are critical."

Using currently available interactive tablets can be frustrating; they often violate expectations built up from experiences with pen and paper and standard workstations, and they are new. They haven't gone through the evolutionary process in which problems are discovered at the expense of initial users and solved through iterative design.

This evolutionary process can proceed along two paths. The first is to introduce new products on a small scale, such as the Sony Palmtop or the Canon AI Notebook. These products run very real risks of failure because seemingly small design problems can make them unusable. Often, you become aware of these problems only when the product is on the market.

Alternately or additionally, the R&D world can develop realistic full-blown prototype applications and get extensive feedback from potential users. MCC's Interactive Worksurface Project and IBM's Paper-Like Interface Project fall into this category.

Designing good interfaces and developing the underlying technologies necessary to make them fully functional is essential to making interactive tablets a part of everyday life. We believe that the coming decade will witness the wide availability of full-functionality tablets that recognize and interpret handwritten and sketched input, and that use wireless communications to link to other computer systems. The state of technology is close to being sufficient to create them now. The challenge is to establish a smooth migration path to move toward more generally useful systems. ■

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# From Hand to Mouth

*Despite advances in interface design, working with a computer still constitutes an "unnatural act" for the vast majority of people. This State of the Art section examines the latest efforts of researchers to make computers more accessible to everyone. For more information on the products and processes described in this section, contact the companies and organizations listed below.*

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**Inquiry 1105.**

**DragonDictate-30K**
**DragonWriter-1000**
Dragon Systems
90 Bridge St.
Newton, MA 02158
(617) 965-5200
**Inquiry 1106.**

**DS200**
Speech Systems, Inc.
18356 Oxnard St.
Tarzana, CA 91356
(818) 881-0885
**Inquiry 1107.**

**Freestyle**
Wang Laboratories, Inc.
One Industrial Ave.
Lowell, MA 01851
(800) 522-9264
(508) 522-5000
**Inquiry 1108.**

**Interactive Worksurface Project**
Microelectronics and Computer Technology Corp. (MCC)
3500 West Balcones Center Dr.
Austin, TX 78759
(512) 343-0978
**Inquiry 1109.**

**Introvoice-5**
**PTVC-756**
The Voice Connection
17835 Skypark Cir., Suite C
Irvine, CA 92714
(714) 261-2366
**Inquiry 1110.**

**The Private Eye**
Reflection Technology
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(617) 890-5905
**Inquiry 1111.**

**Sensor Cube**
Sensor Frame Corp.
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Pittsburgh, PA 15213
(412) 683-9500
**Inquiry 1112.**

**SIR Model 20**
Scott Instruments Corp.
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Denton, TX 76205
(817) 387-9514
**Inquiry 1113.**

**SonicFinder**
Human Interface Group
Apple Computer, Inc.
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Cupertino, CA 95014
(408) 996-1010
**Inquiry 1114.**

**TeleRec**
**VR-4**
Voice Control Systems, Inc.
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Dallas, TX 75244
(214) 386-0300
**Inquiry 1115.**

**3-Draw**
MIT CAD Lab
Massachusetts Institute of Technology
Cambridge, MA 02139
(617) 253-3542
**Inquiry 1116.**

**TI Voice Card**
Texas Instruments, Inc.
P.O. Box 2909, MS 2243
Austin, TX 78769
(800) 527-3500
(512) 250-4114 (demo)
**Inquiry 1117.**

**Verbex 5000**
**Verbex 6000**
**Verbex 7000**
Verbex Voice Systems, Inc.
185 Ridgedale Ave.
Cedar Knolls, NJ 07927
(201) 267-7507
**Inquiry 1118.**

**Virtual Interface Environment Workstation (VIEW)**
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**Inquiry 1119.**

**Voicebox**
Voice Recognition Technologies, Inc.
Computer Voice Systems Division
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(301) 984-1400
**Inquiry 1037.**

**Voice Card VPC-2100**
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(415) 490-7979 (demo)
**Inquiry 1038.**

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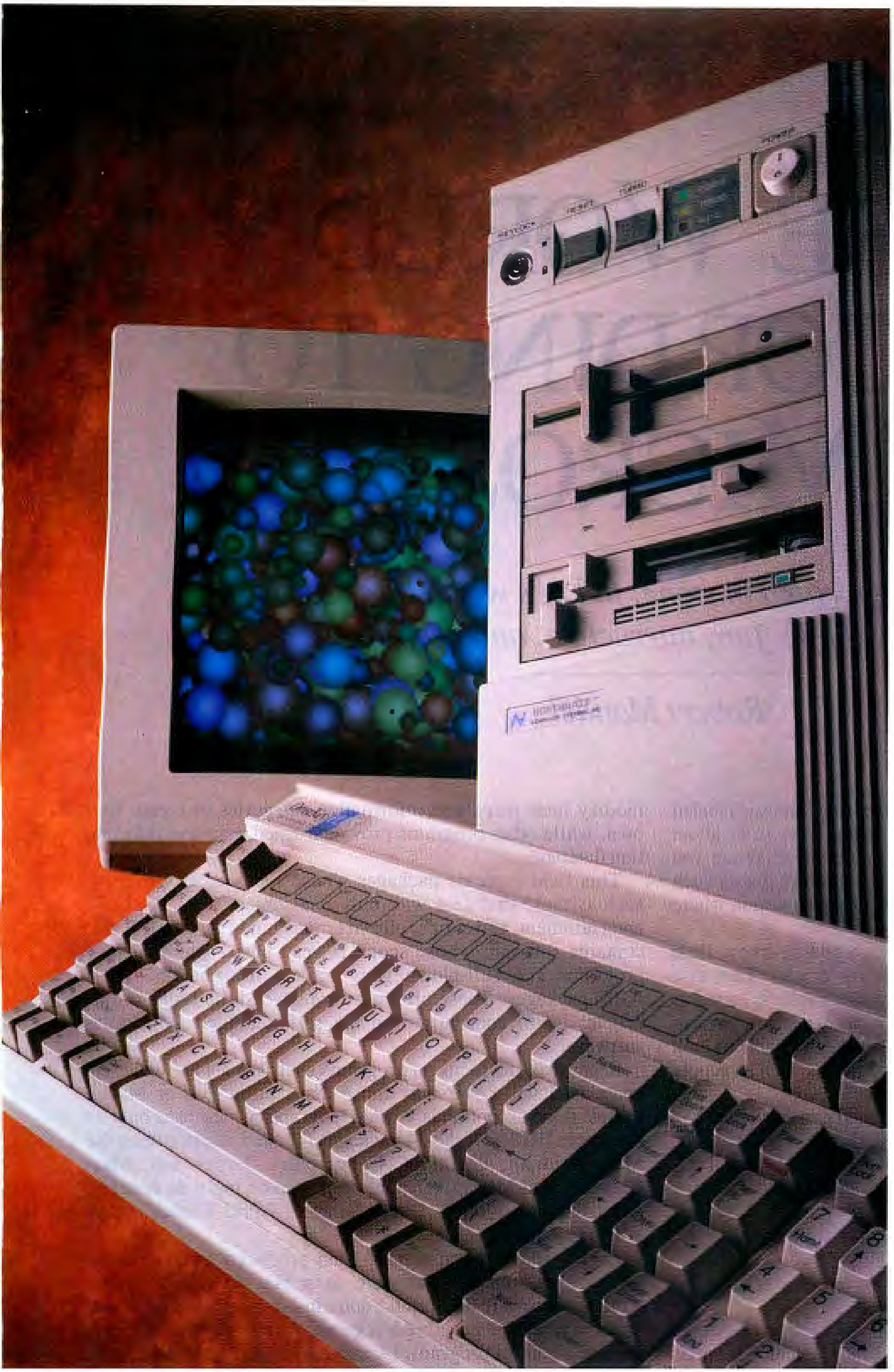
**VoiceReport**
Kurzweil Applied Intelligence, Inc.
411 Waverly Oaks Rd.
Waltham, MA 02154
(617) 893-5151
**Inquiry 1041.**

**VoiceScribe 1000 Plus**
Cherry Electrical, Inc.
3600 Sunset Ave.
Waukegan, IL 60087
(708) 360-3523
**Inquiry 1042.**

**VPC-1000**
Voice Processing Corp.
1 Main St.
Cambridge, MA 02142
(617) 494-0100
**Inquiry 1043.**

*This resource guide lists information sources for the major concepts and products listed in this State of the Art section. Inclusion in the resource guide should not be taken as a BYTE endorsement or recommendation. Likewise, omission from the guide should not be taken negatively. The information here was believed to be accurate at the time of writing, but BYTE cannot be responsible for omissions, errors, or changes that occur after compilation of the guide.*



# Elegance™ 486/25 system configuration

- 25 MHz Intel 80486™ processor with 80387-compatible floating point coprocessor
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- 64K SRAM read/write-back cache (optional 256K cache available)
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- Eight expansion card slots; one 32-bit, six 16-bit and one 8-bit
- Weitek numeric co-processor support
- Two serial and one parallel ports
- 14" monochrome monitor
- Hercules compatible video controller
- MS-DOS 4.01 and GW-BASIC software; Smart Drive disk caching software
- On-line users guide to system and MS-DOS 4.01
- 220 watt power supply
- Elegance 7 drive-bay custom tower cabinet pictured (desktop style available)
- Clock/calendar with 5 year battery backup
- Microsoft® Windows™ 3.0
- Microsoft Mouse
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*Circle 187 on Reader Service Card*

# THE WORLD ACCORDING TO MICROS

*Maps used to be written in stone; today's world atlas software is dynamic, fun, interactive, and useful*

Robert Mandel

Have you ever bought something that was labeled "Made in Brunei" or read a news story about independence coming to Namibia? When you see references mentioning obscure places such as these, do you have the foggiest notion where they are?

Recent studies have shown that many people know little about where various countries and cities are located. They also are unaware of the differences in their demographics, economics, politics, or cultures. Even international experts in government, business, or university settings have been unable to look at a map and visually identify relevant patterns such as supply and demand.

This lack of geographical familiarity has been attributed to a decreasing emphasis in schools on the basics of geography, the difficulties of finding comprehensive and up-to-date global reference data, and the unavailability of map displays showing pertinent data distributions. Even recently published atlases, almanacs, and gazetteers frequently contain outdated or incomplete information.

## Electronic World at Your Fingertips

Fortunately, the recent introduction of interactive electronic world atlases has provided a remedy for this problem. This atlas software simultaneously addresses the gaps in general background knowledge and links this information to other kinds of data and spatial map patterns.

With the recent vast improvements in computer graphics, color, and storage capacity at relatively low costs, the microcomputer now provides a feasible cost-effective alternative to the traditional hardbound atlas. You can use this sophisticated world atlas software in today's PCs and Macintoshes. With it, you can easily spot changing international relationships.

An amazing number of packages have appeared that could be considered "world atlas software." Some programs provide both global mapping and world statistical database capabilities, while others focus on one or the other. Some programs let you modify their maps and information categories or create your own, while other programs provide a fixed map and information database.

This field contains packages whose focus is very narrow, such as those that deal with only one subject (i.e., the U.S., entertainment, travel tips, clip-art maps, and raw data). It also contains software whose scope is very broad—multipurpose programs and full-blown geographical information system (GIS) packages. These programs are beyond the scope of this article; I will concentrate on the self-contained world atlas software.

Because of the focus on programs useful in a wide variety of contexts, I will cover only those that run on PCs or Macintoshes. (One exception is World Geograph, which runs only on the Apple IIGS.) Of the 24 packages I looked at, six run on the Mac: Azimuth, EarthPlot, Geographics, HyperAtlas, MacChoro II, and MapMaker. Only four run on multiple systems: Atlas Explorer, Global Data Manager, World Factbook, and World Geography Series.

Useful atlas programs have been produced as commercial software as well as shareware or public domain software. Among shareware and public domain offerings, you will find some very inexpensive hidden gems. A few of these offerings require a control program. (A control program provides a way of displaying and manipulating the boundary coordinates in the map database.)

Due to the volatility of these products distributed through electronic BBSes, on-line networks, user groups, and shareware distribution outfits, I've included only a sprinkling of the available offerings. None of either kind of software is copy-protected, and most of it is updated at regular intervals. Such updates are most critical when you cannot alter the supplied data.

The software falls into four distinct types: fixed maps with data, customizable maps and data, maps without data, and data without maps. The table provides a comparison of the mapping and geographical database capabilities of the 24 packages.

*continued*


ILLUSTRATION: STEVEN HINES © 1990

## WORLD ATLAS SOFTWARE CAPABILITIES

*World atlas programs vary significantly in their capabilities. With the better packages, you can create or modify map boundaries or geographical data. With the most powerful programs, you can access quite detailed maps and perform substantial data analysis (●=yes; ○=no; N/A = not applicable).*

| Program name | Map coverage | Map size/ projection control | Map import/ export capability | Map alteration capability | Map graphics quality | Data display modes |
|---|---|---|---|---|---|---|
| **Atlas Explorer** | World, main regions | ○ | ○ | ○ | Low | Text |
| **Atlas Graphics** | 6 continents, nations | ● | ● | ● | High | Maps |
| **Azimuth** | World, nations | Size only | ● | ● | Medium | N/A |
| **EarthPlot** | World map with zoom | ○ | ○ | ○ | Medium | N/A |
| **Geographics** | Selected regions | ● | ● | ● | Medium | N/A |
| **Global Data Manager** | World | ○ | ○ | ○ | Low | Map and charts |
| **HyperAtlas** | World, main regions | ○ | ○ | ● | Medium | Text |
| **MacChoro II** | World, main regions | Size only | ● | ● | Medium | Maps and charts |
| **Map Collection** | World, some regions | ● | Import only | ● | High | Maps |
| **MapInfo** | World, nations | ● | ● | ● | High | Maps |
| **Mapit** | 7 continents, nations | Size only | ○ | ● | Low | Maps |
| **MapMaker** | World, 9 regions, 259 cities | ● | ● | ● | Medium | Maps |
| **Map-Master** | World, main regions | ● | ○ | ● | Medium | Maps |
| **Micro World Data Bank II** | World map with zoom | Size only | Export only | ○ | High | N/A |
| **PC Globe** | World, 8 regions, 177 nations | ○ | Export only | ○ | High | Maps and charts |
| **Software Toolworks World Atlas** | World, 14 regions, 198 nations | ○ | Export only | ○ | High | Maps and charts |
| **Windows/On the World** | World map with zoom | ● | ● | ● | High | Maps |
| **World** | World map with zoom | ● | ○ | ● | High | Maps |
| **World Atlas** | N/A | N/A | N/A | N/A | N/A | Text |
| **World Digitized** | 7 continents with zoom | ● | ● | ○ | High | N/A |
| **World Factbook 1989** | World, 12 regions, 248 nations | ○ | ○ | ○ | Medium | Text |
| **World GeoGraph** | World, 6 continents, 21 regions | ○ | ○ | ○ | Medium | Maps and charts |
| **World Geography Series** | N/A | N/A | N/A | N/A | N/A | Text |
| **World29** | World map with zoom | ○ | Export only | ● | Medium | N/A |

### Fixed Maps with Data

This first group of software packages provides an enormous amount of global maps and data. These programs are the closest in form and purpose to traditional hardbound world atlases.

The goal of *Atlas Explorer* is to improve people's geographical knowledge in a classroom setting. It is the only drill-and-practice program that combines mapping capabilities with a text database on each nation. A mouse is almost essential for the program, which operates in two modes: tutorial mode, in which you can explore the world at your own pace; and quiz mode, in which you are tested on what you have learned. The program has a nice record-keeping feature to keep track of test performance.

Unfortunately, this program's map resolution and detail are quite poor (with no support for color or high-resolution graphics), and you may find the learning process sterile and boring. Furthermore, the choice of map features appears somewhat arbitrary, and the quiz questions often seem trivial.

| Global data coverage | Data import/ export capability | Data alteration capability | Data analysis capability |
|---|---|---|---|
| Population, area, currency, language | ○ | ○ | Low |
| 23 demographic categories | ● | ● | Medium |
| N/A | N/A | N/A | N/A |
| N/A | N/A | N/A | N/A |
| N/A | N/A | N/A | N/A |
| Over 180 diverse categories | ● | ● | High |
| 25 demographic and economic categories | Import only | ● | Low |
| None | Import only | ● | High |
| None | Import only | ● | Medium |
| Population | ● | ● | High |
| Population | ○ | ● | Low |
| 20 demographic categories | ● | ● | Medium |
| None | Import only | ● | Medium |
| N/A | N/A | N/A | N/A |
| Over 80 diverse categories | Export only | ● | High |
| Over 80 diverse categories | ● | ● | High |
| None | ● | ● | Low |
| None | ○ | ● | Low |
| Population, location, area | ○ | ○ | Low |
| N/A | N/A | N/A | N/A |
| Over 60 diverse categories | ○ | ● | Low |
| 55 diverse categories | Export only | ● | High |
| Economics, location, area | ○ | ○ | Low |
| N/A | N/A | N/A | N/A |

*Software Toolworks World Atlas* (formerly Electromap World Atlas) strives to be a combination world atlas and gazetteer and succeeds admirably at both. Compared to the other packages in this category, Software Toolworks World Atlas is the winner. None of the other programs contains the diversity and quality of the international maps in this package. The cartography is truly reminiscent of the best hardbound atlases (see photo 1).

The map implementation using the mouse is more complete and intuitive than in any other atlas program—you can click directly from world to region to country levels with ease. The data coverage is comprehensive and logically grouped into geography, people, government, economy, and communications categories. The software includes a nice feature that combines map and background information into a unified hard-copy report on any country.

The newly released version lets you do substantial graphical analysis and comparison of data as well as edit the geographical database itself. The only thing missing is a fuller range of customization tools.

*HyperAtlas* is a series of HyperCard stacks of maps and global information linked together in a geographical data management system. The program, which has separate but linked stacks for the world and the U.S., is intuitively laid out and easy to use. You can add an unlimited number of information stacks, modify existing information, or even change the maps. However, the maps are not very detailed, and the information provided regarding each country is sparse.

*PC Globe* is a comprehensive computerized atlas of the world's nations. I award it an honorable mention (second only to Software Toolworks World Atlas) for its manufacturer-supplied maps and data. The program is very fast and is a snap to run by either keyboard or mouse. The global, regional, and country maps are clear and detailed. Its huge amount of background and statistical information may be viewed on maps, bar charts, and tables. This is the only program that indicates on maps the membership of major international organizations such as NATO or the European Economic Community.

PC Globe's printer support is excellent, as is its ability to export maps and data for other uses. An optional add-on program—PC Nations—displays national flags and plays national anthems. About to be released is an open-architecture version of this program, Mapworks. It differs from the standard version in letting you customize maps and import data from other sources.

On the downside, it would be nice to be able to import maps, and the selection of data categories seems a bit odd. While PC Globe contains incredibly detailed national statistics on issues such as health (including the number of dentists and nurses), it ignores a few major topics, such as energy consumption.

*World GeoGraph* is a geography-learning tool designed primarily for classroom use. It has a highly interactive relationship between the maps and the database. This Apple IIGS program is designed around five geographical themes—location, place, relationships within areas, movement, and regions. It beautifully integrates these concepts in a way that stimulates users to think creatively and analytically.

The manual and accompanying classroom guide are excellent, and the program is quite intuitive to use. Despite the Apple IIGS monitor's course resolution (640 by 200 pixels), the global and regional maps are clear and reasonably detailed. World GeoGraph's developers thought out and clearly organized its data categories.

Although the speed of execution is sometimes a bit slow, you will find World GeoGraph flexible in displaying its data with maps, graphs, and tables. The package contains a feature (similar to that in Software Toolworks World Atlas) that combines maps and data into a finished report. World GeoGraph's search function for comparative analysis across areas—allowing and/or combinations of search criteria—is among the most powerful of all these programs. While this program does not permit much customization, you can add three new data categories and have them fully integrated into the system.

*continued*

## Customizable Maps and Data

Programs in this second group give you the freedom to tailor maps and data to your own needs. The software generally includes extensive tools for mapmaking and data creation.

*Atlas Graphics* is a powerful and well-established package linking maps to data. I award this program an honorable mention (just behind MapInfo) in this category. Atlas Graphics has extensive tools for developing presentation-quality thematic maps. They include using color, cross-hatching, or dot-density map patterns; inserting a wide variety of special symbols and icons; adding text, legends, titles, and labels; and generating output on a wide variety of printers and plotters.

The package is easy to use and has a clear menu structure. The biggest drawback is what isn't included in the basic package. You have to purchase international maps and data separately from the manufacturer, and you may need two costly add-on programs: Atlas Draw, which permits detailed digitization or on-screen drawing of new maps; and Atlas Import/Export, which lets you transfer maps to and from other software.


**Photo 1:** *This map of Hong Kong illustrates the cartographic detail and sophistication contained in Software Toolworks World Atlas.*

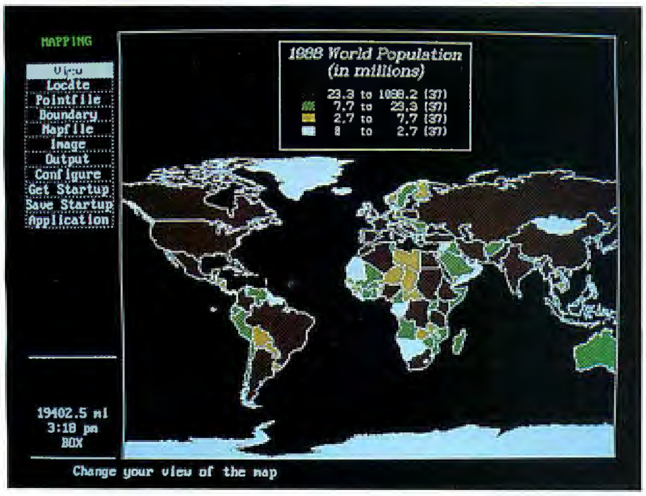



**Photo 2:** *MapInfo's advanced mouse-driven menu structure works well with many kinds of maps, such as this one showing world population distribution.*

*MacChoro II* is a remarkably compact package with an innovative presentation of thematic choropleth maps (i.e., maps that display data patterns on them). The program's unique feature is map animation. It dynamically displays data distributions (up to 60 per second) in such a way that you can immediately see whether areas that are high in one category are also high in another.

This software incorporates multiple windows, including one for drawing graphics, one for spreadsheet data, and a text-editor window for output of classification statistics. MacChoro II's main limitations include the absence of global data supplied or available with the software, and the omission of many map-data customization capabilities common among full-featured programs of this type.

*Map Collection* is an inexpensive and unusually versatile package that displays attribute data values on maps. The program's mapping capabilities include displaying various kinds of symbols, showing geographical contours, and even graphing three-dimensional surfaces. You can digitize, edit, and scale maps, and use over 20 map projections. (The term "projection" refers to the way the round earth is displayed on a flat map.)

One oddity about the program is that even if you use a hard disk drive, you must always boot from a floppy disk to install IBM's Virtual Device Interface for the map graphics. World map boundary coordinates are available but not automatically supplied with the package. Map Collection has two major drawbacks: the lack of integration among the software's many independent program modules, and its counterintuitive keystroke combinations.

*MapInfo* is the most powerful desktop mapping software I ran—its capabilities are staggering. Among software in this category, MapInfo stands at the head of the group. The package can do virtually anything the other programs in this category do—and better. The user interface is more intuitive and easier to use than any other package with flexible links between maps and data. Both the manual and the mouse implementation are excellent.

The program features map creation (with digitizing as an option), customization (with control over boundaries, legends, text, and graphics), and panning. You can also zoom and locate a specific address location on the maps, and create, modify, and visually display almost any kind of data.

With MapInfo, you can analyze and graphically display data trends (see photo 2). While map importing or exporting requires a separate package available from the manufacturer, you can readily perform data importing or exporting. There is also a built-in networking capability. This software's major limitation is the minuscule amount of global statistical data it has or makes available to you.

*Mapit* is a no-frills attempt to provide basic mapping and data display capabilities. The output, which is primarily designed for hard-copy printouts rather than for monitors, is crude compared to the more costly professional mapping packages.

The command structure is straightforward and relatively easy to learn but not intuitive or user-friendly. Mapit lets you create and customize maps (including control of titles, labels, scaling, and fill patterns) and insert your own data. Overall, the program succeeds in achieving its goals, but they may well be too modest for most sophisticated mapping needs.

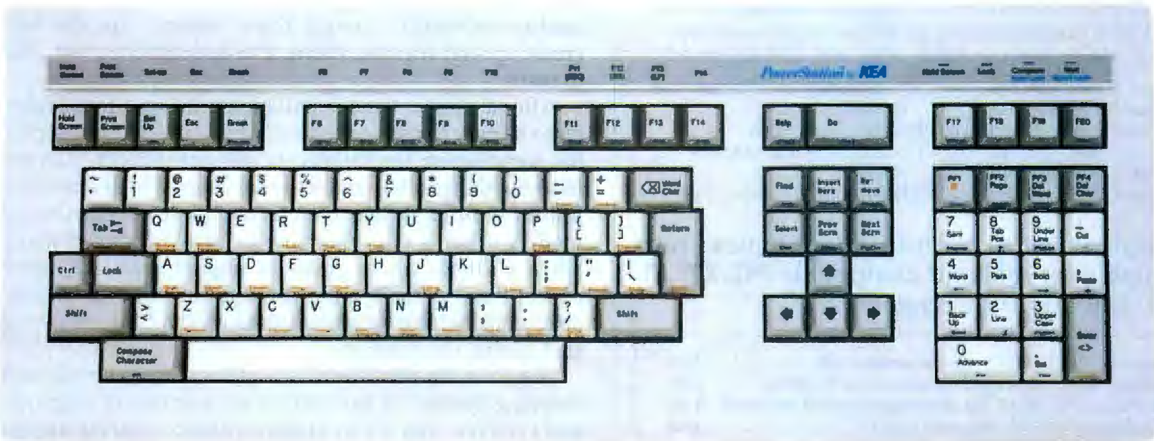
*MapMaker*'s aim is to give you the tools you need to create and design publication-quality maps. Its toolkit and presentation graphics capabilities are impressive. For example, data can appear on map areas through color crosshatch patterns, dot density representations, or area cartograms (in which each

*continued*

# Which terminal emulation keyboard would you rather use?

A.


B.



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*The overall quality of these packages is surprisingly high and promises to get even better.*

area's size is proportionate to its data value). In addition, the program can use multiple map projections and sizes and even lets you create new boundaries from latitude and longitude coordinates.

With MapMaker, you can create, import, export, or compare maps and statistical data. This is the only package that contains worldwide city maps. However, the program is relatively slow and difficult to use, and the quality of the country maps is crude for such a powerful package.

Similarly, *Map-Master* attempts to create presentation-quality maps showing data relationships. It has powerful customization capabilities (though not nearly up to the level of highest-quality software). Among these features are the ability to create special regions, zoom, and add symbols, text, and lines to maps.

After a cumbersome installation process, I found Map-Master to be easy to use and logically laid out. But the program also has some severe limitations: It will not support VGA graphics (640 by 480 pixels), and its maps are not well detailed. Map-Master permits neither the creation of new maps (but you can modify existing ones) nor importing/exporting of maps. And while it allows you to create or import new data, you cannot export data. Although the package includes (or makes available) considerable statistical data on the U.S., it provides no such global information.

*Windows/On the World* is a particularly flexible and open mapping system. It lets you create overlays of graphics, text, and symbols, and it can display distance-bearing and position information. Running under Microsoft Windows, this program can link up well with the increasingly powerful range of Windows applications.

At present, the global boundary coordinates contained in Windows/On the World are less detailed than the U.S. data available on CD-ROM. The global mapping information is extracted from the Micro World Data Bank and is free to any registered user. But the Defense Mapping Agency (a government branch) has recently selected the creator of this program to help develop a future product called Digital Chart of the World.

## Maps Without Data

This category provides full cartographic capabilities, but its programs generally lack the ability to display data distributions on the maps. These packages are especially useful for generating different kinds of long-range global views.

*Azimuth* is a full-featured map-drawing/-drafting program that lets you view the earth from any distance or angle. Its capabilities include rotation, scaling, creation of a library of symbols, and map layering, and it lets you import and export maps. The package contains clear (though complex) instructions.

*continued*

However, Azimuth contains a number of limitations. It does not let you use alternative map projections, it allows only limited use of color, it does not execute very quickly, and—most important—it does not contain the level of boundary detail (particularly for smaller nations) of the best mapping packages. With a forthcoming version, Azimuth developers plan to address these drawbacks and offer optional world data to complement the world boundary files.

*EarthPlot* is one of the pioneer public domain programs for displaying views of the world from outer space. It is designed for long-range viewing—from 1000 to 160,000 miles up, any latitude and longitude, with or without grid lines. But the boundary data excludes both Antarctica and country borders, and the program is slow. You will find that EarthPlot's close-up views are inaccurate, you can't save the maps you create, and the program does not support hard-copy printout.

*Geographics* is a dynamic atlas program. With it, you can create and display points of information either on the supplied maps or on maps you create or import. The program allows you considerable latitude to scale and edit maps, but it contains only select international boundary files, and you will not find using it intuitive. Furthermore, the toolkit for map customization is much more limited than those provided by other packages in this category.

*Micro World Data Bank II* is a condensation of the 6-million-point World Data Bank developed by the CIA for mainframe computers. Comparing programs in this category, the World package got top honors, and Micro World Data Bank was the next best program. The microcomputer version contains 179,000 latitude and longitude points detailing coastlines, islands, and countries, as well as American state borders, lakes, and rivers.

You can generate maps from any latitude/longitude point and a huge range of altitudes, and you can choose from five levels of detail. The level with the finest detail produces maps surpassing most other available mapping programs. This program's developer designed the database so that it can be incorporated into other mapping programs.

PlotMWDB is a powerful control program. With it, you can easily customize the size, shape, and position of world maps. In addition, you can produce hard-copy outputs via several plotters. You can also export maps to other applications.

*World* is the best program included in this discussion with a mapping focus. World's most amazing feature is its ability to draw maps using over 100 different cartographic projections. It can also rotate, scale, and shade maps and incorporate great circle arcs, range rings, symbols, labels, and titles.

The program can use a variety of map boundary files, ranging from those that are quite generalized to a highly detailed file using Micro World Data Bank. This program's biggest disadvantages are its user interface (which is neither intuitive nor easy to use), and the fact that, with a one-monitor system, it overprints text and graphics.

*World Digitized* provides over 100,000 points of coastline, island, lake, and national boundary coordinates organized by continent. You can obtain two control programs for displaying this database. In both cases, you must substantially transform the data.

The first option—the Simple Display Program—supports the use of the mouse, complex zooming and positioning, distance measurement, and integration of maps into BASIC programs. With the other option—the Map Control Program—you can use a variety of map projections, viewing angles, positions, altitudes, and imported map coordinates including Micro World

*continued*



 

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|---|---|---|---|---|---|
| • 80286-12 CPU<br>• 1 Meg RAM<br>• 1.2 Meg Floppy Drive<br>• 1.44 Meg Floppy Drive<br>• 40 Meg 28 ms Hard Drive<br>• 16 bit VGA Board<br>• 14" VGA color Monitor (640×480)<br>• 2S/1P/1G ports<br>• 101-key Keyboard<br>• Genius Mouse<br>• M/S DOS 4.01<br>• Panasonic 1180 printer<br>• Surge Protector | • 80386-16SX CPU<br>• 2 Meg RAM<br>• 1.2 Meg Floppy Drive<br>• 1.44 Meg Floppy Drive<br>• 66 Meg 25 ms Hard Drive<br>• 16 bit VGA Board<br>• 14" VGA color Monitor (640×480)<br>• 2S/1P/1G ports<br>• 101-key Keyboard<br>• Genius Mouse<br>• M/S DOS 4.01 | • 80386-20 CPU<br>• 2 Meg RAM<br>• 1.2 Meg Floppy Drive<br>• 1.44 Meg Floppy Drive<br>• 66 Meg 25 ms Hard Drive<br>• 16 bit VGA Board<br>• 14" VGA color Monitor (640×480)<br>• 2S/1P/1G ports<br>• 101-key Keyboard<br>• Genius Mouse<br>• M/S DOS 4.01 | • 80386-25 CPU<br>• 4 Meg RAM<br>• 1.2 Meg Floppy Drive<br>• 1.44 Meg Floppy Drive<br>• 105 Meg IDE Hard Drive<br>• 16 bit VGA Board<br>• 14" VGA color Monitor (1024×768)<br>• 2S/1P/1G ports<br>• 101-key Keyboard<br>• Genius Mouse<br>• M/S DOS 4.01 | • 80386-25 CPU<br>• 32K 25ns Cache Memory<br>• 4 Meg RAM<br>• 1.2 Meg Floppy Drive<br>• 1.44 Meg Floppy Drive<br>• 105 Meg IDE Hard Drive<br>• Dual HD/FL IDE Controller<br>• 16 bit VGA Board<br>• 14" VGA color Monitor (1024×768)<br>• 2S/1P/1G ports<br>• 101-key Keyboard<br>• Genius Mouse<br>• M/S DOS 4.01 | • 80386-33 CPU<br>• 32K 25ns Cache Memory<br>• 4 Meg RAM<br>• 1.2 Meg Floppy Drive<br>• 1.44 Meg Floppy Drive<br>• 150 Meg 18 ms ESDI Drive<br>• 32K Fast Cache ESDI Controller<br>• 16 bit VGA Board<br>• 14" VGA color Monitor (1024×768)<br>• 2S/1P/1G ports<br>• 101-key Keyboard<br>• Genius Mouse<br>• M/S DOS 4.01 |
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**MapMaker 4.01**.....................$395
Strategic Mapping, Inc.
4030 Moorpark Ave., Suite 250
San Jose, CA 95117
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**EarthPlot 3.0** (public domain)..... $11
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(213) 985-7808
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**MapInfo 4.05**........................$750
MapInfo Corp.
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(800) 327-8627
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Questionnaire Service Co.
P.O. Box 778
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(517) 641-4428
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**Map-Master 6.01** ...................$395
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**Micro World Data Bank II**
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*Includes the control program PlotMWDB 2.4 (shareware).*
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(402) 291-0795
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PC Globe, Inc.
4700 South McClintock, Suite 150
Tempe, AZ 85282
(800) 255-2789
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**World Atlas 2.0**
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CD-ROM version..................$160
The Software Toolworks
19808 Nordhoff Place
Chatsworth, CA 91311
(800) 231-3088
**Inquiry 1064.**

**Windows/On the World 2.36**.....$495
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5680 Peachtree Pkwy., Suite B
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**World 4.04** ..........................$250
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University of Minnesota
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269 South 19th Ave.
Minneapolis, MN 55455
(612) 625-8556
**Inquiry 1066.**

**World Atlas** (public domain) ....... $10
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P.O. Box 51315
Indianapolis, IN 46251
(800) 426-3475
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**World Digitized 1.4** (shareware)
with the Simple Display
Program 2.0 ........................ $30
The World Digitized
166 Shady Lane
Apollo, PA 15613
(412) 778-5072
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or
**World Digitized 1.4**
with Map 2.3......................... $24
Public (Software) Library
P.O. Box 35705
Houston, TX 77235
(713) 665-7017
**Inquiry 1070.**

**World Factbook 1989**
(CD-ROM)...........................$104
Quanta Press, Inc.
2550 University Ave. W, Suite 245N
St. Paul, MN 55114
(612) 641-0714
**Inquiry 1181.**
or
**World Factbook 1989**............... $90
Shryer Publishing, Inc.
1866 West Shryer Ave.
Roseville, MN 55113
(612) 633-3865
**Inquiry 1182.**

**World GeoGraph 1.1** ..............$139
MECC
3490 Lexington Ave. N
St. Paul, MN 55126
(800) 228-3504
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**World Geography Series**..........$240
Intellectual Software
Queue, Inc.
338 Commerce Dr.
Fairfield, CT 06430
(800) 232-2224
**Inquiry 1184.**

**World29 2.98** (shareware) .......... $15
Robert Lloyd
191 Via DeLaReina
Merritt Island, FL 32953
(407) 452-4937

Data Bank's boundary files. World Digitized is not quite as detailed as Micro World Data Bank and contains some minor boundary errors.

*World29* is a well-thought-out map-drawing program with many unusual features. It contains a nice menu system with which you can draw maps from a wide range of altitudes based on either latitude/longitude positions or city/country/region names. World29 also offers an intriguing quiz option, in which a city location and its immediate environs are shown on a map and you have to guess the city name.

In addition, with World29, you acquire the capacity to track storms and extensive tools to customize and save generated maps. However, the program does not support VGA graphics (640 by 480 resolution), and—more important—its map boundary detail is inadequate for most professional purposes.

## Data Without Maps

This type of package provides a more extensive range of data than the others but generally does not permit you to view the data on maps. Thus, these programs fill in holes in our knowledge about critical differences among nations.

*Global Data Manager* attempts to provide a comprehensive inventory of statistical data. This program does indeed contain a dazzling array of information. Among offerings of this type, Global Data Manager emerges in first place. It includes unusual categories such as time-series AIDS data and solar energy potential for each country.

Global Data Manager's database is extremely flexible in letting you alter, import, or export data, and compare or combine any parts of it. (There is only one map available with this package; see photo 3.) Although basically a dedicated spreadsheet, Global Data Manager permits you to view data in bar charts or even on a primitive map display. This program's major drawbacks are its sketchy manual and the difficult and counterintuitive user interface.

*World Atlas* is really designed to be a gazetteer, as it contains no maps. But it does provide useful textual information about continents, countries, islands, cities, oceans, mountains, lakes, and rivers. The program contains an interesting geography trivia quiz, and it has an effective means of comparing areas. But the information is dated, not modifiable, and not in a form suitable for serious aggregate data analysis.

*World Factbook 1989* is a microcomputer version of a CIA-prepared annual reference volume—the most definitive and comprehensive global data the American government provides to the public. One version on CD-ROM contains the crude TextWare Plus information retrieval system. Cards exist for each of 256 countries and territories. You can search using indexed keywords, or you can add or edit data cards, but you need a standard desktop publishing or graphics package to view the black-and-white and color maps.

Another version of World Factbook 1989 that runs on floppy disks includes the far more efficient, flexible, and easy-to-use Folio Views software for organizing the data so you can search through the information in many different ways. So far, though, this version does not include the maps and does not permit modification of the data. (Plans are in the works to improve this.) The biggest drawback of both programs is that you cannot meaningfully use the presented information to perform aggregate comparative data analysis (such as in quantitative studies using spreadsheets or statistical packages).

*World Geography Series* aims to provide text-oriented drill-and-practice geography lessons for classroom use. The program (which includes wall maps) provides short tutorials emphasizing relationships among geographical features. Its coverage includes country and city locations, national economic data, and topographical highlights.

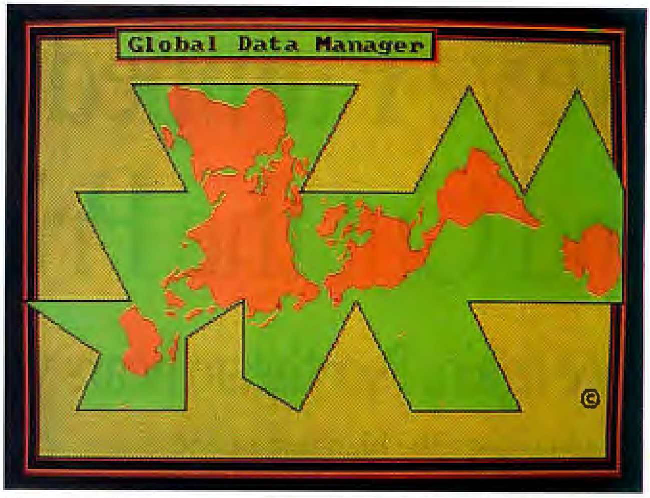



**Photo 3:** *The Dymaxion Map of the World is a highly unorthodox map projection designed by Buckminster Fuller. It is the only map available in the statistics-oriented Global Data Manager.*

Each World Geography Series tutorial is followed by a short quiz on the material. The biggest problem with this package is that the presentation style is so simplistic and the questions so elementary (given the tutorial that immediately precedes it) that users may quickly tire of the program and not retain the small amount of information on which they are tested.

## The New Wave

Obviously, how you evaluate the relative merit of the various world atlas software packages depends to some degree on your particular goal, application, or sophistication level.

The overall quality of these packages is surprisingly high and promises to get even better. This improvement is due to increasing competition, with new market entrants and exploding product demands. Multinational corporations, national governments, and international organizations have found useful applications for this software to solve practical problems. For example, some businesses have been able to spot geographical relationships among areas of greatest sales demand, product supply, and competition.

The next stage in the development of this exciting microcomputer software may be the creation of artificially intelligent rule-based expert systems for mapping/geography databases. Programs could be developed that anticipate the kinds of information users should be seeking and relationships they should be forming. This next wave of atlas software may even provide you with advice concerning optimal decisions or actions. Technology from this generation of world atlas software may enable you to achieve a greater understanding of the complex international setting. ■

ACKNOWLEDGMENT
*My thanks to Inset Systems, Inc., for the use of its HiJaak and Inset graphics-conversion and screen-capture software.*

*Robert Mandel is professor of international affairs at Lewis and Clark College in Portland, Oregon. Mandel is a consultant/reviewer dealing with global mapping and simulation software. He can be reached on BIX c/o "editors."*

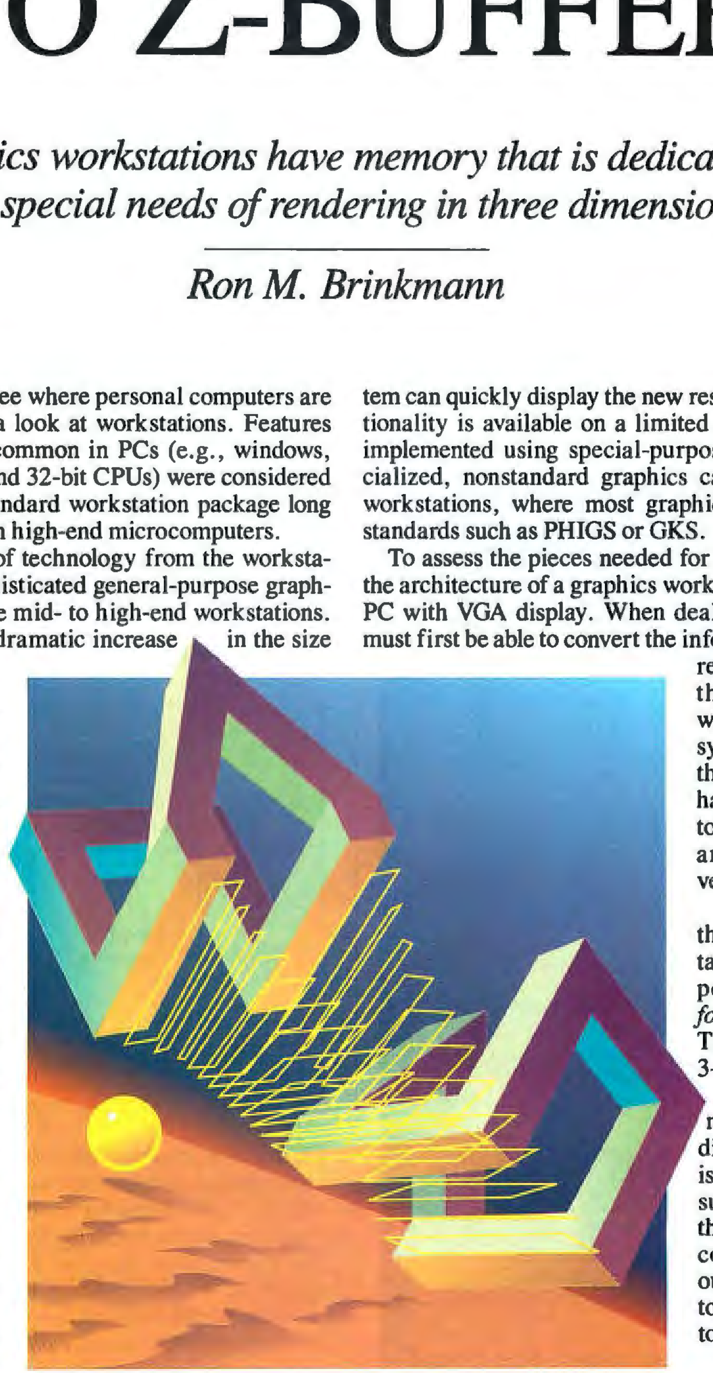
# 3-D GRAPHICS, FROM ALPHA TO Z-BUFFER

*Graphics workstations have memory that is dedicated to the special needs of rendering in three dimensions*

*Ron M. Brinkmann*

If you want to see where personal computers are headed, take a look at workstations. Features that are now common in PCs (e.g., windows, networking, and 32-bit CPUs) were considered part of the standard workstation package long before they began appearing in high-end microcomputers.

The next major migration of technology from the workstation to the PC will be the sophisticated general-purpose graphics hardware now found on the mid- to high-end workstations. For example, there will be a dramatic increase in the size of frame buffers available for a PC, and in the use of specialized graphics transform processors used for three-dimensional rendering. But PC standards and support are lacking.



## 3-D Needs

Although the ability to quickly render 3-D solids is not a universal need, certain applications benefit from it: in particular, the design of mechanical parts and, in general, any sort of 3-D drafting. Designers become more efficient if they are able to quickly visualize their designs in three dimensions. A fast 3-D rendering system lets designers view their models from any direction and distance, effectively "spinning" the object in space. If they wish to modify their models' attributes, such as color or lighting, the system can quickly display the new results. Even though this functionality is available on a limited basis for PCs, it is usually implemented using special-purpose hardware driven by specialized, nonstandard graphics calls. This is in contrast to workstations, where most graphics subsystems use industry standards such as PHIGS or GKS.

To assess the pieces needed for 3-D functionality, compare the architecture of a graphics workstation with that of a current PC with VGA display. When dealing with a 3-D model, you must first be able to convert the information about the object (in real-world coordinates) into the 2-D representation that will appear on the screen. In a system (workstation or PC) that has no specialized 3-D hardware, this conversion has to be done by the main CPU and, consequently, can be very time-consuming.

A graphics workstation, on the other hand, usually contains a specialized floating-point processor, the *transform engine* (see figure 1). Tuned to convert images from 3-D to 2-D, it will dramatically speed up the transformation. Once converted, this display-specific information is then stored in the graphics subsystem's screen memory, the *frame buffer*. The video-conversion system continuously scans the frame buffer to determine which phosphors to light on the screen.

*continued*

ILLUSTRATION: DON BAKER © 1990

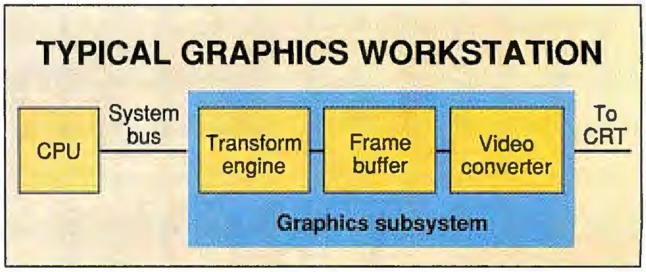



**Figure 1:** *When dealing with a 3-D model, the system's main CPU passes the information about the object to the transform engine (in the graphics subsystem). This specialized floating-point processor converts the information into the 2-D screen image, which is stored in the frame buffer. The video converter reads the frame buffer to create video scan information.*

The design of the graphics processing pipeline varies from system to system. Given a fast-enough CPU in a multiprocessor configuration, the transforms can be done by the system's main processor instead of on an auxiliary specialized engine. Specialized graphics-transform hardware is unlikely to ever become widely available on PCs—not enough applications require it. Also, as the speed of general-purpose CPUs increases, the need for special-purpose engines goes away. This is particularly true if (as in the workstation community) multiple-CPU machines become common. Unlike dedicated 3-D hardware, screen memory in the PC will continue to be more important.

### Screen Resolution

A display's resolution is the number of addressable points, or *pixels*. Unlike VGA, which gives you 640 by 480 pixels—about

*continued*

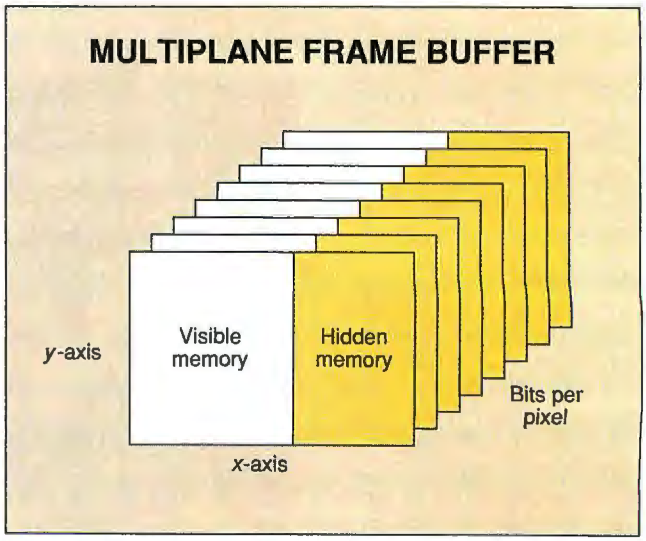



**Figure 2:** *A graphical display with a single plane allows only monochrome images. Increasing the screen depth allows more colors, double-buffering for animation, z-buffering for 3-D rendering, alpha buffering for transparency, or antialiasing. The system shown here has 8 bits per pixel, which provides $2^8$ options (256 color choices), and a portion of nondisplayable (hidden) screen memory, which can be used for fast generation of bit-mapped text, texture mapping, and pattern tiling.*

300,000 pixels of resolution—most high-end graphics workstations offer at least a million pixels, typically 1280 horizontal by 1024 vertical. Display systems with resolution that is higher than VGA are available for PCs (e.g., Super VGA and TIGA), but they are expensive and lack a standard. Consequently, there are few applications that take advantage of these ultra-high-end PC display systems.

Graphics workstations not only have higher resolution, but often also have nondisplayable banks of screen memory, or *hidden memory*. This gives you a sort of display memory scratchpad to help with such things as fast generation of bit-mapped text, texture mapping, and pattern tiling. These effects rely on block memory transfers, which are much quicker when going from one section of screen memory to another (rather than from main memory to screen memory). Not only is screen memory itself faster than main memory, but there is no need to convert from the bit layout used in main memory to the bit layout of screen memory.

Larger banks of hidden memory are becoming more common, and, in fact, some systems let you interactively change which portion of screen memory is visible. This is of particular interest to users who deal with very large bit maps, since they can scroll through an image larger than the system's display resolution by merely respecifying which portion of screen memory is to be displayed.

### Screen Depth

A less familiar term, *screen depth*, refers to the number of bits of information that a pixel contains. A common way of denoting a screen's depth is by specifying the number of *planes* available. Thus, a system with 8 bits per pixel is an 8-plane system. The use of multiple-plane systems in workstations has grown in the last few years. There are several systems with dozens of bits per pixel (see figure 2).

The most common reason to increase screen depth is to broaden the palette of colors available. A single bit per pixel can specify only whether a point is on (white) or off (black). Eight bits per pixel gives you $2^8$ options, or 256 colors. Such a configuration is usually called *pseudocolor*, due to the fact that the eye can easily distinguish differences between adjacent colors in the palette. Twenty-four planes is the point at which there are enough colors to accurately represent the full visual range. Such a system is known as a true-color system and can produce over 16 million color variations.

Frame buffers are not always fixed into a certain configuration or layout. Often you can trade higher resolution for a deeper palette. A 640- by 480-pixel by 24-plane frame buffer contains the same amount of memory as one laid out as 1024 by 900 pixels by 8 planes. A number of graphics cards can run in more than one mode. Anything beyond 24 planes on a PC is rare. Once again, there is no PC industry standard for this option, and only a few software packages can take advantage of these products.

### Double Buffering

The next technique that requires additional screen memory is usually referred to as *double buffering*. This is used for smoothly animating a rapidly changing image. Even with a simple model and fast hardware, continuously redrawing the object can result in a noticeable flicker. The flicker is caused by the need to clear the display before the system begins drawing the object in its next position. To eliminate this, double buffering lets the system draw an image in an undisplayed portion of screen memory and then flip the primary image buffer and this

*continued*

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secondary image buffer to immediately redisplay the object in its new position.

In effect, this technique is really respecifying a certain number of planes (the secondary image buffer) as hidden memory and then flipping the two buffers so that the primary image buffer is undisplayed, or hidden. If you are dealing with pseudocolor images, then you need two 8-plane memory blocks, or a total of 16 planes, to accomplish this. If you wish to double-buffer true-color images, then a total of 48 planes is necessary. Only when the secondary drawing is completed do you inform the video system to change its scanning range, and thus the next frame is already drawn when needed. Note that this does not allow you to draw the frames any faster, it just produces a much more realistic feeling of motion. While it is theoretically possible to generate double-buffered, pseudocolored images on a PC, there is very little software support for this.

### Z-Buffering

To understand z-buffering (also known by the more descriptive, less convenient term "the depth-conditional replace-pixel algorithm"), you must first look briefly at how graphics workstations usually model 3-D objects.

An object is modeled as a collection of adjacent polygons, which appears as a solid. Even smoothly curved surfaces (e.g., spheres) will actually be internally represented by some sort of polyhedron. The smaller a curved surface is subdivided, the smoother it will appear. (After determining other factors, the rendering program will use specialized lighting and shading techniques to eliminate the faceted look.) At this point, no attempt is made to determine which pixels or polygons are visually obscured by others.

The transform engine translates the model's 3-D coordinate system into 2-D screen coordinates, but each pixel has a depth (or $z$-value) associated with it, along with its $x,y$ coordinate and color value. The result is a list of overlapping 2-D polygons that are in the theoretical plane of the video screen. The list needs to be sorted by depth. Graphics workstations designed for solid modeling, such as the Apollo DN 4500DVS, the HP 9000 Series 835 TurboSRX, and the Silicon Graphics Personal Iris (see "Personal Iris: The Dream Maker" on page 174) have special hardware for this work. A system that has no hardware must sort this list as part of the application program; only then can the polygons be drawn in a sequence that ensures that a distant polygon is not drawn over a nearer polygon. There are several algorithms for this sort, but for a model with a large number of polygons, the technique is very time-consuming. A much simpler method is to retain the $z$-value of each pixel as it is drawn and place it in a specialized memory position, known as the *z-buffer*.

### Removal of Hidden Surfaces

Having a polygon list is the preliminary stage to removing hidden surfaces. The solid-modeling software progresses through the list of 2-D polygons, processing each pixel of the corresponding image. If the pixel's $z$-value is greater than the existing $z$-value, then it is behind the existing pixel (relative to the person sitting at the workstation) and consequently does not need to be displayed. If, however, its $z$-value indicates that it is in front of the existing pixel, then it becomes the displayed pixel. The result is that the displayed pixel becomes the color of the pixel just evaluated, and the display's *z*-value reflects the new depth. Objects then appear in the order in which the renderer processes the display list. The end result is an image that is visually consistent with the original model.

Just how much extra screen memory do you need to properly represent these depth values? Eight bits per pixel of z-buffer allows for 256 depth values. For simple models, this may be enough. It would be impractical to represent every possible depth that an object could have, so first you need to place limits on the largest and smallest *z*-values you will deal with. If the 3-D object you are dealing with is, for instance, about 5 centimeters square, then you're probably safe in limiting the range of depth values to a 10-cm range. Eight bits of z-buffer lets you divide this into 256 values, or increments of about a third of a millimeter. Rounding errors may produce a few incorrectly drawn pixels, but for most situations, the representation will be accurate.

Current high-end graphics workstations offer much larger z-buffers—up to 32 bits—effectively allowing you to deal with over 4 billion different depth gradations. There are times when such precision is needed.

A common misconception is that a model of a larger space, say one that is 50 meters square, would need a larger z-buffer. This is not necessarily the case, particularly if everything in the model is on a larger scale. The difficulties arise when you need to deal with models that have both small and large variations in their depth values.

Consider a model that consists of two small objects connected by a 50-meter cylinder. Assuming that you need at least ½ mm of depth resolution to accurately portray the small objects, you must now divide a distance of at least 50 meters into such increments. This means over 100,000 different *z*-values, or at least a 17-bit z-buffer. When you consider some of today's larger models (e.g., a space station that has components ranging from small bolts to huge solar collectors), deep z-buffers become increasingly important. Fortunately, you don't need to have twice as much z-buffering when you wish to double-buffer an image. Once an image is drawn in one of the buffers, the z-buffer memory can immediately be cleared and used by the secondary buffer.

## Alpha Buffering

Just as a z-buffer provides a way to keep track of pixel depth values, alpha buffering is a method used to assign a transparency value to a pixel. This is also known as *blending*. The 256 transparency options from 8 bits of alpha buffering is generally more than sufficient. An alpha value of 255 would indicate that the object is nontransparent, or opaque. It is assumed that a pixel that is closer to the viewer will completely wipe out any pixels behind it.

However, consider an alpha value of 200. The pixel is now about 22 percent transparent, meaning the new pixel to be drawn obtains 78 percent of its color from the nearer (smaller *z*-value) pixel and 22 percent from the existing pixel. Obviously, an object that is 100 percent transparent need not be drawn.

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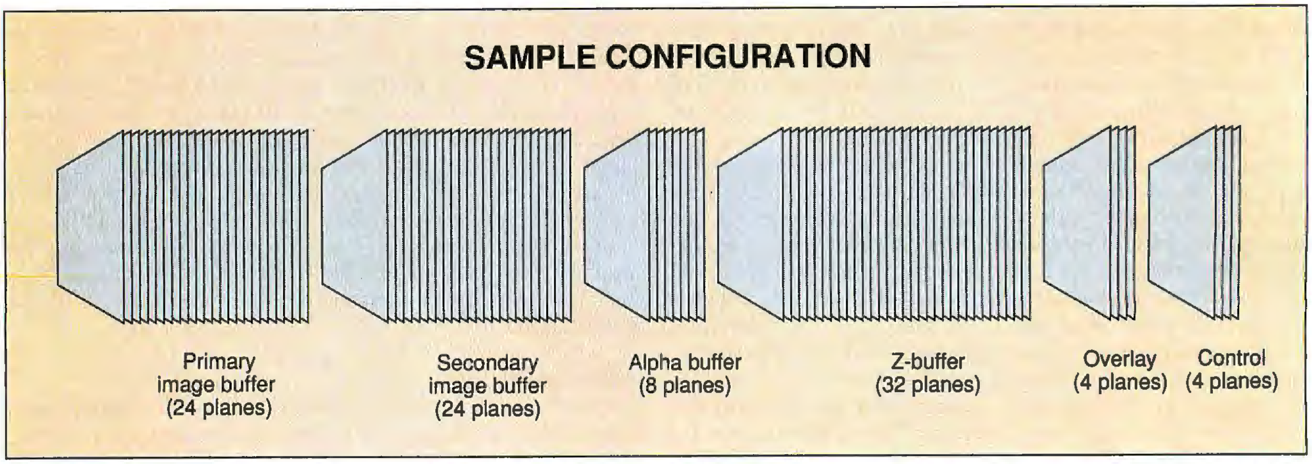


**Figure 3:** *A frame buffer can have many bit planes and require a vast amount of memory. This configuration has a total of 96 bit planes. Assuming a screen resolution of 1280 by 1024 pixels, this represents 125,829,120 bits, or nearly 16 million bytes.*

Alpha buffering is not really an accurate method of modeling translucent substances. No attempt is made to deal with reflection or refraction. A lens-shaped object with a high transparency value will exhibit no magnifying-glass properties; for that you need optical ray tracing. The alpha buffer technique's usefulness lies in its ability to show the interior of a solid object without losing much information about the exterior.

Alternatively, the graphics system can use the alpha buffer to keep lines or polygon edges from looking jagged by simulating the display of partially filled pixels. The technique is called *antialiasing*. With it, a pixel that is slightly obscured is assigned a color value that is based on both the new polygon and the original background. In effect, antialiasing retains the subpixel information and uses it to give an alpha value to the edge pixel. The result is a more gradual transition from the foreground to the background object, eliminating the jagged and rough appearance of lines and edges. (See "Smooth Views," May BYTE.)

## Overlay Planes

Every time the graphics system scans the video memory to produce the current image, it finishes with the overlay plane's information. Consequently, the overlay plane takes precedence over whatever is in the rest of the screen memory. Overlay planes are really nothing more than additional planes of screen memory, except that pixels with a color value of 0 are not drawn. Overlay planes are typically used to keep track of either cursor position or text. This is important, because overlay planes can be modified without destroying the information about the primary image on the screen.

Consider the case of a cursor. Without an overlay plane, every time you move the cursor over an existing screen image the system would have to modify the bits that the cursor crosses over and then restore them to their original state. This can prove expensive in terms of system performance. Instead, the system uses an overlay plane to keep track of the cursor's position. In many ways, the overlay plane can be thought of as a transparent layer that contains only the cursor's image. The same rules apply for overlay planes in terms of color palette. If you wish to have cursors or text with more than two colors, additional bits are needed. Four overlay planes allow for 16 different text colors, which is usually sufficient. While not nearly as common, some systems might also feature underlay planes, which are primarily useful for background images.

## Control Planes

The graphics system can also have bit planes to keep track of things like window relationships. (A workstation without windowing is considered unusable by today's standards.) Often, screen memory needs to be configured differently for the variety of uses of the different windows. One window may need only line-drawing functions, another the full gambit of 3-D controls, a third only monochrome text. A system with only 30 planes or so should be able to display a true-color image in one window while animating a 12-bit pseudocolor image using double buffering in another window; both combinations use the same number of bit planes.

The system may need to use additional bit planes to flag the pixels of certain window types so it can properly deal with them. Memory bit planes for these bookkeeping functions are known as *control planes*.

## Growth Trend

As you can see in figure 3, you may need a system with an extremely large frame buffer. The example, assuming a resolution of 1280 by 1024 pixels, has nearly 16 million bytes of screen memory.

Some of the techniques discussed, particularly z-buffering and alpha buffering, are specifically used for 3-D rendering. Others are applied to nearly all applications. Keep in mind that bandwidth is critical throughout the graphics pipeline. Each piece of the pipelined drawing process is of little or no value unless the other pieces can keep pace.

As new techniques develop, and with the continuing drop in memory prices, all computers capable of graphics will likely be built with increasingly larger frame buffers.

Without a doubt, you will see the resolution of PCs continue to grow. Very few applications would not benefit from a denser, clearer display, and there are really only two things slowing market acceptance: the cost and the lack of a well-defined standard. The cost of memory (video and otherwise) continues to drop, as does (although a bit more slowly) the cost of high-resolution monitors. The migration of resolution-independent display protocols to the PC platform will take care of the other problem. ■

*Ron M. Brinkmann is a technical consultant with Hewlett-Packard's Apollo Systems Division in Rolling Meadows, Illinois. He can be reached on BIX c/o "editors."*


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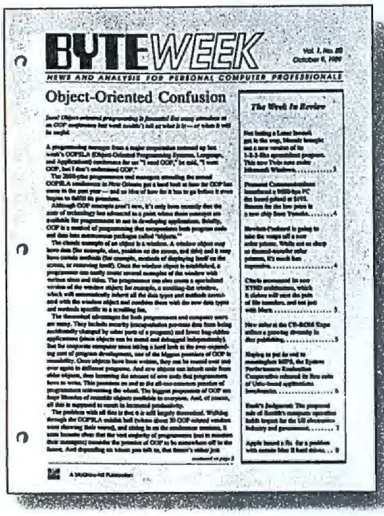



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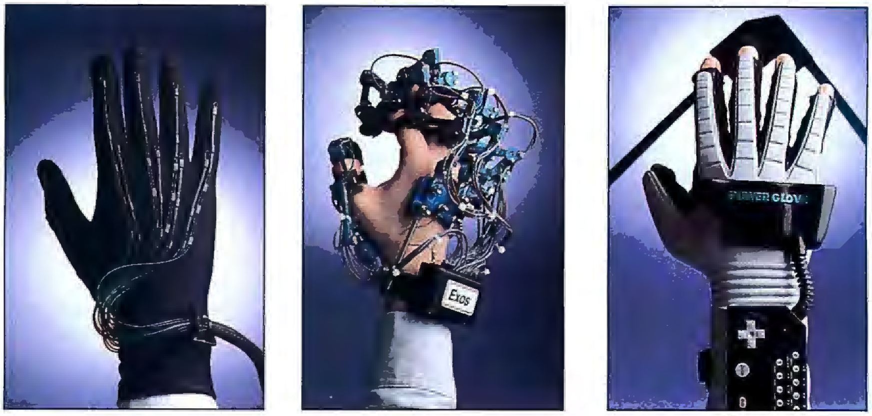
# REACH OUT AND TOUCH YOUR DATA

## Three commercial hand trackers sense your every move




*Left: Perhaps the best-known hand-tracking device, the VPL DataGlove relies on fiber optics to track finger motions. Center: The Dexterous Hand Master from Exos uses an intricate exoskeleton, made of lightweight aluminum, that fits over the back of the hand. Right: Mattel's Power Glove shares a common heritage with VPL's DataGlove, but it was designed for the home video market. As such, it's a lot less expensive and a lot more rugged. Nevertheless, you can easily adapt it to work with a PC-compatible computer.*

Make a fist and shake it at your computer screen. Nothing happens? That's because you're not wearing a hand-tracking device. Although keyboards and mice convert hand movements into data, they can't capture the sweeping gestures and subtle articulation of a hand moving in space.

Three commercial products purport to do just that: VPL Research's DataGlove, Exos's Dexterous Hand Master, and Mattel's Power Glove. When you wear one of these devices, it measures how much your fingers are flexed. A controlling computer, sampling the instrument's sensors at a rapid clip, can figure out the shape of your hand. Add a way to locate the hand in space, and you've got hand tracking. Imagine literally grabbing a dBASE record or rotating an AutoCAD model with a twist of your wrist. There is a world of possibilities; see "Telltale Gestures" on page 237 for more applications now in development.

### It's Not Polite to Point

Each product discussed here uses its own method to track the fingers. Two of them use magnetic field interference to track hand motion, and one uses ultrasound triangulation.

VPL's DataGlove, perhaps the best-known hand-tracking device, relies on fiber optics. When you bend a fiber-optic cable, the light dims in proportion to the amount of flex. The DataGlove uses loops of fiber-optic strands that run up the back of your hand. A part of each loop, which is fixed over the knuckle and first joint of each finger, forms a sensor (see figure 1).

One end of the fiber loop connects to a constant light source, the other to a sensitive photo detector. A microprocessor scans through each of the 10 detectors in turn and takes a light reading. As the light intensity diminishes, the processor records more bend.

After the whole hand has been read, the real fun begins. Calculating the angle of each joint requires knowing a lot about the physical nature of the hand and the makeup of the optical sensors. The microprocessor in the DataGlove controller takes care of managing that model and performing the needed computations.

Precise measurements require that the fibers line up properly over the joint. The DataGlove relies on a snug-fitting Lycra glove that fits, well, like a glove. The fibers, sewn onto the back of each finger, collect at the base of the glove on the back of the hand, as shown in photo 1. A separate unit, the size of a pocket calculator, houses the light source and sensors. A computer interface manages the scanning of the sensors and the communications with the host computer. The DataGlove uses a standard RS-232C serial port, which makes it compatible with most computers.

### Somewhere, My Glove

Now the computer can tell what the fingers are doing. The next thing it needs to know is the position of the hand relative to a fixed point. VPL has incorporated the Polhemus Navigation Sciences' 3Space Tracker into the DataGlove. The Tracker measures magnetic interference in three dimensions. Users of Exos's Dexterous Hand Master typically employ the Tracker, too.

Any coil charged with an electrical current generates an electromagnetic field. The field is strong in the direction of the coil's radius, and it is relatively weak in the perpendicular direction. Similarly, a magnetic field passing through a coil of wire generates an electric current proportional to the field's strength.

*continued*

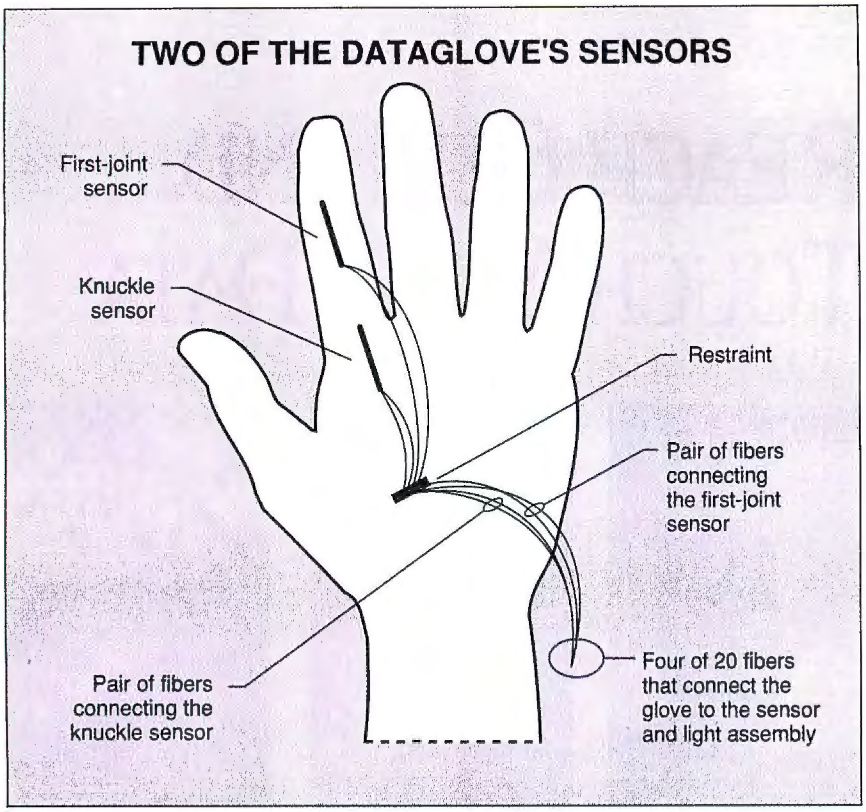



**Figure 1:** *The DataGlove's sensors are glued to the glove, arranged directly over each joint. Loose fibers connect each sensor to a light source/receiver pair for measurement.*

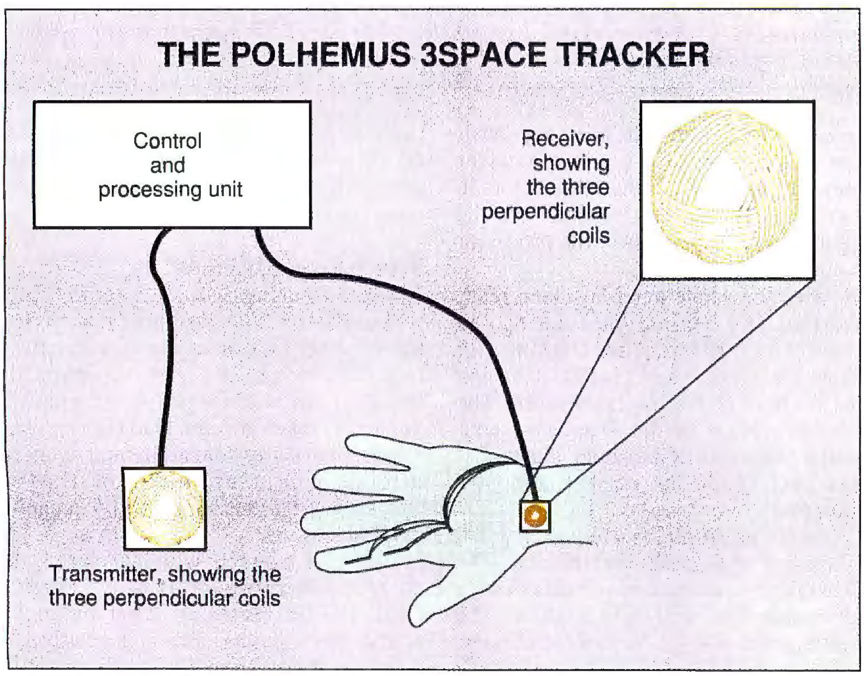



**Figure 2:** *Designed to report the relative location of the user's hand in space, the Polhemus 3Space Tracker consists of a small cube mounted on the hand, and a slightly larger transmitter that rests on a stationary stand nearby. The cutaway views show the three perpendicular coils in both the transmitter and the receiver.*

The Tracker uses a transmitter with three coils of wire, each perpendicular to the other two. A similar receiver has the same arrangement (see figure 2). The Tracker's controller pulses each of the transmitter's coils in turn and reads the current generated in each of the three receiving coils, for a total of nine readings. Determining the receiver's orientation and distance from the transmitter requires plenty of math—more than you'll need to do your taxes.

Knowing that the strongest readings come from coils that lie on the same plane as the transmitter, the microprocessor can determine the orientation of the receiver in space (relative to the transmitter), as well as the distance in $x$, $y$, and $z$ directions. The system works amazingly well. It can determine the relative positioning to the nearest tenth of an inch and to within half a degree, anywhere within a 3-foot radius.

The receiver is a small, lightweight plastic cube, about the size of a sugar cube, that mounts on the back of your wrist. The transmitter, a slightly larger cube, rests near the DataGlove wearer on a stationary stand. Both the receiver and the transmitter connect to a control unit that handles the pulsing and sensing; the control unit connects to the host computer by way of a standard serial or parallel interface.

## Double-Jointed

The DataGlove emphasizes comfort with a good degree of precision. However, unless you are an alien from the planet Zambodia, your fingers have three joints, not two. Exos's Dexterous Hand Master (see photo 2) delivers precise measurements at the expense of form.

The Hand Master uses an intricate exoskeleton that fits over the back of your hand. Velcro bands and finger pads attach this framework to the midpoint of each finger segment, and a hinged joint connects each of the finger pads. Figure 3 shows the arrangement of the joints. Make no mistake—this thing looks bizarre; it's not really a glove at all. But it's considerably more comfortable than it looks.

The skeleton is made of lightweight aluminum. Each of the joints contains a small magnet and a Hall-effect sensor to measure the bending angle. The sensor, built into the hinge assembly, responds with a voltage that is proportional to the strength of a nearby magnetic field. A small magnet bound to the sensor moves closer to or farther from it as the joint bends. The Hand Master connects to any standard AT-bus (Industry Standard Architecture) PC compatible through a custom data-acquisition board. The PC software reads the voltage from each of the sensors in turn to measure the position of the fingers.

### Thumb Fun

Oops—I almost forgot about the side-to-side motion. Happily, Exos didn't. Fingers can do more than go up and down; they go left and right, too, especially the thumb. Extra sensors on the Hand Master take care of the left and right motions, while allowing for measuring the full range of thumb motion.

Like the DataGlove, the Hand Master can't detect the position of the entire hand. Hand Master applications typically use the same Polhemus Tracker that DataGlove applications use.

*Mattel's Power Glove is a completely different animal than the DataGlove, yet the two share a common heritage.*

Clearly, the Hand Master uses a different approach to hand sensing than the DataGlove does. However, both cost as much as a new car. The DataGlove in its standard configuration will set you back about $8800. If you prefer the added precision of the Hand Master, plan on handing over $15,000. But if you need that level of precision and reliability, both are cheap at the price.

The same can be said of computers. Not everyone needs megabytes of memory and a hard disk drive, as the home video game manufacturers have known for years. Case in point: that Nintendo Entertainment System you bought for your kids. Did you know it has the same processor that the Apple II uses? Did you know that Mattel makes a hand-sensing glove for the Nintendo? One that you can buy for about $100?

Mattel's Power Glove is a completely different animal than the DataGlove, yet the two share a common heritage. The Power Glove's basic design derives from the DataGlove's, with a few obvious modifications for the home video market. Most notably, it's a lot more rugged (see photo 3).

**THE EXOS DEXTEROUS HAND MASTER**

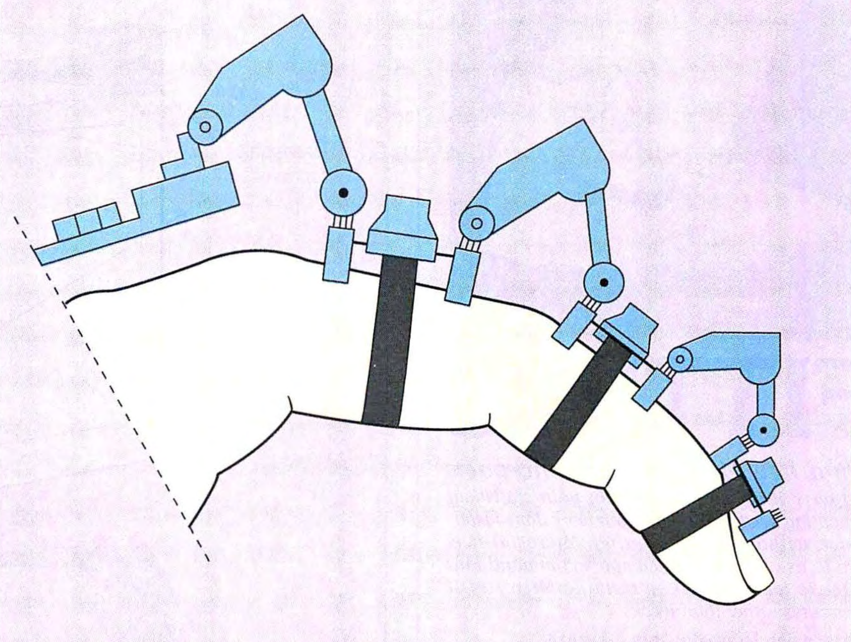


**Figure 3:** *The Hand Master consists of an exoskeletal arrangement of sensors. The sensors are held over each finger joint by lightweight pads and Velcro straps. Each sensor houses both a Hall-effect magnetic pickup and a magnet.*

### Glove at First Sight

The optical fibers on the DataGlove are fully exposed, glued to a lightweight Lycra glove. Not only is that construction expensive, but video-gaming kids would destroy the thing in 10 seconds flat. Mattel replaced the delicate fibers with a flat plastic strain gauge.

The strain gauge has a convoluted history. In the early 1980s, engineers developing the Koala touchpad needed a tough, flexible plastic with a constant resistive surface. During development, there were a number of rejects—one of which changed resistance as it was bent. That material, which is now manufactured by Amtec, forms the basis of the sensor technology that the Power Glove uses in its fingers.

The sensors are 3½-inch strips of polyester, coated with 0.6 mils of a specially formulated ink. As the sensor bends over the normal range of finger movement, the resistance changes. One sensor in each finger measures all the joints at once. This precludes measuring the individual joints, but does Mario really care if you bent your first or second joint? For Nintendo games and many PC applications, it's reasonable to measure the whole finger with some degree of precision and make assumptions about the individual joints.

So, you've got five sensors, one for each finger. That means you also need an A/D converter to read the sensors, and some kind of processing power. The Power Glove uses an 8-bit processor to watch the fingers, communicate with the host computer, and handle the ultrasonics. Ultrasonics? What for?

### You Don't Know Where That Hand Has Been

Polhemus's Tracker technology would be far too expensive to include in a $100 retail product, so Mattel had to come up with something else.

The solution that Mattel chose was an ultrasonic ranging system similar to that on modern Polaroid cameras. A small transducer located on the back of the Power Glove sends out a short click. Three receivers, one each to the left top, right top, and right bottom of your monitor, receive the click. They all hear the same sound, so the time it takes them to

*continued*

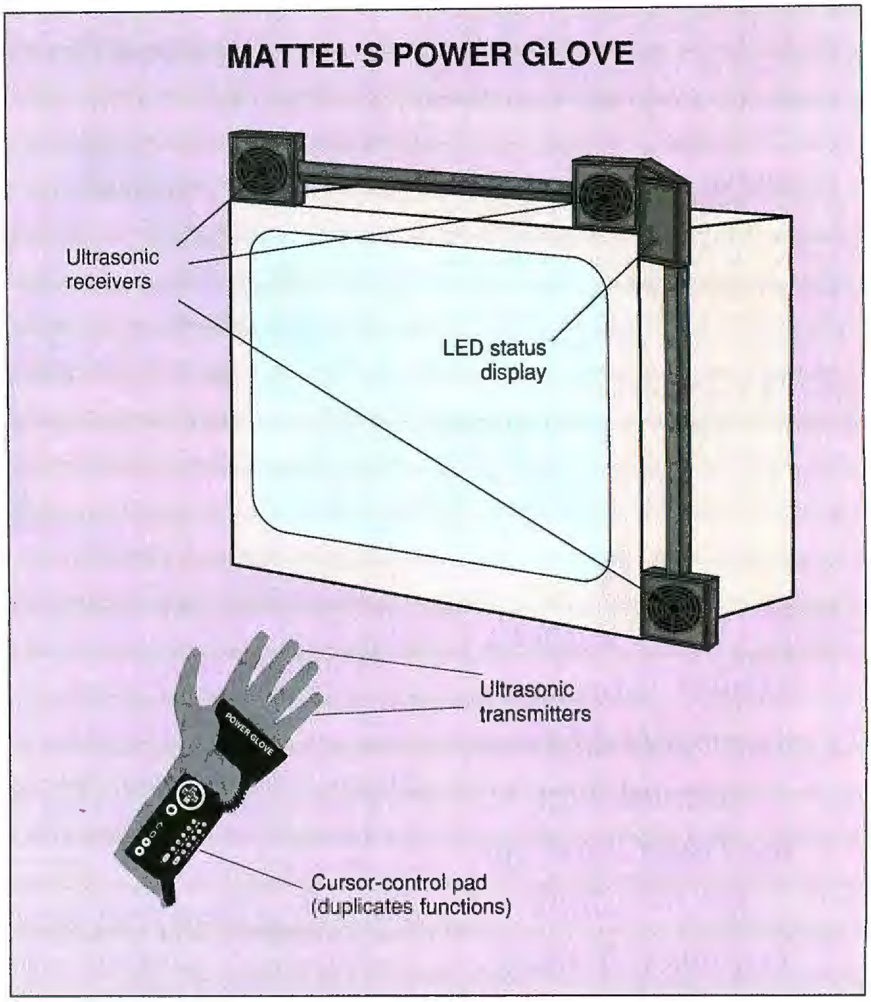



**Figure 4:** *The Power Glove uses two ultrasonic transmitters and three receivers to triangulate the position and orientation of the hand. The cursor keypad duplicates the sensory functions and allows for somewhat more precise input.*

register the click will determine the absolute distance to the glove as well as the relative distance.

A second transducer, which is located a few inches from the first, does the same. From there, the processor, which knows the speed of sound and the spacing between the transmitters and receivers, can use triangulation to compute the distance of the glove from the sensor array as well as the glove's roll and pitch (see figure 4).

Ultrasonics, however, suffer from one inherent disadvantage: They require an unobstructed line of sight. If the transmitters don't point directly at the receivers, the Power Glove simply can't track. Other than that, though, it's a very sound design.

## OK, I'm Game

As long is you're facing the receiver array, and you are within the normal range of the ultrasonics (about 5 feet), the Power Glove can track your hand motion to within a quarter of an inch and measure the flex of your fingers to some fair degree of accuracy.

For the personal computer user, the most significant drawback of the Power Glove is that it will work only with the Nintendo system. To that end, the unit comes with a proprietary Nintendo connector that plugs directly into the game unit.

Even worse, the Power Glove takes all its detailed information and converts it into an emulation of the standard game controller pads. Although there is a special high-resolution mode, the standard mode will give you the A fire button (flexing the thumb), the B fire button (flexing the index finger), Start, Select, and the up/down/left/right motion from center. Notice that it can't tell you how

*continued*

# Can We Talk?

Because the Power Glove is designed for the Nintendo Entertainment System, attaching it to your computer may take some doing. I'll describe how to connect it to a PC compatible, although the same method should work for almost any computer.

The good news is that the Power Glove runs off 5 volts and is therefore electrically compatible with the printer port of a PC compatible. The bad news is that you'll have to find a way to supply the 5 V; that's something a printer port normally doesn't do.

Connecting the Power Glove requires three data lines, a ground, and 5 V. It's probably best to connect the glove to an unused printer port; you can get 5 V from any of a number of sources.

For my prototype, I used an external regulated power supply. No external supply? The red and black wires on a spare disk drive power connector will give you 5 V, or you might tap 5 V from the keyboard connector using an extension with a tap on the keyboard's 5-V supply. Pin 5 of the five-pin DIN plug is the keyboard power, and pin 4 is ground (see figure A). With a pair of male and female five-pin DIN connectors, make a short keyboard extension cable, with all five lines. However you get power, check that the voltage is correct and fairly spike-free before you go any further.

Now for the tricky part. The glove connects to a small box that controls the ultrasonics. It's that short cable with the goofy seven-pin connector that you have to modify. Make sure you don't cut off the nine-pin connector from the glove itself!

You'll be removing the game unit connector, so you might want to find a Nintendo controller extension cable and make the modifications to that. Curtis

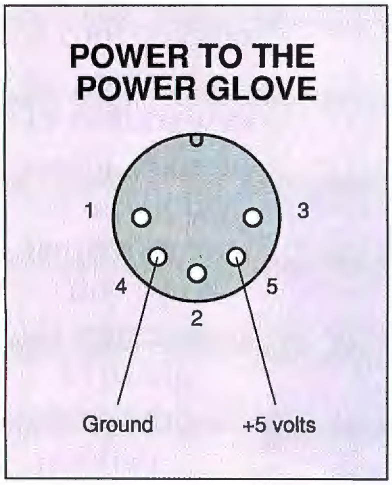



**Figure A:** *To connect a Power Glove to your PC compatible, you need a 5-V power source. Pins 4 and 5 of a standard five-pin keyboard connector provide 5 V to the keyboard and can also be used to power the Power Glove.*

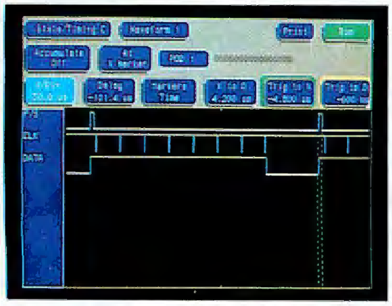
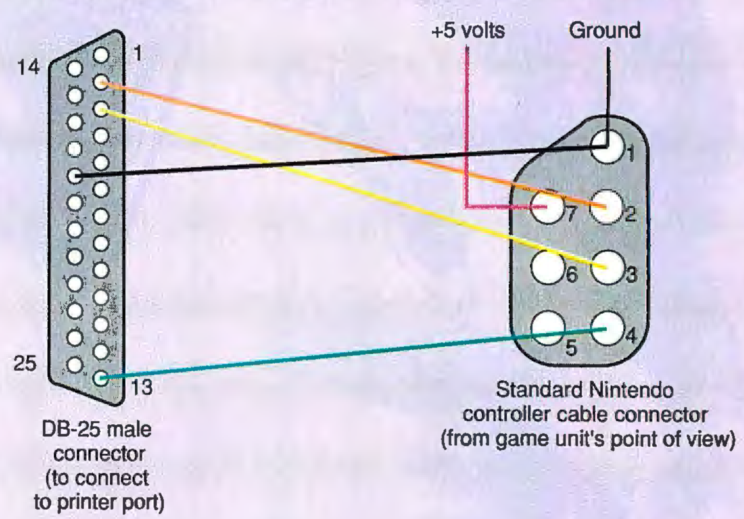


**Figure C:** *Shown here are the timing pulses required to retrieve data from the Power Glove. P/S is the reset pulse to set the glove's shift register back to bit 0. CLK moves the register from bit to bit. After pulsing the P/S line, you sample bit 0, pulse CLK, and then sample and pulse seven more times for bits 1–7.*

## FROM POWER GLOVE TO PRINTER PORT




| Pin | Function | Pin | Function | Color | Curtis NC-1 |
|---|---|---|---|---|---|
| 2 | Data clock | 1 | Ground | Black | Orange |
| 3 | Latch | 2 | Data clock (to controller) | Orange | Red |
| 13 | Data in | 3 | Latch (to controller) | Yellow | Brown |
| 18 | Ground | 4 | Data out (from controller) | Green | Black |
| | | 5 | (No connection) | | |
| | | 6 | (No connection) | | |
| | | 7 | +5 volts (to controller) | Red | White |

**Figure B:** *This diagram details the wiring necessary to connect the Power Glove to a standard PC-compatible printer port. The colors shown are for the Mattel unit. They may vary from unit to unit, so be sure to verify them. If you choose to use the Curtis NC-1 Super Extendo cable, go by the colors listed for it.*

**Listing A:** *A portion of the source for PG.COM, showing the 8088 implementation of the timing in figure C. The bit assignments on the printer port assume that the printer port is wired as shown in figure B.*

```
LPT1_addr      equ     0378h      ; LPT1
LPT2_addr      equ     0278h      ; LPT2
Mono_addr      equ     03BCh      ; LPT1 on mono cards
Clock_HI       equ     01h        ; data clock is low bit
Latch_HI       equ     02h        ; data latch is bit #1
Clock_LO       equ     0
Latch_LO       equ     0
Data_in        equ     10h        ; from port (Printer_addr+1), mask with this
                                  ; for current data bit
Printer_addr   dw      LPT1_addr
Glove_byte     db      0
delay_val      dw      1          ; empty loops to delay after an OUT
speed_constant equ     800h       ; delay=loops/speed_constant
; Power Glove cursor emulations (bit assignments in "Glove_byte")
PG_rt          equ     01h
PG_left        equ     02h
PG_dn          equ     04h
PG_up          equ     08h
PG_start       equ     10h
PG_select      equ     20h
PG_B           equ     40h
PG_A           equ     80h
PG_fist        equ     PG_A+PG_B
;
outdx  macro
       local   delayloop
;
       out     dx,al
       push    cx
       mov     cx,delay_val
delayloop:
       loop    delayloop
       pop     cx
       endm

; This is the only Power Glove-specific part of the code, from here to HANDLE_TSR
; talks to the glove. From that point on, the code merely does the keyboard buffer
; management and any mapping of glove functions -> keyboard functions.
;
; The RESET pulse.  An L-H-L pulse, a minimum of 4 µs long.
       mov     dx,Printer_addr
       mov     al,Latch_LO+Clock_HI
       outdx
       mov     al,Latch_HI+Clock_HI
       outdx
       mov     al,Latch_LO+Clock_HI
       outdx
       mov     cx,8               ; # of bits
       mov     bl,0               ; BL will collect the data bits
bit_loop:
       shl     bl,1               ; make a place for the new bit
       mov     dx,Printer_addr
       inc     dx
       in      al,dx              ; read the LPT status
; The bit is now in bit 5 (on the select line)
       and     al,Data_in         ; isolate it
       shr     al,1               ; move it to bit 0 (low)
       shr     al,1
       shr     al,1
       shr     al,1
       add     bl,al              ; and store
; strobe in next bit - pulse the clock line from H-L-H
       mov     dx,Printer_addr
       mov     al,Latch_LO+Clock_LO
       outdx
       mov     al,Latch_LO+Clock_HI
       outdx
       loop    bit_loop           ; back, a total of 8 times
; We've got all 8 bits. Invert them.
       mov     al,bl
       xor     al,0ffh
       mov     Glove_byte,al      ; Now, 1='pressed'
```

sells the NC-1 Super Extendo set (a pair of game controller extension cords) for around $10. One end will mate perfectly with the Power Glove's connector. On the glove or extension cable, remove the end that normally plugs into the Nintendo unit, leaving a couple of inches of wire. Now, strip off some insulation from each strand and confirm the color coding. The Mattel wiring on the glove I worked with used the color scheme shown in figure B. If you use a Super Extendo cable, you may find the colors shown in the second color chart.

Connect the glove end of the wire to the 25-pin connector, as shown in figure B. The +5-V wire (formerly from pin 7) and ground (pin 1) should be connected to the 5-V supply that you chose earlier.

## Serial for Breakfast

The Power Glove speaks a form of serial communications that is more like the PC keyboard than the RS-232C port. The 8 bits of data are presented one at a time on a TTL-level data line. Since there's no built-in clock rate, the computer has to provide the clock, so a second TTL line serves as the clock to advance from one bit to the next.

To keep everything synchronized, a third line serves as a master reset, to clear the glove's interface and reset it back to the first bit. Figure C shows the relative timing of the reset line, the data line, and the clock line. In the figure, the glove is completely at rest: No directions or "fire" buttons are in effect.

Pulses should be kept between 3 and 8 microseconds, and the bit sampling should be packed as tightly as possible. In figure C, the reset pulse is about 4 µs, and the clock pulses are about 3 µs. Unfortunately, the printer port on the PC has a finite response time somewhat longer than that, so you need to add some delay. The exact amount depends on the speed of your machine and the makeup of your particular printer port.

Listing A is a code snippet from the source for PG.COM, a sample TSR cursor-key driver that uses the glove output to drive the cursor keypad. If you're not working with a PC compatible, you'll need to write a piece of code that does something similar. [Editor's note: *The source code for PG.COM is available on disk and on BIX. See page 5 for details.*]

## COMPANY INFORMATION

**Amtec International**
(Strain gauges inside the Power Glove)
3653 West 1987 South
Salt Lake City, UT 84104
(801) 977-0359
**Inquiry 988.**

**Curtis Manufacturing, Inc.**
(NC-1 Super Extendo)
30 Fitzgerald Dr.
Jaffrey, NH 03452
(603) 532-4123
**Inquiry 989.**

**Exos, Inc.**
(Dexterous Hand Master)
8 Blanchard Rd.
Burlington, MA 01803
(617) 229-2075
**Inquiry 1185.**

**Mattel, Inc.**
(Power Glove)
Consumer Affairs
5150 Rosecrans Ave.
Hawthorne, CA 90250
(213) 978-5150
**Inquiry 1186.**

**Polhemus Navigation Sciences**
(3Space Tracker)
P.O. Box 560
Colchester, VT 05446
(802) 655-3159
**Inquiry 1187.**

**VPL Research, Inc.**
(DataGlove)
656 Bair Island Rd., Suite 304
Redwood City, CA 94063
(415) 361-1710
**Inquiry 1188.**

far from the center you are, just that you're off-center.

The Power Glove's low price makes it a fascinating device for folks who are interested in experimenting with hand trackers. I created crude but usable gesture-recognition software using only the cursor pad emulation. The text box "Can We Talk?" on page 288 describes the communications protocol and the cabling that are required to connect the glove to an unused printer port on your PC compatible.

### Give Your Computer a Hand?

After getting my hands on these three products, it's evident that none in its present form could ever replace the mouse. The Dexterous Hand Master measures the anatomical motions of the hand with more precision than today's applications could exploit. The DataGlove would be more practical for mainstream applications, but the fibers mounted on it seem too delicate to withstand the rigors of everyday use. And the price tags of these two products clearly put them out of reach as a replacement for your computer's mouse.

What about the Power Glove? Maybe. Mattel implemented it beautifully for the home video market. It's priced right and has more-than-adequate resolution for its intended purpose. The appearance is less than professional, but then, it wasn't designed to be used in the boardroom. The Power Glove is one rugged puppy, built for hard use by kids playing Nintendo games.

Being so new, no one really knows how long the Power Glove will hold up under actual use. The unit I worked with was connected to a PC compatible for several weeks. It looked haggard after being crunched under piles of books and papers, but it never failed to work. Still, the Power Glove will probably never become a popular accessory for Macs or PCs. We need something else.

All three vendors agree that some yet-undeveloped product would fill that need nicely. A product with the Hand Master's precision, the DataGlove's ease of use, and the Power Glove's affordability and rugged construction would be just the ticket. In the meantime, don't sell these products short. Many applications—most obviously, CAD—are just crying out for a good three-dimensional input device.

The Dexterous Hand Master and the DataGlove are here today, and they are priced within the budgets of those who really need them. If you're just curious, you might want to try experimenting with a Power Glove. I've navigated Lotus 1-2-3 spreadsheets, logged onto BIX, and scrolled through hours of Prodigy screens without ever touching my keyboard. The Power Glove is just downright fun, and it's a good way to get your hand on (or in) a piece of the future. ■

*Howard Eglowstein is a BYTE Lab testing editor. He can be reached on BIX as "heglowstein."*

*Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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>
> —ROBERT KENDALL
> PC MAGAZINE 12-26-89

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|---|---|---|---|---|---|
| Interface | **QIC-80** | QIC-40 | QIC-80 | IRWIN | QIC-02 |
| Capacity w/ Standard Long Length Tape | **120 MB** | 60 MB | 120 MB | 120 MB | 250 MB |
| Typical Capacity w/ Data Compression | **300 MB** | 120 MB | 150 MB+ | not available | not available |
| List Price | **$545** | $399 | $795 | $849 | $1,895 |
| Price per Megabyte: Normal | **$4.54** | $6.55 | $6.62 | $7.07 | $7.58 |
| Price per Megabyte: Compressed | **$1.82** | $3.33 | $6.62 | N/A | N/A |
| Random Access Restore | **YES** | YES | NO | YES | NO |
| Ferrite Head | **YES** | NO | NO | NO | NO |
| Metal Frame | **YES** | NO | YES | NO | YES |
| Warranty | **18 mos.** | 12 mos. | 12 mos. | 12 mos. | 12 mos. |

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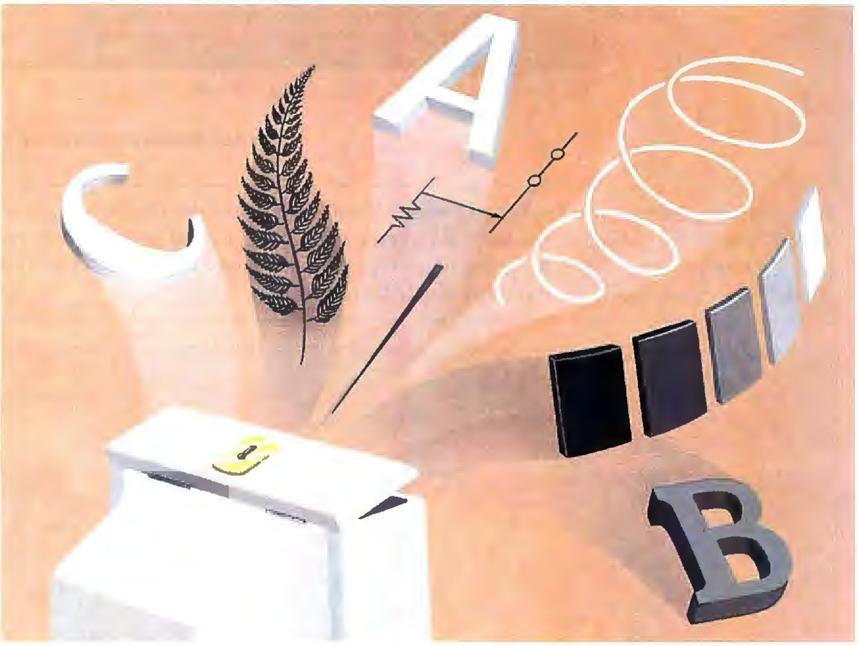
# POSTSCRIPT INSIDER SECRETS

## You can vastly improve your PostScript output with a few tricks



Put aside those PostScript graphics-generating and page-layout programs and do the work yourself for a change. Some good sense and a few secrets are all that you need to get your PostScript device to perform like you have never realized was possible. The only tool you need for good PostScript output is a text editor.

**PostScript by Adobe Systems**

PostScript is more than a page-description language. It is actually an incredibly powerful general-purpose computer language that can easily hold its own against any other modern contender.

Yes, PostScript does excel at putting marks on pages. The feature that makes it quite good at this is its *device independence*. You can use any editor or almost any word processor on any host computer to generate PostScript source code.

The device independence lets you use laser printers, phototypesetters, display screens, high-resolution fax substitutes, sign makers, printed circuit prototypers, plotters, CAD/CAM production systems, slide imagers, and even the three-dimensional photolithography "Santa Claus" machines, all interchangeably from the same PostScript source files.

Another big plus of PostScript lies in its ultrastrong graphical transformation capabilities. Fonts and graphics can be freely intermixed in *any* combination in *any* scale along *any* path.

The font machinery in PostScript is especially impressive; it uses single outline descriptions to create any font size or shape from a single master font dictionary. The font descriptions often include *hints* (i.e., special attributes of character shapes) and weight-versus-size adjustments. Hints can optimize your results on low-resolution output devices, as well as preserve balance in larger headline typography.

Since the font descriptions are really procedures, you can easily "postprocess" your final characters for outline, shading, three dimensions, pattern, distortion, and many other special effects.

A nearly infinite variety of PostScript fonts are available. These range from several dozen standard ones built into PostScript printers to thousands of fully professional downloadable fonts, on down through countless shareware and freeware products of lower cost and quality. You can easily create your own PostScript fonts or customize existing ones.

Another powerful PostScript feature involves its extensive use of Bézier cubic spline curve descriptions to create smooth and graceful shapes, the resolution of which improves (rather than degrades) when you increase size.

PostScript is somewhat related to Forth. It is an interpreted, stack-oriented, postfix (Reverse Polish notation) language. It makes heavy use of multiple dictionaries (i.e., collections of variables and definitions). PostScript is both reentrant and extensible, meaning that you can add or redefine any portion of the language in any manner.

PostScript is also a fun language to use, and it can become downright addictive. You can create useful output while understanding only a very few PostScript commands, but you can learn a little bit at a time and still be productive. I have seen beginning students create award-winning graphics after one class.

Usually, you do not run out and buy a copy of PostScript. Instead, the language is built into your PostScript-speaking output device, a laser printer or phototypesetter. Some laser printers that use PostScript are the NEC Silentwriter LC-890 and the Apple LaserWriter IINT and

*continued*

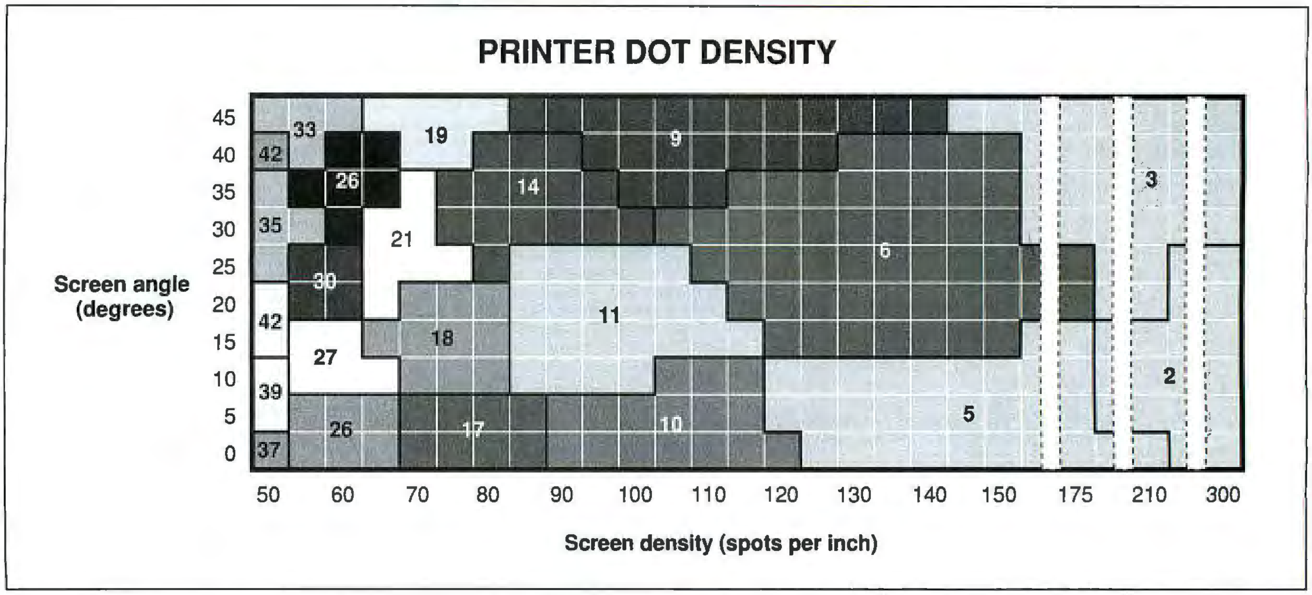



**Figure 1:** *This secret gray map shows many of the hidden 300-dpi PostScript grays found on the LaserWriter. The best all-around gray is the 106-spot-per-inch, 45-degree one, while a good reprogray for reduction is 85 spots and 35 degrees. The 135-spot, 25-degree screen gives india ink wash effects. The printer default is 53 spots and 45 degrees. The values on the map indicate the number of available gray levels for the region.*

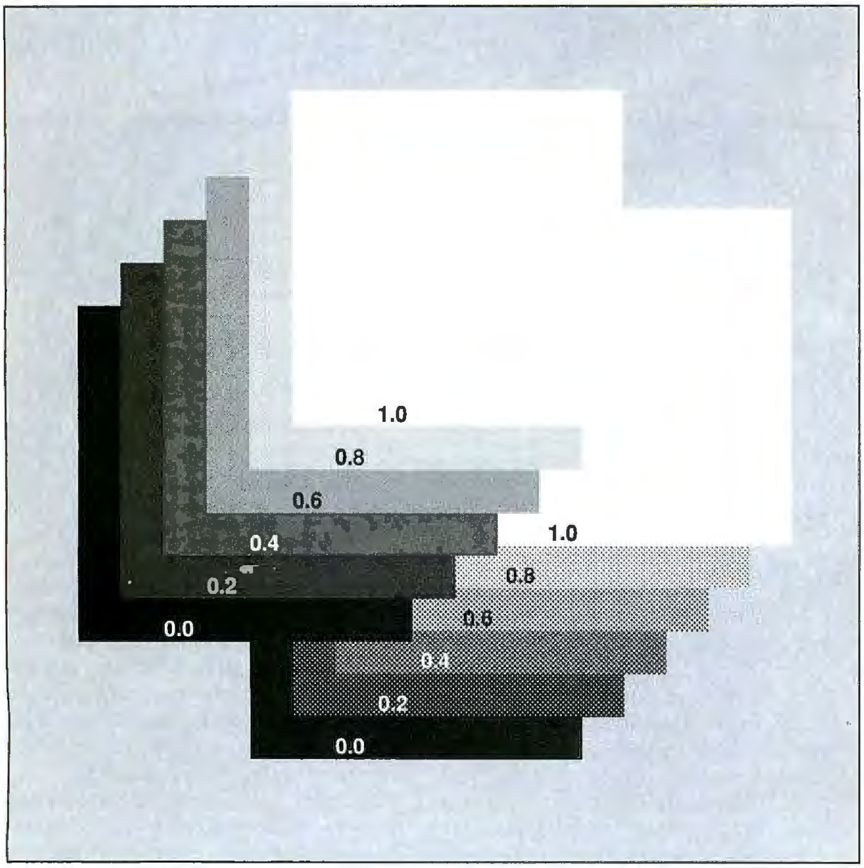



**Figure 2:** *PostScript lets you vary grays by specifying the spot density and the angle of spot placement. Here, the lower set of grays is the printer default of 53 spots per inch and 45 degrees. The upper set is the optimum 106 spots and 45 degrees. The numbers in the squares represent the* `grayvalue`.

IINTX. The Linotron 200-P is an example of a PostScript phototypesetter.

PostScript can be run on older dot-matrix and ink-jet printers by using inexpensive PostScript clone software emulators such as GoScript, Freedom of Press, and UltraScript.

PostScript is a loosely typed language that also gives you many data structures that you can redefine at will. PostScript is polymorphic; in other words, its wide range of operators accepts different data types as inputs. Most important, PostScript permits redefinable primitives. This lets you rearrange the scenery to suit yourself.

PostScript automatically does matrix transformations on the fly, maintaining both a user space and a device space. Its key-value dictionary structures are extremely powerful. One little-known advanced feature of these dictionaries is that you can link any two data types as a key-value pair.

What I'd like to do is introduce you to some sneaky and little-known PostScript insider secrets that will turn your PostScript machine into a super device that can leap tall buildings in a single bound. I have this column for two months, so I will be giving you two healthy portions of my brew.

Should you want more on PostScript fundamentals, check into Adobe's blue book, otherwise known as the *PostScript Language Tutorial and Cookbook*, and

*continued*

the red book, also titled the *PostScript Reference Manual*. Or you might call me for more information. On to the sneaky stuff....

### Those Secret Grays

For some unfathomable reason, most PostScript application packages and most users frequently end up using the seventeenth most gruesome group of grays available on their 300-dot-per-inch PostScript printers. Yet with just a few keystrokes, you can substitute absolutely outstanding grays, some of which even simulate an india ink wash.

Most 300-dpi PostScript printers are capable of putting dots only in specific locations on the page. To create a gray, the printer uses patterns of dots, which are called *spots*. For instance, a 3- by 3-dot spot could give you 10 gray levels (including black and white) with a resolution of 100 spots per inch.

Because the spots have to perfectly replicate themselves over the entire page, complex integer math is involved that decides which spot combinations are allowed. A parameter called the *screen angle* decides how the spots will orient on your page. Typically, screen angles near 45 degrees are preferred, since they will introduce fewer visual artifacts or aberrations.

Figure 1 shows the secret gray map of all the available denser grays. Because of the integer tiling, a request for a screen angle and density will automatically be converted into one of those shown on the map.

The overall "best" gray is a 106-spot, 45-degree one, while the 85, 35 option is best for camera-ready copy for later reproduction. The 135, 25 option can give you india ink wash effects, but it requires careful paper and toner selection.

The default screen is clear down at 53 spots and 45 degrees, which explains the "Sunday funnies" results of most improperly done PostScript work. There is, of course, one trade-off. The denser screens permit you fewer gray levels. But one decent and dense light gray is all that you need to spruce up line art and improve your layouts. To change a halftone screen, enter the following sequence:

```
106 45 {dup mul exch
    dup mul add 1.0
    exch sub} setscreen
```

Figure 2 shows the difference between the default 53, 45 and the much finer 106, 45.

The sequence inside the braces is called the *spot function*. It determines the rule as to which pixels are turned on as the gray value goes from white to solid. You can create other spot functions for other uses. Most spot functions behave similarly when imaging their lightest gray. You can also use PostScript's `currentscreen` operator to preserve the existing spot function, while changing its density or screen angle.

### Dropout-Free Gray Grids

There are other sneaky tricks you can pull once you understand your PostScript grays.

Figure 3 is the result of the PostScript code in listing 1, a fine gray *rubbergrid* that is both uniform and dropout-free (i.e., all the dots print uniformly). The tricks here involve using a special spot function and locking to exact multiples of 4 pixels. Notice that not only are the lines uniform, but also each of the crossings has precisely a single pixel dot at its center.

You can easily expand or contract a rubbergrid to fit the available space, and once you have created it, further graphics and text are locked to it until your next `restore`. You can use the grid just for layout or make it part of the final image. It is particularly attractive for engineering graphs.

But there are several minor gotchas. You can create the rubbergrid at only a 1-to-1 scale, and any scaling or repositioning gets rather involved. Because of the exact locking to 4-pixel multiples (which seems crucial for preventing 300-dpi dropouts), your final grid may not end up exactly the size you wanted or precisely in your desired location.

*continued*

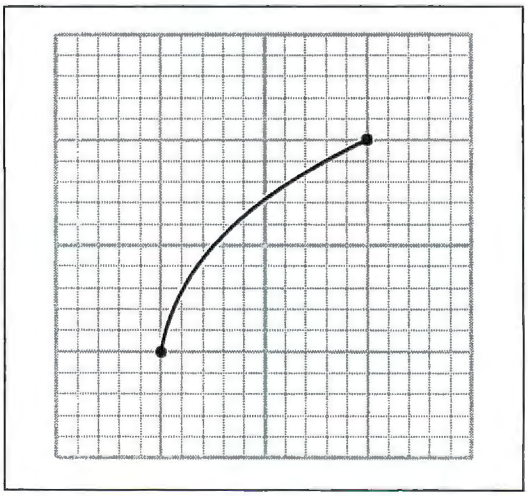


**Figure 3:** *Uniform and dropout-free 300-dpi gray grids can be done at a 1-to-1 scale by first locking to exact 4-pixel multiples and then using the special halftone screen function as shown here. Note that each crossing consists of a single and uniform dot. PostScript stays "locked" to the grid until the next occurrence of a* `grestore`.

**Listing 1:** *The PostScript for a fine gray rubbergrid that is both uniform and dropout-free must be very delicately tuned to the capabilities of the printer. The spot function is null so that the* `setgray` *function produces a specific dot.*

```
%  Creates uniform and ultrafine gray grids without any dropouts or rattiness.
%  The code shown is device-specific and is intended for 300-dpi printers.
%  To create a grid, use  -hpos- -vpos- -gridsize- setgrid.  Until restored, all
%  further images will be "locked" to the grid, expanding and contracting with it.
%  Note that optimum line widths and font sizes will usually be much less than 1.0
%  after locking.
%  To show a grid, use -#hlines- -#vlines- showgrid.
%  The seegrid command displays the grid when true.
%  The fat5 command emphasizes every fifth line when true.
%  The fatter10 command emphasizes every tenth line when true.
/quadpixel {transform 4 div round 4 mul itransform} def
/setgrid {save /rubbersnap exch def quadpixel /size exch def quadpixel exch quadpixel
exch translate size dup scale} def
/drawlines {72 300 div lw mul size div setlinewidth /hposs 0 def #hlines gs div 1 add
cvi {hposs 0 moveto 0 #vlines rlineto stroke /hposs hposs gs add def} repeat /vposs 0
def #vlines gs div 1 add cvi {0 vposs moveto #hlines 0 rlineto stroke /vposs vposs gs
add def} repeat} def
/showgrid{ seegrid {gsave /#vlines exch def /#hlines exch def 106 45 {pop pop 0}
setscreen 0.9 setgray /gs 1 def /lw 1 def drawlines fat5 {/gs 5 def /lw 3 def
drawlines} if fatter10 {/gs 10 def /lw 5 def drawlines} if grestore}if} def
/fat5 true def /fatter10 true def /seegrid true def
%  use examples: -xpos- -ypos- -gridsize- setgrid -#hlines- -#vlines- showgrid
%  {anything you want locked to the grid} rubbersnap restore
%  /// demo - remove before use ////
100 200 10 setgrid 20 20 showgrid showpage quit
```

If you just want a rubbergrid and do not care how it looks, defeat the `quadpixel` function with `/quadpixel {} def` to prevent the locking. Without the locking, you get the exact size and position you want, but you may end up with dropouts and variations in line weight.

Notice that the grid extends infinitely in both directions but is clipped to values passed to `showgrid`. You can prevent showing any of the grid by commenting out (i.e., %) the call to `showgrid`.

## Opaque Icons

Many PostScript images use blobs sitting on strings. An obvious example is a component in an electronic schematic (see figure 4). Other examples are found in flowcharts, printed circuit boards, piping diagrams, organizational charts, and schedules.

A nearly unknown concept called an *opaque icon* can help here. There are rules: All the symbol icons are stored in dictionaries, all the icons are opaque and thus obscure anything they are sitting on, and each icon has an obvious *action point* that determines where it sits. You erase the underlining wire or string (by writing white over it) before creating the rest of the icon.

The advantage of using opaque icons is that, even after you position them, you can still slide all your continuous wires underneath. To do this, you simply describe your continuous wires *earlier* in your file. This lets you reposition the icons at any time. You never have to worry about making and breaking any of the actual connections.

A similar scheme is the *fat white, thin black* ploy. The line breaks for drawing unconnected crossing wires are created by drawing a thick white line, followed by a thin black one. You can use the same method for piping and braiding, unusual borders, isometric depth illusions, and fonts that automatically break an underline.

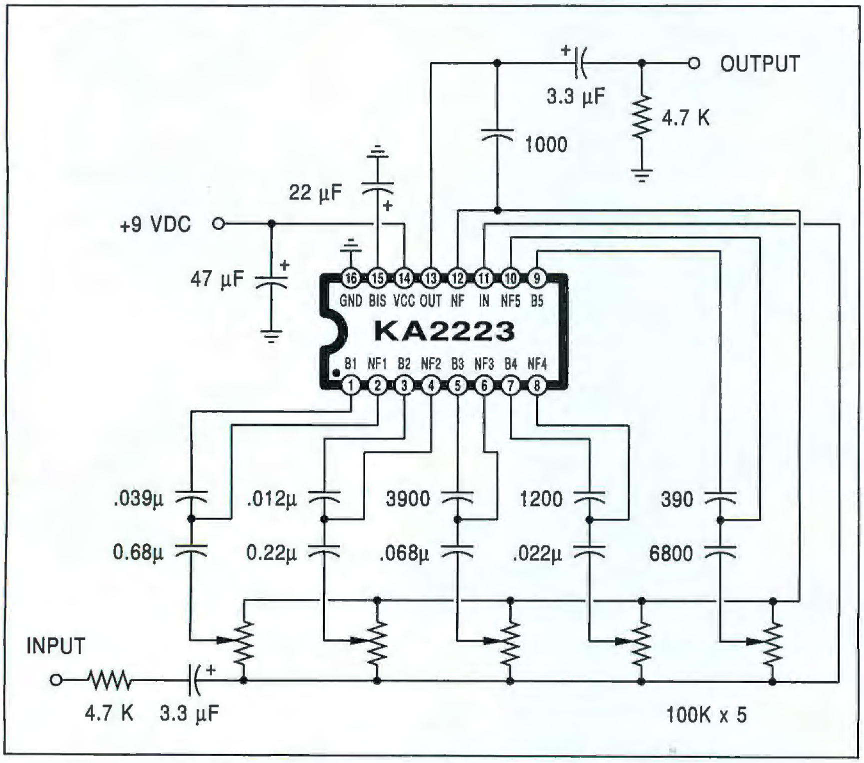



**Figure 4:** *Opaque icons greatly simplify drawing PostScript electronic schematics, flowcharts, and other "blobs on strings" illustrations. All the background wires are continuous, and you slide them under the icons simply by placing them earlier in the text file. Line breaks are first printed as an opaque fat white line and then as a thin black line.*

**Listing 2:** *A faster and easier way to encrypt your own PostScript code than the* eexec *that Adobe uses.*

```
/mask 16#D971 def /mult1 16#6000 def /mult2 16#6E6D def /adder 16#58BF def
/strrx (X) def /trunc 16#FFFF def /char 32 def /hexvalues (0123456789ABCDEF) def
/printashex {cvi /vall exch def vall 16 div cvi hexvalues exch 1 getinterval print
vall 15 and hexvalues exch 1 getinterval print flush 20 {37 sin pop} repeat
formatcount 1 add 32 eq {(\ n) print flush 100 {37 sin pop} repeat} if /formatcount
formatcount 1 add cvi 31 and def} def
/makeeexecfile {/formatcount 0 def 4 {char mask -8 bitshift or char mask -8 bitshift
and not and /echar exch def echar printashex flush 15 {37 sin pop} repeat mask echar
add dup mult1 mul trunc and exch mult2 mul trunc and add trunc and adder add trunc
and /mask exch def} repeat {currentfile strrx readstring {0 get /char exch def char
mask -8 bitshift or char mask -8 bitshift and not and /echar exch def echar
printashex flush 15 {37 sin pop} repeat mask echar add dup mult1 mul trunc and exch
mult2 mul trunc and add trunc and adder add trunc and /mask exch def} {pop exit}
ifelse} loop} def
% //// demo - remove before use. ////
1500 {37 sin pop} repeat
%  Here is the expected host-returned blackflashing result ...
%  F983EF00C334F148421509DC30FA053D6DD4273E416E6A2EA64F917B5D20E111
%  9F220AF8FC50D545AB51A0D18B6DD7543D27A21CD55887C1C7D51608F6A316EE
%  8891D92A6E0D09D1D039159DA3A0781E1380B1228C
makeeexecfile
0 0 moveto 1000 0 rlineto 0 1000 rlineto -1000 0 rlineto closepath fill showpage quit
```

## An Enigmatic Operation

PostScript has a very enigmatic operation, `eexec`, that is of major interest on my PostScript help line (see my biography). The `eexec` was a failed early attempt at making PostScript code files unreadable, but with the penalties of longer files and slower execution times.

Actually, you can easily read any `eexec` file by installing a stack-dumping error trapper and selectively inserting extra characters into your data stream or truncating your file with a Control-D end of file. You can easily reconstruct the plaintext source file from the error messages that result. The tools that you need appear in Adobe's documentation.

Listing 2 shows a faster and easier way to employ `eexec` to encrypt your own PostScript code. Listing 3 shows you how to convert your previously `eexec`-encrypted file back into plaintext.

So how does `eexec` work? The key is a 16-bit pseudorandom sequence. To encrypt, the upper 8 bits of the current pseudorandom mask get exclusive-ORed with your original ASCII value, creating a new character that will get saved as a 2-byte pair. Since an XOR operation is reversible, if you do it again with the same

*continued*

**Listing 3:** *How you convert your previously* eexec*-encrypted text back into plaintext.*

```
/mask 16#D971 def /mult1 16#6000 def /mult2 16#6E6D def /adder 16#58BF def
/trunc 16#FFFF def /strrx (X) def /skip4 -4 def
/readeexecfile {{currentfile strrx readhexstring{0 get /echar exch def echar mask
-8 bitshift or echar mask -8 bitshift and not and /char exch def skip4 0 ge {strrx 0
char put strrx print flush 15 {37 sin pop} repeat /skip4 skip4 1 add def}{/skip4
skip4 1 add def} ifelse mask echar add dup mult1 mul trunc and  exch mult2 mul trunc
and add trunc and adder add trunc and /mask exch def}{pop exit} ifelse} loop} def
%  //// demo - remove before use. ////
1500 {37 sin pop} repeat
%  Here is the expected host-returned result for this demo . . .
%  0 0 moveto 1000 0 rlineto 0 1000 rlineto -1000 0 rlineto closepath fill showpage
readeexecfile
F983EF00C334F148421509DC30FA053D6DD4273E416E6A2EA64F917B5D20E111
9F220AF8FC50D545AB51A0D18B6DD7543D27A21CD55887C1C7D51608F6A316EE
8891D92A6E0D09D1D039159DA3A0781E1380B1228C
```

**Listing 4:** *A fractal fern generated from a table of 128 transformations. The routine uses this table to build up the final fern.*

```
/problistcreate {mark /counter 0 def probabilities {128 mul round cvi {transforms
counter get} repeat /counter counter 1 add def} forall counttomark 128 sub neg dup 0
gt { [1 0 0 1 0 0] repeat} {pop} ifelse] /problist exch def} bind def
/doit {problistcreate 1 1 20 {problist rand -24 bitshift get transform 2 copy moveto
0.001 10 rlineto} repeat newpath numdots {problist rand -24 bitshift get transform 2
copy moveto 0.001 0 rlineto stroke} repeat} bind def
% /// demo - remove before use. ///
/numdots 6000 def   % increase for denser image; decrease to print faster
/transforms [ [0 0 0 .16 0 0] [.2 .23 -.26 .22 0 1.6] [-.15 .26 .28 .24 0 .44]
[.85 -.04 .04 .85 0 1.6] ] def
/probabilities [ .01 .07 .07 .85 ] def
1 setlinecap 0 setlinewidth 200 300 translate 30 dup scale doit showpage quit
```

**Figure 5:** *The fern is the output generated by the code in listing 4. PostScript's ability to do continuous translate-rotate-scale matrix transformations on the fly makes it particularly attractive for many fractals.*

key, you will get the original plaintext from the encrypted form.

You can generate a new pseudorandom value by adding the existing value to the current encrypted character, multiplying by a 16-bit constant, and adding a second one. You can find these constants by eexecing a bunch of $00 (null) values to reconstruct the unshifted pseudorandom sequence. The first 4-byte pairs are ignored in the eexec interpreter. Presumably, these let you add a user key to your coding process.

## Curve Tracing

PostScript includes a pair of strong Bézier cubic spline curve generators in its `curveto` and `rcurveto` operators. These let you draw the smooth and continuous curves used for high-quality typography, signatures, cartoon animation, and fancy borders, and for any flowing curves.

A third-order spline curve permits only a single cusp, a single loop, or two inflection points. To do anything fancier, you have to use multiple splines arranged end to end. And this is where things can get tricky. To look good on the page, adjacent splines must join, must have the same slope at their junction, and, ideally, must have a continuous rate of change of slope where they meet. They also, of course, should accurately approximate the curve you are trying to generate.

You can use a curve-tracing routine to properly align splines to get a smooth and continuous result. While there are many options, the curve-tracing routine I use seems to give me lots of control and appears to do the job. To use it, I enter three data values for each and every spline end, with which the routine builds the composite curve spline by spline. The data values are the $x$ position, the $y$ position, and the desired slope angle at each spline end. Since I am specifying the end slope, I am guaranteed that the curve is continuous and that the slope is an exact match at each spline joint.

As a simple example, the single curve shown in figure 3 is coded as the following:

```
[5 5 80 15 15 25] curvetrace
```

In this example, you start at `5, 5` with an angle of +80 degrees and end up at `15, 15` at an exit angle of +25 degrees.

The curve-tracing routine can either generate a new path or append an existing one. The convention that I use is that initial data values of `0,0` append an existing curve, letting you mix curves and

*continued*

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straight lines in the same path. You can create cusps or inflection points by repeating a data point pair with different entry and exit angles. You can generate variable curve widths by curve-tracing up one side and down the other.

To draw a pictorial wire, you first curve-trace the wire path. Next, set a `1 setlinecap` for rounded ends. Then stroke fat white to break anything the wire is running over. Stroke black to set the wire outline. Finally, stroke gray to color the wire.

### Fractal Art

If the dire predictions in the *PostScript Reference Manual* are taken seriously, any attempt whatsoever at doing fractal art with PostScript will result in the immediate vaporization of all small furry animals within an eight-block radius of your PostScript printer. In reality, PostScript is ideal for many kinds of fractals.

To prove this, see figure 5. I've taken the fern routine that first appeared in "A Better Way to Compress Images" (January 1988 BYTE). I was struck by how ungainly all the translate-rotate-scale transformations were done in both the BASIC and C code examples. In contrast, matrix image transformations between device space and user space are inherent to the very core of PostScript.

The code works by first creating a table of 128 different transformations based on the required probabilities (see listing 4). The routine uses this table to build up the final fern. As in the example cited, the first 20 dots are thrown out to give the strange attractor time to start strange attracting. It takes a mere 28 data values to *completely* define this fractal image.

What utterly amazes me about this fern fractal image is that you do not really draw it. Instead, you simply let it out, and it leaps at you with a vengeance. Very much like learning PostScript. ■

Editor's note: *The complete text of the code in this article is available in a variety of formats. See page 5 for details.*

*Microcomputer pioneer and PostScript authority Don Lancaster is the author of 26 books and countless articles. He maintains a no-charge PostScript help line at (602) 428-4073. The best time to call is from 8 to 5 (MT) on weekdays. You can also contact him on BIX c/o "editors."*

*Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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# THE BYTE VIP AWARDS

*The ballots are in for BYTE readers' Very Important Product awards*

BYTE 1990 READERS' AWARDS

**BYTE's biggest assets are its readers. The tools you use are important to us. Knowing what you use and how you use it helps us to know what information to bring you each month.**

**We recently asked several thousand of you, selected at random, to tell us which devices and programs you find the most helpful in your day-to-day business and personal computer activities. We were gratified that so many of you took the time to respond thoroughly. Here are the products you told us you prefer in each group, winners of BYTE's VIP—Very Important Product—awards.**

# HARDWARE

*Readers voted the Compaq Deskpro 386 the most popular computer system, out of a field of dozens of 286s and 386s.*

MICROPROCESSOR CHIP

**Intel 386**
It comes as no surprise that the 386 placed first in this category, since it can simultaneously run multiple operating systems and handle memory management far more efficiently and with greater flexibility than the 286 does. What was a surprise was that, although they were distant also-rans, the i486 was a little ahead of the 286 for second place.

COMPUTER SYSTEM

**Deskpro 386 and Mac II**
Readers nominated a total of 63 computer systems in this classification. Among the dozens of 286 and 386 clones fighting for position, the Compaq Deskpro 386 was the favorite, with the Mac II coming in first among Motorola-based systems.

PRINTER

**LaserJet II**
There wasn't even a close contender for honorable mention in this category, in which readers nominated 57 different machines. The Hewlett-Packard LaserJet II won with a third of all votes cast. Although the HP LaserJet IIP has been out only a few months at this writing, it came in with a respectable 12 percent of the votes.

MONITOR

**MultiSync 3D**
The NEC MultiSync 3D was far and away the winner in this classification, with 37 percent of the votes.

MASS STORAGE DEVICE

**Seagate ST251**
In the category of mass storage devices, readers nominated a variety of their favorite hard disk drives, tape backup devices, and even WORM (write once, read many times) drives. Seagate's ST251 hard disk drive was the VIP winner, but honorable mention goes to the Imprimis Wren series.

GRAPHICS BOARD

**Paradise VGA Plus**
Widely used in PC clones, Western Digital's Paradise board came out on top in this category, while the ATI VGA Wonder deserves an honorable mention as a close contender.

MEMORY BOARD

**AboveBoard Plus**
Fully half of the respondents in our survey voted the Intel AboveBoard Plus as their favorite memory board. The AboveBoard Plus garnered close to four times as many votes as the next runner-up in this category.

LAN HARDWARE

**(no winner)**
Readers nominated several products in this category, but no product received enough votes for us to accord it a VIP award. Honorable mentions, for those who led the pack, go to 3Com's EtherLink, Western Digital's Ethernet, and Novell's Ethernet cards.

MODEM

**Smartmodem 2400**
Modem users nominated 41 devices as outstanding, although many of the units received only a few votes. The Hayes Smartmodem 2400 took the spotlight in this category, receiving 18 percent of the votes cast—twice as many votes as the next most popular modem, the Hayes 9600.

INPUT/POINTING DEVICE

**Microsoft Mouse**
The Microsoft Mouse got the nod from our readers for the most popular input/pointing device, with 44 percent of the votes. Honorable mention goes to the Logitech Mouse, which received 29 percent of the votes. Votes for other devices fell way short of the top two.

*continued*

# BYTE Celebrates Its 15th Anniversary With A Special September Issue!

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- **Donald Knuth**, professor of Computer Science, Stanford University, author of several classic computer science books
- **Niklaus Wirth**, developer of Pascal, Modula-2, and Oberon languages

And, several well-known industry commentators, including:

- **Stewart Alsop**, editor and publisher of *P.C. Letter*
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# SOFTWARE

WORD PROCESSOR

**WordPerfect 5.1**
WordPerfect 5.1 landed a whopping lead in the word processor category, clearly a VIP among readers. It seems that this program not only holds its own, but grows in the popularity polls. Honorable mention goes to Microsoft Word, another favorite among wordsmiths.

SPREADSHEET

**Quattro Pro and Lotus 1-2-3 release 2.2**
Among spreadsheet programs, Borland's Quattro Pro and Lotus 1-2-3 release 2.2 came in at a dead heat, each with a third of the votes. Honorable mention goes to Microsoft's Excel, with almost 25 percent of the votes.

GRAPHICS

**Harvard Graphics**
Readers nominated a mixed bag of products in the category of graphics software. Far and away the winner was Software Publishing's Harvard Graphics, which outdid the next highest vote-getter by 4 to 1.

DESKTOP PUBLISHING

**PageMaker**
In desktop publishing packages, Aldus's PageMaker grabbed the VIP honors. An honorable mention goes to Xerox's Ventura Publisher, which received seven times as many votes as the third-place product.

DATABASE MANAGER

**Paradox 3**
BYTE readers gave their nod for top database manager to Paradox 3. Ashton-Tate's dBASE III Plus and IV share an honorable mention by coming in close behind.

FINANCIAL/ACCOUNTING

**Quicken**
The difference between the first and second spots in financial/accounting software was significant. BYTE readers showed their preference by voting Intuit's low-cost Quicken a strong first place among the contenders.

ENGINEERING/TECHNICAL

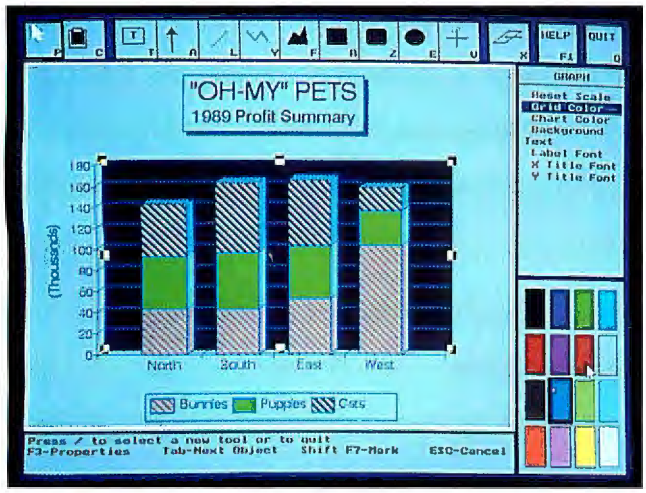
**AutoCAD**
Autodesk's AutoCAD was a clear winner in this class of software, with 42 percent of respondents nominating it as their favorite package. No other package received more than 10 percent of the votes.

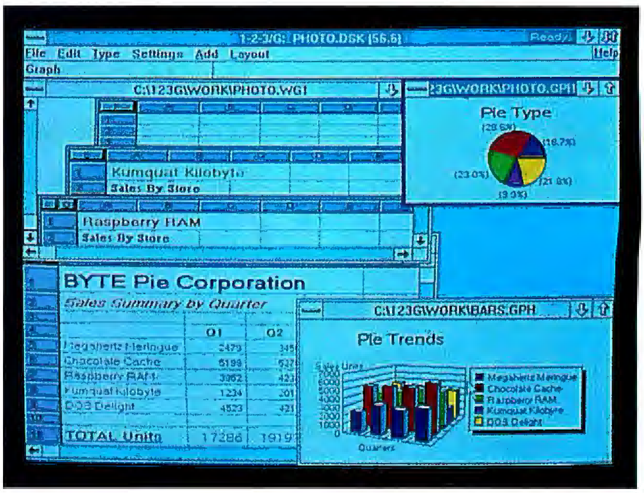
NETWORKING

**NetWare 386**
Another sweep-the-field product was Novell's NetWare 386, favored by over 40 percent of the readers surveyed. A distant runner-up—but still in the Novell family—was NetWare 286, with 10 percent of the votes.

TELECOMMUNICATIONS

**Procomm Plus**
Fully 50 percent of those responding to our survey chose Datastorm Technologies' Procomm Plus as their telecommunications package of choice. It is interesting, but perhaps not surprising, that a program that started out as a shareware product would be the preference of BYTE's readers 4 to 1 over its nearest competitor in the balloting.




*In the only category with two winners, Borland's Quattro Pro (left) and release 2.2 of Lotus 1-2-3 finished in a dead heat as readers' favorite spreadsheets.*

PROGRAMMING LANGUAGE IMPLEMENTATION

**Turbo Pascal 5**
Borland's Turbo Pascal 5 turned out to be the VIP in this category, according to BYTE readers. Interestingly, three other products crossed the finish line together with almost exactly the same number of votes: Borland Turbo C, Microsoft C 5.1, and Microsoft QuickBASIC.

UTILITY

**Norton Utilities Advanced Edition 3.X**
Sweeping the utility field with 48 percent of the votes was Norton Utilities Advanced Edition 3.X. BYTE readers also put in a strong vote for Central Point Software's PC Tools, an honorable mention with 26 percent of the votes. No other package received more than 5 percent of the votes.

OPERATING SYSTEM

**MS-DOS 3.3**
By far the heaviest votes here went to Microsoft's MS-DOS 3.3, favored by more than half of those surveyed. Among those who cast their votes for their favorite non-PC-compatible operating system, there was no clear winner. An almost equal number of votes came in for AT&T's Unix System V and the Apple Macintosh's System 6.0.

The computer industry is maturing. BYTE readers have named as Very Important Products those that have steadily provided the best in features, quality, and ease of use. Our congratulations to the winners! ■

## 1990 BYTE Readers VIP Awards

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Software Publishing Corp.
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**Intel 386 AboveBoard Plus**
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(408) 765-8080
**Inquiry 1194.**

**LaserJet II**
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Palo Alto, CA 94304
(800) 752-0900
(415) 857-1501
**Inquiry 1191.**

**Lotus 1-2-3 release 2.2**
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
**Inquiry 1195.**

**Mac II**
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
**Inquiry 1196.**

**Microsoft Mouse**
**MS-DOS 3.3**
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
**Inquiry 1197.**

**MultiSync 3D**
NEC Technologies, Inc.
1255 Michael Dr.
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(708) 860-9500
**Inquiry 1198.**

**NetWare 386**
Novell, Inc.
122 East 1700 South
Provo, UT 84601
(800) 453-1267
(801) 379-5900
**Inquiry 1200.**

**Norton Utilities Advanced Edition 3.X**
Peter Norton Computing, Inc.
2210 Wilshire Blvd., Suite 186
Santa Monica, CA 90403
(213) 319-2000
**Inquiry 1199.**

**PageMaker**
Aldus Corp.
411 First Ave. S, Suite 200
Seattle, WA 98104
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(206) 622-5500
**Inquiry 981.**

**Paradise VGA Plus**
Western Digital Imaging
Paradise Systems
800 East Middlefield Rd.
Mountain View, CA 94043
(800) 331-8127
(415) 960-3353
**Inquiry 982.**

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**Quattro Pro**
**Turbo Pascal 5**
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**Inquiry 983.**

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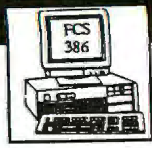


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**Premium 386-33,486-25**

| | | |
|---|---|---|
| 1MB | 500718-002 | $155.00 |

## LAPTOP MODELS

### TOSHIBA

**Models T8500,T5200**

| | | |
|---|---|---|
| 2MB | PC10-PA8304V | $399.00 |

**Model T5100**

| | | |
|---|---|---|
| 2MB | PC7-PA8301V | $399.00 |

**Model T3200SX**

| | | |
|---|---|---|
| 2MB | PC12-PA8307V | $399.00 |

**Model T3200**

| | | |
|---|---|---|
| 3MB | PC6-PA7137V | $699.00 |

**Model T3100**

| | | |
|---|---|---|
| 2MB | PC3-PA7135E | $439.00 |

**Model 3100E**

| | | |
|---|---|---|
| 2MB | PC9-PA8341V | $399.00 |

**Model T1600**

| | | |
|---|---|---|
| 2MB | PC8-PA8302V | $399.00 |

### ZENITH

**Super Sport 286**

| | | |
|---|---|---|
| 1MB | ZA180-66 | $199.00 |
| 4MB | ZA180-67 | $899.00 |

### COMPAQ

**Portable LTE 286**

| | | |
|---|---|---|
| 1MB | 117081-001 | $295.00 |
| 2MB | 117081-002 | $485.00 |

**SLT-286**

| | | |
|---|---|---|
| 1MB | 110235-001 | $325.00 |

## ZENITH

**Models Z386-20/25**

| | | |
|---|---|---|
| 1MB | ZA3600ME | $149.00 |

**Model Z386-20**

| | | |
|---|---|---|
| 2MB | ZA3600MG | $275.00 |

**Model Z386-33**

| | | |
|---|---|---|
| 1MB | ZA3800ME | $149.00 |

## SIMMS

Also available in static column

### IBM TYPE

ADD $10.00 FOR SIPPS

| | |
|---|---|
| *4Mx9-80* | *$469.00* |
| 1Mx9-12 | $83.00 |
| 1Mx9-10 | $84.00 |
| 1Mx9-80 | $88.00 |
| 1Mx9-70 | $91.00 |
| 256x9-12 | $25.00 |
| 256x9-10 | $27.00 |
| 256x9-80 | $29.00 |
| 256x9-60 | $49.00 |

### APPLE TYPE

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| | |
|---|---|
| 1Mx8-12 | $73.00 |
| 1Mx8-10 | $75.00 |
| 1Mx8-80 | $78.00 |
| 256x8-12 | $24.00 |
| 256x8-10 | $26.00 |
| 256x8-80 | $28.00 |

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## DRAM

**DIP,ZIP,OR SOJ**

**1MG X 1**

| | |
|---|---|
| 1Mx1-10 | $8.75 |
| 1Mx1-80 | $8.95 |
| 1Mx1-70 | $9.00 |
| 1Mx1-60 | $CALL |

**256K X 4**

| | |
|---|---|
| 256x4-10 | $10.50 |
| 256x4-80 | $11.00 |

**256K X 1**

| | |
|---|---|
| 256x1-12 | $2.40 |
| 256x1-10 | $2.80 |
| 256x1-80 | $3.20 |
| 256x1-70 | $3.45 |

**64K X 4**

| | |
|---|---|
| 64Kx4-10 | $4.00 |
| 64Kx4-80 | $4.50 |

**64K X 1**

| | |
|---|---|
| 64Kx1-12 | $1.49 |
| 64Kx1-10 | $1.59 |

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|---|---|---|
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| 8087-1 | 10MHz | $169.95 |

**80286 Systems**

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|---|---|---|
| 80287 | 6MHz | $139.95 |
| 80287-8 | 8MHz | $209.95 |
| 80287-10 | 10MHz | $239.95 |

**80386 Systems**

| | | |
|---|---|---|
| 80387-16 | 16MHz | $349.95 |
| 80387-20 | 20MHz | $399.95 |
| 80387-25 | 25MHz | $499.95 |
| 80387-33 | 33MHz | $649.95 |

## SIP Modules

| | | |
|---|---|---|
| 41256A9A-80 | 80ns, 256Kx9 | $54.95 |
| 41256A9A-10 | 100ns, 256Kx9 | $44.95 |
| 421000A9A-70 | 70ns, 1Mx9 | $169.95 |
| 421000A9A-80 | 80ns, 1Mx9 | $124.95 |
| 421000A9A-10 | 100ns, 1Mx9 | $116.95 |
| 94000L-80 | 80ns, 4Mx9 | $499.95 |
| 94000L-10 | 100ns, 4Mx9 | $499.95 |

## SIMM Modules

| | | |
|---|---|---|
| 41256A9B-80 | 80ns, 256Kx9 | $49.95 |
| 41256A9B-10 | 100ns, 256Kx9 | $39.95 |
| 421000A8B-10 | 100ns, 1Mx8 | $109.95 |
| 421000A9B-70 | 70ns, 1Mx9 | $139.95 |
| 421000A9B-80 | 80ns, 1Mx9 | $119.95 |
| 421000A9B-10 | 100ns, 1Mx9 | $113.95 |
| 94000S-80 | 80ns, 4Mx9 | $499.95 |
| 94000S-10 | 100ns, 4Mx9 | $499.95 |

## NEC V20 & V30 Chips

| | | |
|---|---|---|
| UPD70108-5 | 5MHz, V20 Chip | $5.25 |
| UPD70108-8 | 8MHz, V20 Chip | $6.95 |
| UPD70108-10 | 10MHz, V20 Chip | $10.95 |
| UPD70116-8 | 8MHz, V30 Chip | $7.95 |
| UPD70116-10 | 10MHz, V30 Chip | $13.49 |

## Dynamic RAMs

| | | |
|---|---|---|
| TMS4416-12 | 120ns, 16Kx4 | $2.25 |
| TMS4416-15 | 150ns, 16Kx4 | $2.00 |
| 4116-12 | 120ns, 16Kx1 | $1.49 |
| 4116-15 | 150ns, 16Kx1 | $1.09 |
| 4116-20 | 200ns, 16Kx1 | $.89 |
| 4164-100 | 100ns, 64Kx1 | $2.75 |
| 4164-120 | 120ns, 64Kx1 | $2.39 |
| 4164-150 | 150ns, 64Kx1 | $2.15 |
| 4164-200 | 200ns, 64Kx1 | $1.75 |
| 41256-60 | 60ns, 256Kx1 | $5.25 |
| 41256-80 | 80ns, 256Kx1 | $3.75 |
| 41256-100 | 100ns, 256Kx1 | $3.15 |
| 41256-120 | 120ns, 256Kx1 | $2.95 |
| 41256-150 | 150ns, 256Kx1 | $2.59 |
| 41464-80 | 80ns, 64Kx4 | $5.95 |
| 41464-10 | 100ns, 64Kx4 | $4.95 |
| 41464-12 | 120ns, 64Kx4 | $3.95 |
| 41464-15 | 150ns, 64Kx4 | $3.59 |
| 511000P-70 | 70ns, 1Mx1 | $13.95 |
| 511000P-80 | 80ns, 1Mx1 | $12.95 |
| 511000P-10 | 100ns, 1Mx1 | $12.35 |
| 514256P-80 | 80ns, 256Kx4 | $13.45 |
| 514256P-10 | 100ns, 256Kx4 | $12.95 |

## Static RAMs

| | | |
|---|---|---|
| 6116P-3 | 150ns, 16Kx 1(CMOS) | $2.79 |
| 6264LP-10 | 100ns, 64Kx1 (CMOS) | $6.95 |
| 6264LP-15 | 150ns, 64Kx1 (CMOS) | $4.95 |
| 43256-10L | 100ns, 256Kx1 | $10.95 |
| 43256-15L | 150ns, 256Kx1 | $9.95 |
| 62256LP-15 | 150ns, 256Kx1 (CMOS) | $10.95 |

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**M3650, 3650B & M4650 only:**
- Also measure frequency and capacitance

**M4650 only:** • Data hold switch • 4.5 digit

| | | |
|---|---|---|
| M3610 | 3.5 Digit Multimeter | $49.95 |
| M3650 | 3.5 Digit Multimeter w/Frequency & Capacitance | $69.95 |
| M3650B | Same as M3650 w/Bargraph | $74.95 |
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## Jameco 12MHz 80286 Desktop Computer Kit

- Fully IBM AT Compatible
- Free! DR DOS (Disk Operating System) Software Included
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- 512KB RAM Included, Expandable to 4MB on board
- 8/12MHz Keyboard Switchable Operation
- AMI BIOS ROMs Included
- Fliptop Case w/200 Watt Power Supply
- Teac 5.25" 1.2MB DSHD Disk Drive
- Parallel Printer Port, Serial (RS232) Port, Game Port
- Fujitsu 101-Key (Enhanced) Keyboard

Shown with EGA Option (not included)
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(See Right)

**JE3008** 12MHz 80286 Compatible Kit..........................................**$599.95**

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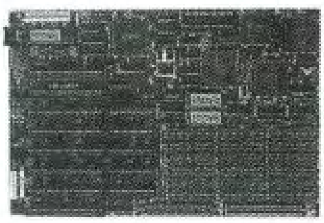
SL90

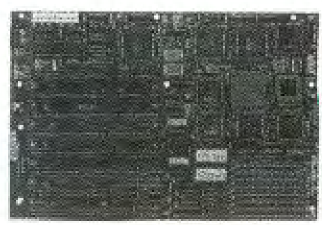
## Jameco 16MHz 80286 Motherboard



- Baby size motherboard
- Expandable to 1MB RAM using 256KB DRAM chips or 4MB using 1MB DRAM chips
- Additional 1MB with 256KB DRAM SIPs or 4MB with 1MB DRAM SIPs for a total of 8MB
- Uses 100ns DRAMs
- 8/16MHz hardware or keyboard selectable operation
- AMI BIOS ROMs included
- 16MHz CMOS Harris CPU
- Supports all NEAT® CHIPSet™ functions including shadow RAM, LIM EMS 4.0, RAM re-mapping, selectable wait states, memory interleaving, etc...
- Battery-backed clock/calendar
- Five 16-bit and three 8-bit expansion bus slots
- Size: 13" x 8.5"

**JE3010**.................................................................**$299.95**

## Jameco 20MHz 80386 Motherboard



- Baby size motherboard
- Expandable to 2MB RAM using 256KB SIPs, 8MB using 1MB SIPs or 16MB using the optional JE3530 memory card (Please note the minimum RAM expansion is 4 SIP Modules at a time)
- Uses 100ns SIPs
- Includes battery pack
- 8/20MHz keyboard selectable operation
- AMI BIOS ROMs included
- Shadow RAM for fast BIOS and video performance
- Adjustable bus speeds and wait states
- 8 expansion slots - one 32-bit (for optional memory card), five 16-bit, and two 8-bit
- Size: 13" x 8.5"

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### Jameco 20MHz 80386 Desktop Computer Kit

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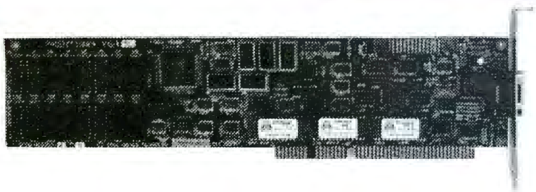
- 4MB RAM Included, Expandable to 8MB on board, 16MB with optional expansion board
- 8/16/20MHz Keyboard Switchable Operation
- AMI BIOS ROMs Included
- Fliptop Case w/200 Watt Power Supply
- Conner High-Performance IDE 3.5" 40MB Hard Disk Drive
- Teac 1.2MB Floppy DSHD Disk Drive
- Multi I/O Card with Universal Floppy Controller
- Fujitsu 101-Key (Enhanced) Keyboard

Shown with VGA Option (not included) JE2059 Multiscan Monitor and VGA Card....$669.90 (See Below)

**JE3551** 20MHz 80386 Compatible Kit....................................**$1949.95**

### Jameco IBM PC/XT/AT Compatible Cards



JE1057

| | | |
|---|---|---|
| **JE1043** | 360KB/720KB/1.2MB/1.44MB Floppy Disk Controller Card (PC/XT/AT) | **$49.95** |
| **JE1050** | Monochrome Graphics Card w/Parallel Printer Port (PC/XT/AT) | **$49.95** |
| **JE1052** | Color Graphics Card w/ Parallel Printer Port (PC/XT/AT) | **$49.95** |
| **JE1055** | EGA Card w/ 256KB Video RAM (PC/XT/AT) | **$139.95** |
| **JE1057** | 8/16-Bit VGA Card w/ 256KB Video RAM (PC/XT/AT) | **$199.95** |
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| **JE1062** | RS232 Serial Half Card (PC/XT/AT) | **$29.95** |
| **JE1065** | I/O Card w/ Serial, Game and Parallel Printer Port (AT) | **$59.95** |
| **JE1077** | Multi I/O Card w/ 360KB/720KB/1.2MB/1.44MB Floppy Controller (AT) | **$99.95** |

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Relisys 14" Multiscan monitor and 16-bit VGA card package (640 x 480 max. resolution)

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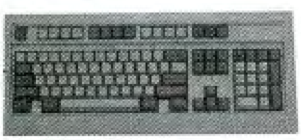
JE2061

### IBM PC/XT/AT Compatible Keyboards

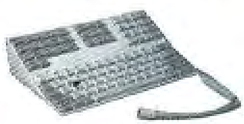


FKB4700

**JE2015** 84-Key Standard AT Style Layout .......................... **$59.95**

**FKB4700** 101-Key Enhanced Layout with 12 Function Keys ........ **$69.95**

### MEI 100-Key Microtype Keyboard



- IBM PC/XT/AT/386 Compatible
- Saves an amazing 60% of the desk space used by equivalent standard keyboards

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- 400 dpi

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### Modems

9600E Pictured

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|---|---|---|
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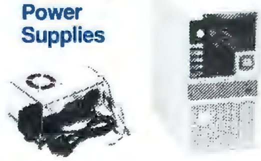
| **2400C** | Datatronics 2400 Baud | **$149.95** |
| **9600E** | Prometheus 9600 Baud | **$699.95** |

**Internal Modems**

| | | |
|---|---|---|
| **1200B** | Jameco 1200 Baud | **$49.95** |
| **2400B** | Jameco 2400 Baud | **$99.95** |

Modems listed above include ProComm Software

### IBM Compatible Cases and Power Supplies



JE1030 JE2012

| | | |
|---|---|---|
| **JE1010** | Flip-Top Standard PC/XT Case | **$39.95** |
| **JE1011** | Side Standard PC/XT Case | **$39.95** |
| **JE1030** | 150 watt PC/XT Power Supply | **$59.95** |
| **JE1032** | 200 watt Baby AT Power Supply | **$89.95** |
| **JE1035** | 300 watt AT Power Supply | **$139.95** |
| **JE2011** | Vertical Case w/300W Pwr. Supply | **$269.95** |
| **JE2012** | Mini-Vertical Case w/200W Pwr. Supply | **$169.95** |
| **JE2019** | Flip-Top Baby AT Case | **$69.95** |

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**MF353B** 3.5" 720KB Internal Drive ..... **$99.95**

**Toshiba**

**356KU** 3.5" 1.44MB Internal Drive .. **$109.95**

**Teac**

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**FD55G** 5.25" 1.2MB Internal Drive.... **$99.95**

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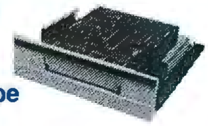
| **M8425XT** | 20MB (68ms) 3.5"HH (Kit) | **$289.95** |
| **M8425AT** | 20MB (68ms) 3.5"HH (Kit) | **$339.95** |

**RLL**

| | | |
|---|---|---|
| **M8438** | 30MB (68ms) 3.5"HH | **$249.95** |
| **M8438XT** | 30MB (68ms) 3.5"HH (Kit) | **$299.95** |
| **M8438AT** | 30MB (68ms) 3.5"HH (Kit) | **$389.95** |
| **M8450** | 40MB (46ms) 3.5"HH | **$329.95** |
| **M8450XT** | 40MB (46ms) 3.5"HH (Kit) | **$369.95** |
| **M8450AT** | 40MB (46ms) 3.5"HH (Kit) | **$429.95** |

(Kit) Includes Hard Disk Drive, Controller & Cables

### Colorado Memory Systems 40MB Tape Back-Up



• IBM PC/XT/AT/386 Compatible • Back-up 40MB in 40 minutes • Back-up 60 to 120MB with extended tapes and data compression software • Includes 40MB tape cartridge

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**KE10** External Enclosure Kit ............**$149.95**

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- 8088-**10mhz**
- 512K RAM
- 1 360K floppy disk drive
- 1 parallel port
- 1 serial port
- 1 game port
- clock/ calendar with battery back-up
- 84 keyboard
- 150 watt UL approved power supply
- FCC class B approved
- Dow Jones 48 hour depot service

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- Add $10 for 1:1 HD/FD controller
- 1 1.2MB floppy disk drive
- 1 parallel l port
- 1 serial port
- 1 game port
- 101 keyboard
- 200 watt UL approved power supply
- FCC class B approved
- Dow Jones 48 hour depot service

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*1 YEAR WARRANTY*

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*Incorporates advanced 32-bit processing with speeds of over 25MHz. Kaypro also features a line of 32-bit microcomputers with cache memory and speeds of up to 33MHz. Tomorrow's technology today !*

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- 80386-**16mhz SX**
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- 2:1 HD/FD controller
- Add $10 for 1:1 HD/FD controller
- 1 1.2MB floppy disk drive
- 1 parallell port
- 1 serial port
- 1 game port
- 101 keyboard
- 200 watt UL approved power supply
- FCC class B approved
- Dow Jones 48 hour depot service

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*1 YEAR WARRANTY*

### MC-30/20

- 80386-**20mhz**
- 1 MB RAM
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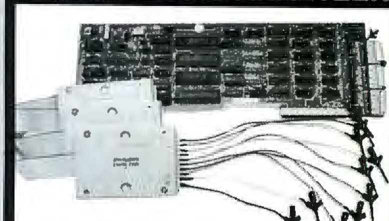

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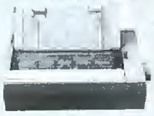

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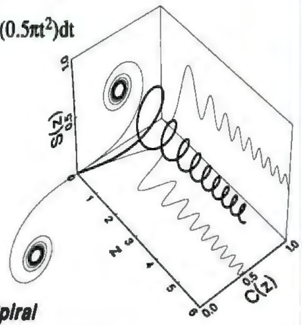


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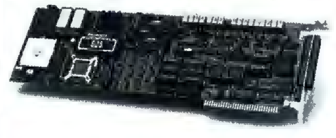

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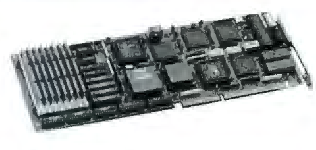

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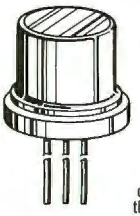

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| 2716 | 24 | 2048 x 8 | 450ns (25v) | 3.29 | 3.13 | 2.82 |
| 2716-1 | 24 | 2048 x 8 | 350ns (25v) | 3.79 | 3.60 | 3.24 |
| TMS2716 | 24 | 2048 x 8 | 450ns | 6.29 | 5.98 | 5.38 |
| 27C16 | 24 | 2048 x 8 | 450ns (25v-CMOS) | 3.99 | 3.79 | 3.41 |
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| 2732A | 24 | 4096 x 8 | 250ns (21v) | 3.69 | 3.51 | 3.16 |
| 2732A-4 | 24 | 4096 x 8 | 450ns (21v) | 3.19 | 3.03 | 2.73 |
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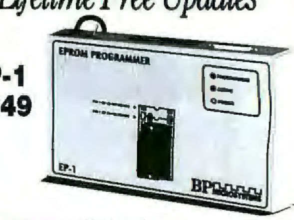


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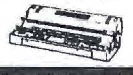

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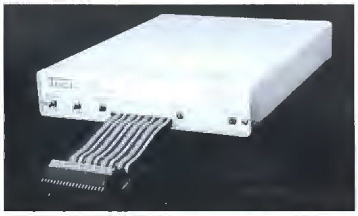

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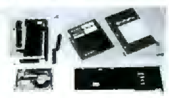

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| 1MB Memory Exp. Bd | 113633-001 | Deskpro 386S | $309^{00}$ |
| 4MB Memory Exp. Bd | 113645-001 | Deskpro 386/20e | $799^{00}$ |
| 4MB Memory Exp. Bd | 113634-001 | Deskpro 386S | $799^{00}$ |
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| 256 x 8 Apple | $19^{00}$ | $24^{00}$ | $29^{00}$ | $39^{00}$ | — |
| 256 x 9 IBM | $14^{00}$ | $19^{00}$ | $29^{00}$ | $33^{00}$ | $59^{00}$ |
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| 80287-8 | 8MHz | $189^{00}$ | Above Piggyback 512K exp 2 Meg #4220 | | $149^{00}$ |
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| 80C287-12 | Laptop | $289^{00}$ | | | |

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Specify Machine Type

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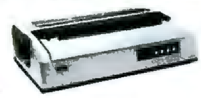

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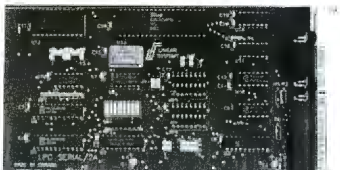

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| 80287-6 | $135 | 80387-20 | $355 |
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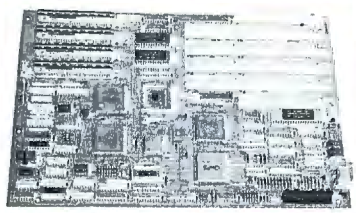

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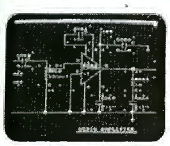

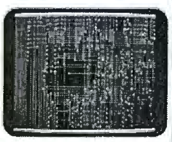

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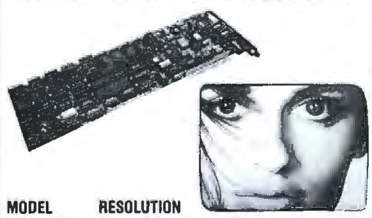

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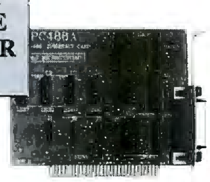

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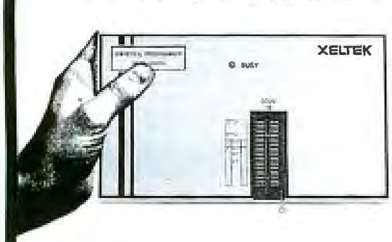


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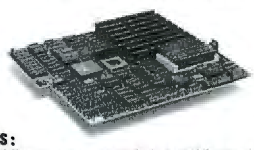

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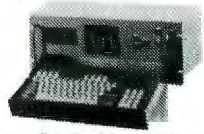

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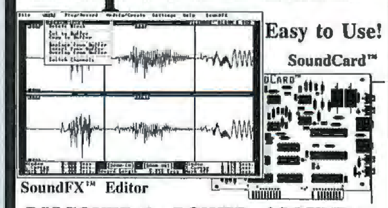


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Index of companies covered in articles, columns, or news stories in this issue
Each reference is to the first page of the article or section in which the company name appears

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| 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 |
| 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 |
| 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 |
| 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 |
| 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 |
| 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 |
| 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 |
| 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 |
| 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 |
| 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 |
| 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 |
| 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 |
| 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 |
| 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 |
| 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 |
| 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 |
| 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 |
| 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 |
| 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 |
| 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 |
| 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 |
| 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 |
| 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 |
| 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 |
| 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 |
| 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 |
| 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 |
| 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 |
| 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 |
| 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 |
| 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 |
| 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 |
| 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 |
| 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 |
| 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 |
| 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 |
| 921 | 922 | 923 | 924 | 925 | 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 |
| 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 |
| 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 |
| 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 |
| 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 | 1017 | 1018 | 1019 | 1020 |
| 1021 | 1022 | 1023 | 1024 | 1025 | 1026 | 1027 | 1028 | 1029 | 1030 | 1031 | 1032 | 1033 | 1034 | 1035 | 1036 | 1037 | 1038 | 1039 | 1040 |
| 1041 | 1042 | 1043 | 1044 | 1045 | 1046 | 1047 | 1048 | 1049 | 1050 | 1051 | 1052 | 1053 | 1054 | 1055 | 1056 | 1057 | 1058 | 1059 | 1060 |
| 1061 | 1062 | 1063 | 1064 | 1065 | 1066 | 1067 | 1068 | 1069 | 1070 | 1071 | 1072 | 1073 | 1074 | 1075 | 1076 | 1077 | 1078 | 1079 | 1080 |
| 1081 | 1082 | 1083 | 1084 | 1085 | 1086 | 1087 | 1088 | 1089 | 1090 | 1091 | 1092 | 1093 | 1094 | 1095 | 1096 | 1097 | 1098 | 1099 | 1100 |
| 1101 | 1102 | 1103 | 1104 | 1105 | 1106 | 1107 | 1108 | 1109 | 1110 | 1111 | 1112 | 1113 | 1114 | 1115 | 1116 | 1117 | 1118 | 1119 | 1120 |
| 1121 | 1122 | 1123 | 1124 | 1125 | 1126 | 1127 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1135 | 1136 | 1137 | 1138 | 1139 | 1140 |
| 1141 | 1142 | 1143 | 1144 | 1145 | 1146 | 1147 | 1148 | 1149 | 1150 | 1151 | 1152 | 1153 | 1154 | 1155 | 1156 | 1157 | 1158 | 1159 | 1160 |
| 1161 | 1162 | 1163 | 1164 | 1165 | 1166 | 1167 | 1168 | 1169 | 1170 | 1171 | 1172 | 1173 | 1174 | 1175 | 1176 | 1177 | 1178 | 1179 | 1180 |
| 1181 | 1182 | 1183 | 1184 | 1185 | 1186 | 1187 | 1188 | 1189 | 1190 | 1191 | 1192 | 1193 | 1194 | 1195 | 1196 | 1197 | 1198 | 1199 | 1200 |
| 1201 | 1202 | 1203 | 1204 | 1205 | 1206 | 1207 | 1208 | 1209 | 1210 | 1211 | 1212 | 1213 | 1214 | 1215 | 1216 | 1217 | 1218 | 1219 | 1220 |
| 1221 | 1222 | 1223 | 1224 | 1225 | 1226 | 1227 | 1228 | 1229 | 1230 | | | | | | | | | | |

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**1** Circle numbers on reply card which correspond to numbers assigned to items of interest to you.

**2** Check all the appropriate answers to questions "A" through "C".

**3** Print your name and address and mail.

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Name

Title Phone ( )

Company

Address

City State Zip

**A. What is your level of management responsibility?**

1 ☐ Senior-level Management
2 ☐ Other Management
3 ☐ Non-Management

**B. What is your primary job function/principal area of responsibility? (Check one.)**

4 ☐ Administration
5 ☐ Accounting/Finance
6 ☐ MIS/DP/Information Center
7 ☐ Product Design and Development
8 ☐ Research and Development
9 ☐ Manufacturing
10 ☐ Sales/Marketing
11 ☐ Purchasing
12 ☐ Personnel
13 ☐ Education/Training
14 ☐ Other: ______

**C. Please indicate your organization's primary business activity: (Check one.)**

**Computer-Related Businesses:**

15 ☐ Manufacturer (Hardware, Software)
16 ☐ Computer Retail Stores
17 ☐ Consultants
18 ☐ Service Bureau/Planning
19 ☐ Distributor/Wholesaler
20 ☐ Systems House/Integrator/VAR
21 ☐ Other: ______

**Non-Computer-Related Businesses:**

22 ☐ Manufacturing
23 ☐ Finance, Insurance, Real Estate
24 ☐ Retail/Wholesale
25 ☐ Education
26 ☐ Government
27 ☐ Military
28 ☐ Professions (Law, Medicine, Engineering, Architecture)
29 ☐ Consulting
30 ☐ Other Business Services
31 ☐ Transportation, Communications, Utilities
32 ☐ Other: ______

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| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 |
| 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 |
| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 |
| 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 |
| 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 |
| 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 |
| 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 |
| 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 |
| 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 |
| 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 |
| 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 |
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| 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 |
| 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 |
| 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 |
| 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 |
| 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 |
| 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 |
| 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 |
| 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 |
| 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 |
| 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 |
| 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 |
| 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 |
| 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 | 926 | 927 | 928 | 929 | 930 |
| 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 |
| 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 |
| 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 | 1017 | 1018 | 1019 | 1020 |
| 1021 | 1022 | 1023 | 1024 | 1025 | 1026 | 1027 | 1028 | 1029 | 1030 | 1031 | 1032 | 1033 | 1034 | 1035 | 1036 | 1037 | 1038 | 1039 | 1040 | 1041 | 1042 | 1043 | 1044 | 1045 | 1046 | 1047 | 1048 | 1049 | 1050 |
| 1051 | 1052 | 1053 | 1054 | 1055 | 1056 | 1057 | 1058 | 1059 | 1060 | 1061 | 1062 | 1063 | 1064 | 1065 | 1066 | 1067 | 1068 | 1069 | 1070 | 1071 | 1072 | 1073 | 1074 | 1075 | 1076 | 1077 | 1078 | 1079 | 1080 |
| 1081 | 1082 | 1083 | 1084 | 1085 | 1086 | 1087 | 1088 | 1089 | 1090 | 1091 | 1092 | 1093 | 1094 | 1095 | 1096 | 1097 | 1098 | 1099 | 1100 | 1101 | 1102 | 1103 | 1104 | 1105 | 1106 | 1107 | 1108 | 1109 | 1110 |
| 1111 | 1112 | 1113 | 1114 | 1115 | 1116 | 1117 | 1118 | 1119 | 1120 | 1121 | 1122 | 1123 | 1124 | 1125 | 1126 | 1127 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1135 | 1136 | 1137 | 1138 | 1139 | 1140 |
| 1141 | 1142 | 1143 | 1144 | 1145 | 1146 | 1147 | 1148 | 1149 | 1150 | 1151 | 1152 | 1153 | 1154 | 1155 | 1156 | 1157 | 1158 | 1159 | 1160 | 1161 | 1162 | 1163 | 1164 | 1165 | 1166 | 1167 | 1168 | 1169 | 1170 |
| 1171 | 1172 | 1173 | 1174 | 1175 | 1176 | 1177 | 1178 | 1179 | 1180 | 1181 | 1182 | 1183 | 1184 | 1185 | 1186 | 1187 | 1188 | 1189 | 1190 | 1191 | 1192 | 1193 | 1194 | 1195 | 1196 | 1197 | 1198 | 1199 | 1200 |
| 1201 | 1202 | 1203 | 1204 | 1205 | 1206 | 1207 | 1208 | 1209 | 1210 | 1211 | 1212 | 1213 | 1214 | 1215 | 1216 | 1217 | 1218 | 1219 | 1220 | 1221 | 1222 | 1223 | 1224 | 1225 | 1226 | 1227 | 1228 | 1229 | 1230 |

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Company

Address

City State Zip

**A. What is your level of management responsibility?**
1 ☐ Senior-level Management
2 ☐ Other Management
3 ☐ Non-Management

**B. What is your primary job function/principal area of responsibility? (Check one.)**
4 ☐ Administration
5 ☐ Accounting/Finance
6 ☐ MIS/DP/Information Center
7 ☐ Product Design and Development
8 ☐ Research and Development
9 ☐ Manufacturing
10 ☐ Sales/Marketing
11 ☐ Purchasing
12 ☐ Personnel
13 ☐ Education/Training
14 ☐ Other: ________

**C. Please indicate your organization's primary business activity: (Check one.)**

**Computer-Related Businesses:**
15 ☐ Manufacturer (Hardware, Software)
16 ☐ Computer Retail Stores
17 ☐ Consultants
18 ☐ Service Bureau/Planning
19 ☐ Distributor/Wholesaler
20 ☐ Systems House/ Integrator/VAR
21 ☐ Other: ________

**Non-Computer-Related Businesses:**
22 ☐ Manufacturing
23 ☐ Finance, Insurance, Real Estate
24 ☐ Retail/Wholesale
25 ☐ Education
26 ☐ Government
27 ☐ Military
28 ☐ Professions (Law, Medicine, Engineering, Architecture)
29 ☐ Consulting
30 ☐ Other Business Services
31 ☐ Transportation, Communications, Utilities
32 ☐ Other: ________

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| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 |
| 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
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| 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 |
| 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 |
| 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 |
| 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 |
| 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 |
| 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 |
| 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 |
| 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 |
| 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 |
| 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 |
| 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 |
| 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 |
| 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 |
| 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 |
| 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 |
| 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 |
| 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 |
| 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 |
| 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 |
| 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 |
| 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 |
| 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 |
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| 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 |
| 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 |
| 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 | 1017 | 1018 | 1019 | 1020 |
| 1021 | 1022 | 1023 | 1024 | 1025 | 1026 | 1027 | 1028 | 1029 | 1030 | 1031 | 1032 | 1033 | 1034 | 1035 | 1036 | 1037 | 1038 | 1039 | 1040 | 1041 | 1042 | 1043 | 1044 | 1045 | 1046 | 1047 | 1048 | 1049 | 1050 |
| 1051 | 1052 | 1053 | 1054 | 1055 | 1056 | 1057 | 1058 | 1059 | 1060 | 1061 | 1062 | 1063 | 1064 | 1065 | 1066 | 1067 | 1068 | 1069 | 1070 | 1071 | 1072 | 1073 | 1074 | 1075 | 1076 | 1077 | 1078 | 1079 | 1080 |
| 1081 | 1082 | 1083 | 1084 | 1085 | 1086 | 1087 | 1088 | 1089 | 1090 | 1091 | 1092 | 1093 | 1094 | 1095 | 1096 | 1097 | 1098 | 1099 | 1100 | 1101 | 1102 | 1103 | 1104 | 1105 | 1106 | 1107 | 1108 | 1109 | 1110 |
| 1111 | 1112 | 1113 | 1114 | 1115 | 1116 | 1117 | 1118 | 1119 | 1120 | 1121 | 1122 | 1123 | 1124 | 1125 | 1126 | 1127 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1135 | 1136 | 1137 | 1138 | 1139 | 1140 |
| 1141 | 1142 | 1143 | 1144 | 1145 | 1146 | 1147 | 1148 | 1149 | 1150 | 1151 | 1152 | 1153 | 1154 | 1155 | 1156 | 1157 | 1158 | 1159 | 1160 | 1161 | 1162 | 1163 | 1164 | 1165 | 1166 | 1167 | 1168 | 1169 | 1170 |
| 1171 | 1172 | 1173 | 1174 | 1175 | 1176 | 1177 | 1178 | 1179 | 1180 | 1181 | 1182 | 1183 | 1184 | 1185 | 1186 | 1187 | 1188 | 1189 | 1190 | 1191 | 1192 | 1193 | 1194 | 1195 | 1196 | 1197 | 1198 | 1199 | 1200 |
| 1201 | 1202 | 1203 | 1204 | 1205 | 1206 | 1207 | 1208 | 1209 | 1210 | 1211 | 1212 | 1213 | 1214 | 1215 | 1216 | 1217 | 1218 | 1219 | 1220 | 1221 | 1222 | 1223 | 1224 | 1225 | 1226 | 1227 | 1228 | 1229 | 1230 |

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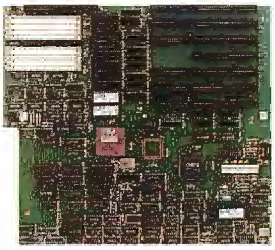

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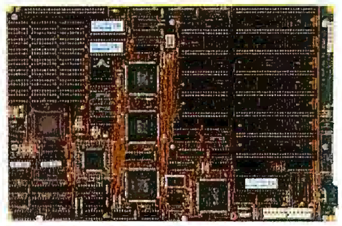

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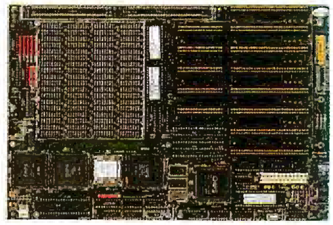

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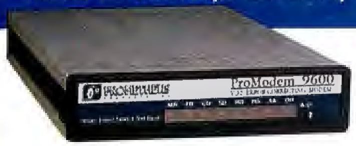


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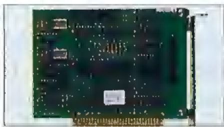

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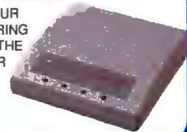

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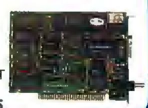

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# Chaos Manor Mail

*Jerry Pournelle answers questions about his column and related computer topics*

**Take WordPerfect...Please**

Dear Jerry,

I, too, have tried WordPerfect, both versions 4 and 5, and in the end I deleted them from my files. That bizarre control interface, non-mnemonic and nonintuitive, is too much. It is not so much feature-rich as it is feature-ridden.

I have witnessed this phenomenon: Some trustful rube shells out $200-plus for WordPerfect and proceeds to struggle for months. It is a contest of will, shaping the credulous innocent until he or she finally memorizes enough commands to make it all work. At this point he or she cannot go back, and becomes instead another WordPerfect booster. The free unlimited help line is a very necessary part of the package.

My first word processor was Better Working on the Commodore 64, and it was a good lesson on the limitations of that platform. Luckily, I had my introduction to PC word processing via the Leading Edge word processor. A program that borrowed the folder-and-drawer metaphor, it was very rational in its controls and allowed 30-character filenames. Alas, it was another orphan format and had a very limited subdirectory structure for hard disks. Designed as a floppy disk-based program, it was never upgraded. Later, I tried a couple of versions of Volkswriter that were OK, but, again, they had a peculiar system of keystrokes to maneuver through subdirectories. Like you, I have settled on Q&A for nearly all my writing chores.

If I had the paranoiac outlook of a Stephen King, I'd suspect a conspiracy by WordPerfect Corp. to brainwash and preprogram millions of proles for future use as slaves in some gigantic intergalactic data processing project—probably a census.

How many WordPerfect users continue to use it after trying other, more sensible systems, and how many are there who are afraid to try something new, lest they experience another agonizing period of frustration? They are suspicious of any new programs because they might be as obtuse and difficult to learn as WordPerfect.

I have a theory that our search for the perfect application is as inevitable and possibly endless as the search for the lost chord, enlightenment, or the infinite, all-knowing mind of God—something most of us don't discover until it's too late.

Bill Copenhaven
*Richmond, CA*

*I'm sure your theory is wrong! But it would make a good science fiction plot...*—Jerry

**String Handling in C**

Dear Jerry,

I am writing to you to address the issue of C's string-handling capabilities in the letter from Paul A. Elias (December 1989). It is a well-known fact that C's facilities for manipulating strings are less than convenient. Programmers have to know beforehand not only what strings they intend to use, but also how much memory each string will require at run time. This requirement makes it difficult for programmers to manipulate strings whose size and values can be determined only at run time.

What makes BASIC so appealing to some people is its built-in support for dynamic string manipulation; for example, the functions MID$, RIGHT$, and LEFT$ let the programmer dissect parts of a string at will. And in BASIC, all strings are created on demand. This is done simply by using a string variable. The C programmer could resort to dynamic memory allocations and therefore create the space needed for new strings, but this wouldn't be desirable, because the programmer would have to make sure that all memory allocated to strings that are not needed anymore is returned to the

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heap. BASIC has an advantage over C in that respect because it has a garbage collector. But there is a solution: C++.

C++ is a superset of C, so it retains 99 percent of the features of the programming language as defined by ANSI. Thus, in C++, the programmer could design and implement a string class that would provide all the expressiveness and power of BASIC, but with the speed and control of C. I developed my own string package using Zortech's C++ 2.0 compiler. It allowed me to use syntax like the following:

```
string s1 = "Hello"
string s2 = "Bob";
string s3 = s1 + s2;
  // s3 is the concatenation of s1
  // and s2, "Hello Bob"
string s3 = s3.mid(1,5)
  // s3 is set to "Hello"
string s4 = s1 + " " + s2;
  // demonstrates use of standard C
  // character string in expression
```

and so on.

A programmer could easily develop a "complex" data type for performing complex arithmetic. C++ has facilities for integrating user-defined types with existing data types in the language. As a result, a programmer could develop a complex number class that could, say, be added to integral expressions. For example,

```
complex x(1,5);
  // x = 1 + 5i
int i = 5;
complex sum = x + i;
  // sum = 1 + 5i + 5 == 6 + 5i
```

This type of expressive power is *not* possible in a language like BASIC. So, for those programmers who have a legitimate gripe about C's string-manipulation support, I believe that C++ is the answer.

Bruce W. Bigby
*West Somerville, MA*

*I'm fairly certain that if C++ had existed back when I was trying to learn C—that was a long time ago, with Leor Zolman's BDS C, which was the only thing that would run on old Ezekial the Z80—I might have learned it thoroughly and would be using it yet.*

*I suspect that at my age and state of activity I will not be learning C++, but you never know: There's pressure for me to learn Unix, and if I do that I'll have to know some C. For the nonce, QuickBASIC has all the string handling that I need built into the language, and I have not noticed that I need more speed and control in what I do, which isn't to say that others wouldn't.*—Jerry

## Pascal Placement

Dear Jerry,

In reference to your review of *Computer Science with Pascal for Advanced Placement Students* in Computing at Chaos Manor (February), I don't think the Educational Testing Service cares anymore about UCSD Pascal. The people there may still claim that they want Standard Pascal, but the fact remains that I did just fine on the AP test last year without knowing a shred of UCSD Pascal.

Frederick Bertsch
*East Lansing, MI*

*Thanks; I hope you're correct, because UCSD Pascal is a bit passé, I fear.*
—Jerry ■

# PRINT QUEUE

Hugh Kenner

## Zen and the Art of Assembly

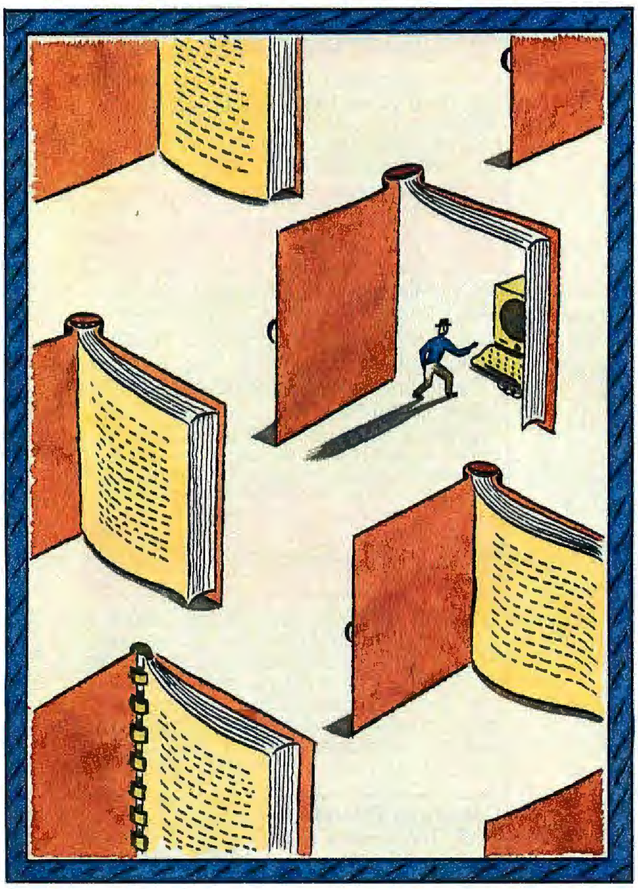
*A valuable series for those contemplating the way of assembly*

Generally I find better things to do in this space than discuss those staples of the computer book industry, its endless instruction manuals. (Every publisher needs an assembly book on its list; they are mostly the same book, rewritten.) But this month I make an exception to announce a conceptual breakthrough. I hope the industry is watching; there are implications for other sorts of books as well.

Start from an observation. Arguably the worst assembly program ever published lurks partway through Borland's *Turbo Assembler User's Guide*, a clearly written book designed to teach beginners the elements of what they covet assembly for—writing programs that are "small and blindingly fast." The program is `WCount.EXE`, a compact little package for counting words in a text file. Small, yes: 676 bytes. But "blindingly fast"? Counting through the 2000-word file that I tried it on took it—hold on!—35 seconds! The commercial word counter I'd been using zipped through the same file in 4 seconds. And a program called BWC, for BIX Word Counter (courtesy of BIXen Terje Mathisen), took under 1 second!

My howls about `WCount` drew an instructive response from someone at Borland. It's naive, he said, to expect optimal quality from something the purpose of which is only to demonstrate a structure and the use of some directives. To which I'd respond, I don't ask for optimal quality, but at the least for minimal quality.

In his foreword to the Scott, Foresman Assembly Language Programming Series, of which he is general editor, Jeff Duntemann fingers the theme `WCount` illustrates so ludicrously: "the difference between assembly language programs that work and assembly language programs that work *well*." For assembly is a lot of bother, with little point if the result is no better than C or Pascal. (And as we've just been seeing, it can even be abysmally worse.) He goes on: "I have yet to see any assembly language book make this point, much less dwell on it."



Right. And dwelling on it means getting rid of the notion that assembly is what most books make it out to be, a set of mnemonics tied to a microprocessor. Making it work *well* entails "knowledge of the machine, the individual instructions, and the relationships among instructions that transcend all three." Yes, "The subject deserves better than it has gotten at the hands of the computer book industry."

Thus, one assumption behind Duntemann's Scott, Foresman series is that good assembly code is machine-specific; they're talking about the AT and compatibles, not just the 80x86 chips. (If you're vague about things like the PC's screen I/O, you'll probably be wondering where a lot of instruction cycles went.) Another assumption is that details are "an interconnected web," so that serial discussion of any topic without "forward references" to more advanced topics is well nigh impossible. "This means that the same broad set of topics must be taught in each book, but that the level of detail be gradually increased in moving from beginner to expert." Amen. So even if you Know Nearly All about assembly, start with Volume 1.

That volume is by Duntemann himself. He leads off with *Assembly Language from Square One* ($29.95) and assumes that you know how to run your PC, but assumes *nothing* about either programming or "what happens inside the box itself." So pretend that this is the case. Pretend too that assembly is your first stab at a language. It's easier, Duntemann alleges, than learning how to play the piano. Mistakes won't make the dog howl, and "what takes *years* of agony in front of a piano can be done in a couple of months in front of your average PC." In fact, "compared to raising an average American child from birth to five years, it's a cakewalk."



ILLUSTRATION: MICHAEL KLEIN © 1990

Turn the page, and a Scotts Valley housewife is planning a hectic morning. Her list ends, "Drop off groceries at home. If it's time, pick up Nicky. If it's not, collapse for a few minutes, then pick up Nicky. Collapse!" (You've spotted the IF conditionals. And in assembly language, "Collapse!" might be "END Start.")

By page 145 we're being told, "Programming involves two major components of the PC: the CPU and the memory. Most books begin by choosing one or the other and describing it. My own opinion is that you can't really describe memory and memory addressing without describing the CPU and you can't really describe the CPU without going into memory and memory addressing. So let's do both at once."

What follows is not only the sole fail-safe account of segments and offsets I've seen, it's also the most useful exposition of what the CPU registers do. We're next taught to consolidate this understanding by looking at the PC's video refresh buffer via DEBUG. And without being sure how it happened, we're suddenly in command of a field of topics, instead of clinging to whichever handle the usual book chooses to offer.

By page 200, the discussion of a program that works is telling us, "The stack segment contains the program's stack. I haven't explained stacks just yet, and...I'm going to hold off just a little while longer. In short, a stack is simply an ordered place to stash things for the short term, and that will have to do until we cover the concept in depth in Section 7.2." You see what was meant earlier by "forward reference"? It's a simple device straitjacketed manuals never seem to employ. There are things we need to be aware of before knowing all about them. Why have manual writers never discovered that?

But move on we must. Volumes 2, 3, and 4 are *Assembly Language Magic*, by William Murray III and Chris H. Pappas ($29.95), and a two-volume *Zen of Assembly Language* by Michael Abrash. (Part 2 of *Zen*, "The Flexible Mind," is promised for this year, but I've seen only the first part, "Knowledge," $29.95.) Further books in the series are promised but not yet specified.

*Assembly Language Magic* starts with a quick summary of themes already covered by Duntemann—things like hexadecimal numbers and using a debugger—but Murray and Pappas are soon offering much more detail about assemblers and linkers. Also, their unit of attention is the complete program, whereas Duntemann's tended to be the instruction or the memory fetch. They do a lot with lookup tables: real time savers, especially if you need such brutes as logarithms but have no 80x87 chip. They're alert to 386 special cases. By chapter 15, we're getting characters, strings, and numbers in and out of programs, something most texts I've seen scamp utterly.

*Zen*, finally. The point of the Abrash *Zen* (yes, his name and title do bracket the alphabet) is that the PC abounds in "cycle stealers" that are so interwoven that only hunches can save you. (There's an art to hunches; you can pick it up.) He starts with an example of a horrible program: a published "Optimizing for Speed" article that used all information available, saved cycles by the bushel, and (as its author never noticed) ran more slowly than the naive version it was trying to improve. Moral? The available information was "accurate but incomplete": a general truth.

So Abrash gives us, straight off, code for a Zen timer that's right to about a microsecond and could have spared Mr. Optimizing for Speed all that egg on his face. One Abrash theme is, "Assume nothing." Clock it with the Zen timer. Not that Intel is lying when we're told that the SHR instruction takes just two clock cycles; no, but fetching those instructions each time they're used can take four cycles per fetch. Thus, `shr ax,1` repeated five times can use not a mere 10 cycles (two per SHR) but up to 40, depending on the state of the prefetch queue when we start. Yes, as Duntemann said, "an interconnected web." Zen is the art of swinging through such webs: "We fit you" versus "We give you fits."

I'll not wander into the labyrinths of Zen, but return instead to the state of instruction manuals. They derive, it seems, from a custom called "Documentation," which told an engineer how the previous engineer had left things. That assumed a fund of knowledge, inaccessible to innocents like me when we faced, years back, what was called "Documentation" for the CP/M operating system: chunks of verbiage, impenetrable in their presumption of knowledge we didn't have.

*What follows is not only the sole fail-safe account of segments and offsets I've seen, it's also the most useful exposition of what the CPU registers do.*

For no reason we understood, the system was broken into topics, each dealt with (exhaustively) once and then discarded. And "exhaustively," in isolation, was apt to mean "unintelligibly." "Prayer and fasting," as Doug Cooper used to intone over something akin, the International Standards Organization's version of Pascal. Item by item, you would not make hide nor hair of it.

A bad tradition has persisted, and at Borland, where they write superb assembly code—witness Turbo Pascal and Turbo C and Turbo Assembler—they still issue a thick manual to "document" the 80x86 instruction set and think they're teaching us assembly. Isolated instructions, that's all, for congealing into a clunker like `WCount`.

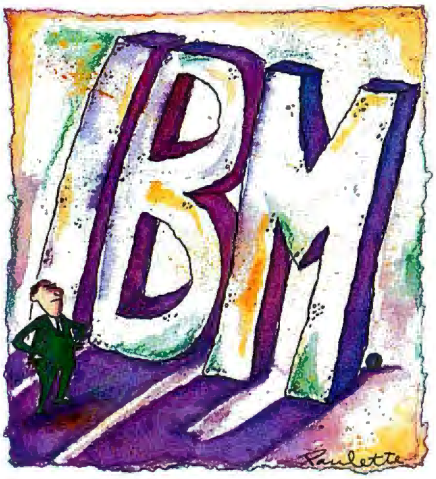
Although they understand quality well at Borland, it's beyond the reach of such fragmented presentation, the way of which holds their suave writers fast by the neck. Zen—which "teaches nothing," merely "points the way"—Zen in Scotts Valley is unthinkable.

That's my 1600 words for this month. `WCount` (invoked for olde tymes' sake) has just taken 27 seconds to tell me so. BWC verified that in less than a second. But BWC is inward with Zen. ■

---

*Hugh Kenner is a professor of English at Johns Hopkins University. His reviews have appeared in publications like the* New York Times *and* Harper's. *His recent books include* A Sinking Island *and* Mazes. *He can be contacted on BIX as "hkenner."*

*Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*



STOP BIT ■ Joel S. Moskowitz

# QUEST FOR A MOUSEBALL

## All I wanted was a small gray ball, quantity one

Something should have clicked in my mind when I saw my children bouncing a small gray ball as they ran to the car. Only later did I see my IBM mouse on the floor, its bottom off and its ball . . . gone to the mall!

When my children returned, I stood with one hand open to retrieve the mouseball and the other with a finger in scolding position. "All right," I said sternly, "where's my mouseball?" It isn't easy to sound stern while demanding a mouseball.

"Your what?" each child repeated blankly.

"The small gray ball you swiped from my den and bounced out the door!"

One child turned to the other: "It's your fault. You bounced it in the store, and now it's gone!"

"Gone?" I sputtered. "Where?"

"Under some racks of clothes," my wife explained patiently, wondering why a grown man would get so upset over a little rubber ball.

I didn't know it then, but I had just been drafted into the ranks of consumer crusaders like Ralph Nader. Of course, Nader is out to save the planet. I just wanted my mouseball.

I called a computer store and ordered a new mouseball. Three days later, the manager called back and told me that I'd have to call IBM directly. "I can only order parts that have a number in my order book," he said. "I have a part number for the mouse, but I can't get a number for the mouseball. But I'm sure IBM will have one for you."

The next day, I called IBM customer service. I work right next to IBM's headquarters, so I thought I could walk over and pick up a mouseball. Wrong.

"I'm sorry," the customer service rep cooed with practiced sympathy. "IBM has no part number for the mouseball, and cannot order one for you."

"Wait a minute," I replied. "This mouse says 'IBM' on it. IBM manufactures this mouse. Somewhere, IBM has barrels of mouseballs. Of course IBM is *able* to get me a mouseball. What you're telling me is that IBM *won't* get me one."

"No, sir," the customer service rep replied, an edge creeping into her voice. "What I said is that no number has been assigned, so the part cannot be ordered."

"But IBM assigns these numbers," I insisted. "And if only a mouseball with a number can be ordered, then IBM can just assign a number or make an exception to the rule."

"I'm sorry. There's nothing I can do."

"Of course there is. You can switch me to your supervisor."

This turned out to be a bad idea. The supervisor had evidently been pulled away from sticking pins in voodoo dolls, and she was in no mood to be pleasant.

"I hope you understand," she said. "The part has no number. It cannot be ordered. Why don't you just buy another mouse? It's only $100 or so."

Yes, I said to myself, I suppose that I will have to buy another mouse. But it sure won't be an IBM mouse.

That evening, still brooding, I curled up with the latest issue of BYTE and looked through the ads for clone mice. And there it was: a full-page ad with a picture of an IBM mouse, disassembled into parts scattered all over the page. "An IBM Mouse," the ad read, "has 55 moving parts. And if any of them break, you're out of luck." The ad was for an electronic mouse, with no moving parts. It was not made out of rubber, and it was not round, so it could not be bounced out the door. But it *was* pretty expensive.

Just then, I got a wicked idea. What if I wrote to the clone mouse company and offered my story in return for a mouse? That would certainly prove their point about moving parts, and I would get a mouse (and get even with IBM to boot!).

Then I got an even better idea. Why not call IBM first and announce that I was going over to the enemy camp? That would give me two chances to solve my problem.

The next day, I called the corporate offices of IBM and spoke to a man who seemed to be a mid-level executive. I told my story and ended with the theatrical threat. "I see," he said. "I'll get back to you." A few minutes later, the phone rang. It was IBM. "We'll give you a *new* mouse," the executive said somberly. "I will meet you in the lobby of your building, so that this problem may be concluded."

In the lobby, he looked at me without expression. He handed me a small gray box containing a small gray mouse, which in turn contained a small, gray, numberless mouseball.

"You must understand," he said. "We are doing this one time. We will not do this again."

I thought for a moment and said, "I cannot imagine that all this could happen ever, ever again."

And, indeed, the bottom of my new mouse has four screws, designed to keep its mouseball from making solo trips to the mall. And though I never made it big in clone mouse advertisements, I'll be able to remember the day I looked IBM squarely in the eye. And it blinked. ■

*Stop Bit is an open forum for informed opinion on topics related to personal computing. The opinions expressed are those of the author and not necessarily those of BYTE or its staff. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

*Joel S. Moskowitz is an environmental lawyer with Gibson, Dunn & Crutcher in Los Angeles. He can be reached on BIX c/o "editors."*

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